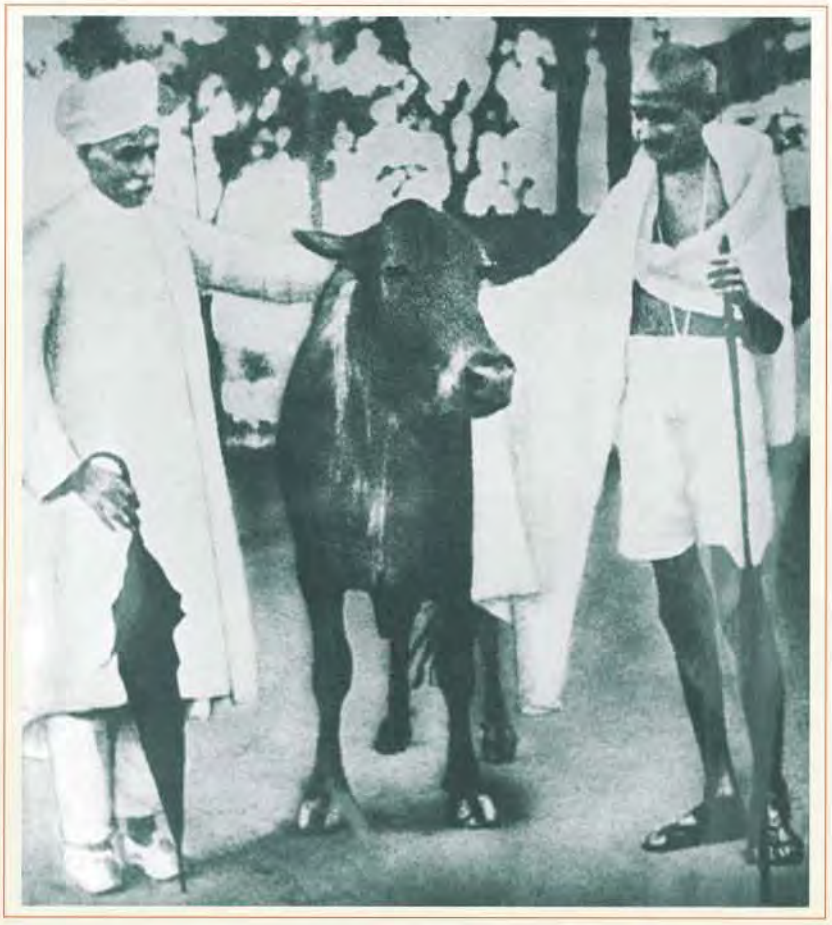
Livestock Technologies

way to diversified agriculture

Animal Science Division
Indian Council of Agricultural Research
Krishi Bhawan, New Delhi-110 001



The Cherished Reminiscence from the Mist of History:
Rastrapita Mahatma Gandhi & Pandit Madan Mohan Malviya at SRS NDRI, Bangalore in 1927

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way to diversified agriculture

भाकृअनुप
ICAR

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कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद
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Foreword

Our livestock diversity accords a cogent contribution to the national exchequer to weave rich wealth for multifaceted development of rural India. The troika of 'animal husbandry, dairying and fisheries' has been pivotal in building tapestry for income generation and social transformation midst the weaker economic and nutritional spectrum of society. Significantly, it has provided livelihood support and empowered women. It has accelerated a 'paradigm shift' through vital alterations in sustainable geo-topography, social integration and assured consumer market economy. The binary global metamorphosis of 'barrier-free' trade and 'climate-change' has redefined the importance of livestock farming systems. This 'win-win' situation summons synchronization of 'cutting edge' research technologies in assisted livestock improvement through breeding, feeding, management and health care. The product delivery conduit challenges on value addition, processing and effective door-step delivery from 'barn to basket' under stringent quality norms.

The Animal Science Division of the ICAR orchestrates research modules of eighteen establishments mandated on various missions for 'need based' criteria of emerging challenges that focuses on livestock and poultry sectors. It drafts and augments assured fortifications to equip the country for contingencies and sustainability to equilibrate global postulates. The genre of 'Animal Science Division' has excelled in objective deliverance in myriad frontiers through trained manpower and 'state of the art' resources to achieve the ICAR initiative on 'Farmer First'.

This compilation is an archive on salient edicts, technologies formulated, products generated, elite germplasm conserved and sequential dissemination to the stake holder.

This information charter, re-affirm my convictions for its indispensability to policy planners, entrepreneurs, researchers, veterinarians and extension personnel.

I compliment the Animal Science Division and the team of Directors for bringing out such a useful document.

(S. Ayyappan)

Dated: July 8, 2012
New Delhi

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उपमहानिदेशक (पशु विज्ञान)
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Prologue

India has the pride of being endowed with the world's widest diversity of livestock distributed over 100 million households fanned across 6, 00,000 villages. The livestock census (2007) registers strength of 529.7 million livestock and 648 million poultry, almost close to the human population of 1.2 billion with global credits of 'number one' in bovines, second and third in caprine and ovine domains, respectively.

National Livestock Scenario

Livestock sector is a prime component of India's agrarian economy providing food and nutritional security and livelihood. Its ownership is highly egalitarian, with proven growth-accentuating and poverty-alleviation helping the marginal and small farmers. This paradigm of national livestock sector is proliferating vis-à-vis complying with the global dynamism of ushering the socio-economic, environmental and technological forces. The national livestock treasure includes 199.1 million cattle, 105.3 million buffaloes, 71.5 million sheep, 140.5 million goats, 11.3 million pigs, 0.26 million mithuns, 0.08 million yaks. India is the world leader with the current milk production of 112.5 million tonnes (2009-2010), contributing about 5.3 per cent to India's agricultural GDP, fuelling the growth engine of this sector. Further, sheep, goats, pigs, and buffaloes contribute to meat production. The vibrancy of poultry industry is evident from annual production of about 55 billion eggs and 2.3 million tonnes of chicken meat. The country prides 0.52 million versatile camels, boosting commercial tourism besides draft and milk. The contribution of livestock sector was Rs. 1702 billion with an overall contribution of 3.26 % to National GDP and over 27% to the agricultural GDP (2009-10), with upwards acceleration in future. It is imperative that national livestock looks beyond the food security to draught power, manure and fuel.

Since time immemorial, India has fostered a tradition of keeping milch animals as part of the farming household. Buffalo and cow and, to a limited extent, goat are the main milch animals in the Indian subcontinent. With an annual production of 108 million tons of milk, 65 per cent of

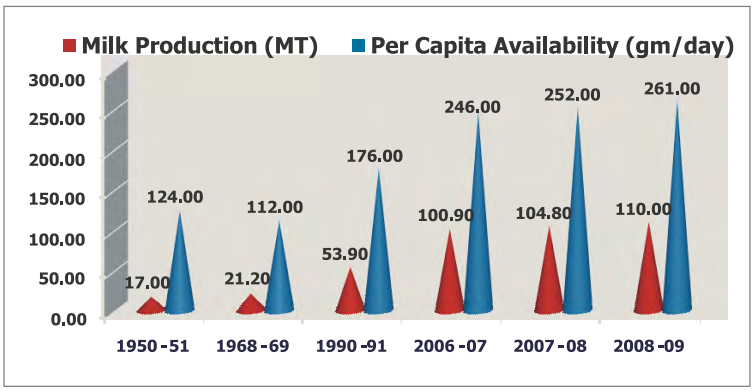
which is produced by buffaloes, and a national herd of 113 million head of cattle/ buffaloes, India is the world's largest milk-producing country. Some 75 million dairy farming households, with an average of 1.5 adult female cows or buffaloes per farm, are engaged in the sector each producing about 4 litres of milk per farm/day (2010-11). The contribution of goat in milk production is 3 per cent to India's total milk output. The milk produced by camel, yak, sheep and mithun is also used as raw or value added products in their respective breeding tracts. Yak is the only source of milk above Himalayan snowline. Indigenous breeds of cattle like Gir, Rathi, Kankrej and Tharparkar have potential to produce about 2500 liters milk per lactation. Following independence, though elite milch breeding tracts of Sahiwal and Red Sindhi were geographically lost, India preserves high valued germplasm with select farmers and NGOs.

Greater emphasis is given to harvest the great genetic variation in the milk yield for the improvement of dairy characteristics using appropriate breeding strategies. The coverage of regular health care, feeding and management, insurance schemes, technical advice and marketing expertise must percolate to the grassroots through extension agencies of the various governmental and social agencies to affect a paradigm to realise the per capita 'quality' milk to every Indian as per WHO standards.

The livestock sector has inherent limitations due to low production, poor reproductive potential, limited feed and fodder resources, inadequate health cover and unbridled strength of numbers-collectively leading to meager productivity on reckoning standards. This scroll cascades comprehensive annals about the ICAR research institutes in animal sciences, strengths in terms of facilities and capabilities, improved germplasm developed over the years, technologies and methodologies developed and transformed for adoption. It visualizes feedbacks of these proven technology conduits on replication and upscaling for the varied spectrum of stakeholders.

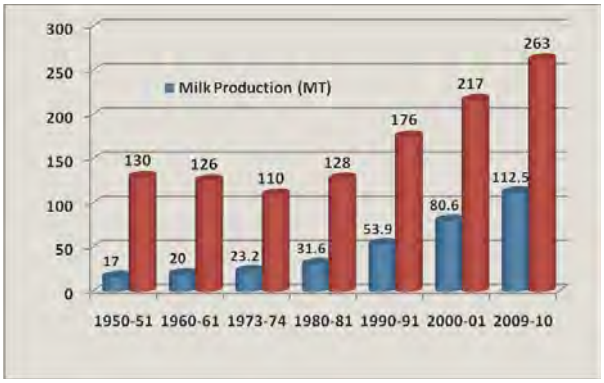
Dairy Sector

Dairying in India glimpses a monumental success saga of effective synchronized endeavour of Government programmes, developmental agencies and milk producer unions after independence. Milk production in India increased from 17 million tons in 1950-51 to 112.2 million tons in 2010-11. India has rapidly positioned itself as the world's largest producer of milk. The per capita availability of milk, which declined during the 1950s and 1960s (from 124 gm per day in 1950--51 to 121 gm in 1973-74) expanded substantially during the 1980s



Animal Production Trends-Impact of Research

and 1990s and reached about 226 gm per day in 2001-02, which is now around 263 gm per day against the world average of 285 gm per day. This has been achieved through concerted efforts of dairy cooperatives and the technology backstopping by the NARS. The spurt in milk production due to R & D efforts could very well be visualized over the years.



The growth trends in milk production and per capita availability in last sixty years

This 'giant leap forward' was realized through an increase in lactating bovine population by triumvirate co-ordination of improved livestock management practices, health cover, nutritional and physiological interventions. Elite germplasm in the form of crossbred cattle like Karan Swiss, Karan Fries, and Freiswal cattle have been produced by ICAR. The improved indigenous cattle herds of Sahiwal, Tharparkar, Gir, Kankrej, Ongole breeds have been established through AICRP projects. Similarly, the progeny testing programme in buffalo has helped in establishing Murrah and other breeds across the country through net work projects. The potential of marketable indigenous traditional milk based confectionery and sweets is to the tune of around Rs.12, 000 crores through technologies developed for converting milk in to value added products.

However, a comprehensive strategy is required for improving the milk production and productivity of livestock by genetic improvement, better health inputs and adequate nutritional interventions to produce quality and safe dairy products to meet the global standards. Adaptable and cost-effective technologies have to be generated for making export oriented and value added milk products, addressing the unorganized sector, where the standardized brands are non-existent.

Cost effective technologies in nutrition and health care management, reproductive technologies, value added products, livestock improvement programmes have together made this sector sustainable in spite of several challenges.

Small Ruminants

Small ruminants play an important role in the rural economy, as they are primarily reared by resource poor and under-privileged rural population. The 71.6 million national ovine strength is showing an increase in growth. However, fine wool sheep is decreasing due to accelerated mutton demand. Coherently consistent emphasis is given for quality mutton production through intensive feeding and health control.

Aptly named –'the poor man's cow' goats are the primal species for dual produce of meat and milk in South and Southeast Asia. They are among the smallest domesticated ruminants and have served mankind longer than cattle or sheep. The world's dairy goat production has grown

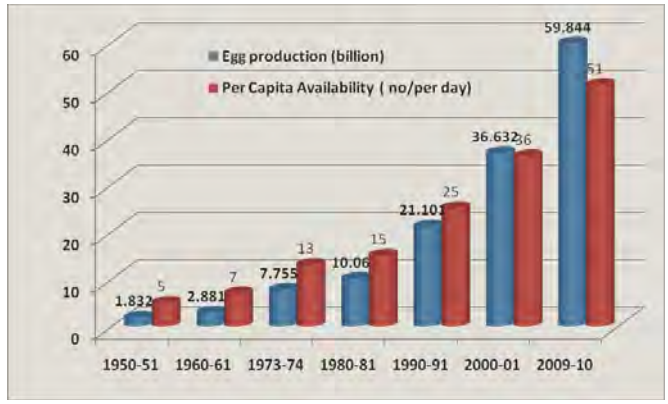
partly because of a trend toward increasing self sufficiency by people in many countries. A goat eats little, occupies a small area, and produces enough milk for the average unitary family, thriving in arid, semitropical, or mountainous eco-systems. The goat population is showing tremendous increase despite a large proportion of annual slaughter. The goat population has been estimated to be 140.54 million. There are excellent dairy goat breeds in India like Jamunapari, Jakhrana, Beetal, Surti and Mehsana. The Deccani, Malabari and Black Bengal contribute to chevon production. Technologies in improving productivity, quality meat production, value addition of products, resource based feeding modules and health management has provided lead for rapid growth of the sector.

Pig Farming

The pig farming is an important component of the north-eastern and southern peninsular regions especially amidst tribal communities. Despite, pork being a primary dietary protein source of these people, the local production is not able to meet the demand. It is met through import of pigs from other parts of the country. ICAR, through its institute at Guwahati, has enhanced pork production programme in a significant way and pig village concept has been popularized amongst local farmers. Through All India Coordinated Research Project on Pigs and Mega Seed Project, emphasis is given to recognize more indigenous pig breeds, selective breeding, improved AI practices and distribution of improved piglets to farmers and marketing avenues to develop and boost sustainable solutions to livelihood improvement.

Poultry Sector

India has the pride of place in the World Poultry History for its outstanding role in the evaluation of modern layer and broiler breeds based on the Red Indian Jungle Fowl and the *Aseel* otherwise known as Indian Game Bird. Poultry production for egg and meat is considered to have been more than 5,000 years old. The co-ordinated development of national poultry industry has witnessed a potential growth in the last 50 years. Presently, the poultry industry is firmly established, with worldwide recognition. There are about 60,000 full-scale poultry farms in India in urban and peri-urban regions and additionally a few lakh small poultry farms with holding of 50 to 1000 birds in rural areas. The Indian poultry industry engages more than 3 million farmers and 15 million agrarian farmers. Out of total global egg production, 3.6% is produced in India and the production cost of these eggs is lowest in the



The growth trends in egg production and per capita egg availability in last sixty years

world. The growth trends in egg production and per capita availability in last sixty years has shown a tremendous increase.

This Poultry Revolution ranked India as the fifth largest producer of eggs in the world. Over the entire planning era both egg and broiler production registered the highest growth rates consistently in the entire agricultural sector. Currently milk and eggs are the cheapest food items considering their nutritive value and are available at affordable prices. This has been possible due to emphatic research and development activities on poultry under public and private sectors. Under highly intensive poultry production egg yield of 350 or more egg/year/hen has been achieved while under semi intensive system, annual egg yield of 305 eggs has been achieved.

After achieving tremendous growth in poultry, to strengthen the genetic support to this activity the ICAR set up All-India Coordinated Research Projects one for Layers and another for broilers. The agricultural and veterinary universities also stepped up research efforts in the poultry sector. Consequent on these intensive efforts over two decades ago, several new strains of poultry had been developed by several centres which showed promise for use in rural areas in the unorganized sector to provide success for the rural poor. These are Giriraja, Vanaraja, Gramapriya and Nandanam to name a few. There are over a dozen different strains poised to be extremely popular in different locations. Of these Giriraja and Vanaraja are the two varieties, which transcended state boundaries conquering a major part of the country.

Regional Eco-belt Species

Yak *(Poephagus grunnins)* has a special place in the economy of people inhabiting areas with an altitude ranging from 2,500 to 5,000MSL. It is known for its ability to withstand low temperature, sure footedness and capability to thrive on coarse fodder at high altitude where no other large animals can survive. It is the only species which produces milk, meat, hair fibre and also provide transport in high altitudes. The milk yields of the yak vary between 1-2 kg per day, with positive aberrations from hybrids. Research on characterization of yak breeds, AI and other services to improve the yak production has helped the yak rearers in reaping rich benefits. . Value added yak products like *Churpi,* a wet soft cheese, and butter, both made from fermented milk, are the principal milk products that have been standardized.

The value of camel (*Camelus dromedarius*), as ship of desert has been realized long ago. These versatile arid-region animals well adapted with their unique metabolic pathways to survive sans food and water for many days. The usefulness of camel in terms of draft, milk and commercial tourism attraction has been explored. ICAR has been working on breed improvement, development of nutritional and health packages for camel farmers as well as value addition of camel milk and exploiting the nutraceutical value of camel milk.

Dwindling importance of equines are attributive to improvement in transport and communication. This has resulted in gradual decline over the years. Characterization of equine breeds, its utilization in producing high quality mules for working in difficult terrains, diseases and equine sport activities to make these popular amongst farmers and utilization in the present economic scenario has been given priority over the years by ICAR.

Livestock Health

The diseases affect animal productivity through reduced fertility, delayed maturity, decreased production of milk, eggs or wool and draught power. Prevention of infectious diseases by vaccination is the most beneficial intervention, due to its targeted activation of the animal immune system. Concurrently, disease diagnosis is equally important to efficiently apply the therapeutic strategies and contain the disease spread.

The credit of eradication of Rinderpest, a deadly disease of livestock, is an important milestone achieved by ICAR. Vaccines and diagnostics for various economically important diseases have been developed which has helped in faster diagnosis and cure. This has paved way for the control of major diseases like FMD, BT, HS, PPR etc. The excellent BSL 3+ facilities available at HSDAL, Bhopal has lead to quicker investigations of avian Influenza in poultry and check its large scale outbreak. For its meritorious work the lab has been awarded OIE recognition.

A livestock revolution is taking place in India. A fast-growing urban population, sustained income growth, a burgeoning middle class, increasing participation of women in work force, increasing availability of credit cards and availability of house hold food refrigeration facilities are fuelling rapid growth in demand for animal food products; and for meat and egg to be 16 million tonnes. To meet the expected demand, milk production has to increase by over 4 million tonnes a year and the meat and egg by 0.3 million tonnes a year.

Animal science research is capital- and skill intensive and has a longer gestation period to yield new work technologies. Hence, generation appropriate technologies will require considerable financial resources and quality human resource. Currently, the expenditure on agricultural research is only 0.5% of the agricultural gross domestic product, and livestock research shares 17% of the total expenditure on agricultural research, which is not in congruence with the contribution of livestock to agricultural gross domestic product, which is about 25%.

Animal Science Division

Animal Science Division of ICAR coordinates and monitors research activities in its 18 Research Institutes and their Regional Centers. The Division has two National Research Institutes with conferred Deemed University status, five Central Research Institutes one dedicated for conducting basic and fundamental research, one National Bureau, four Project Directorates and six National Research Centers. The Division coordinates seven All India Coordinated Research Projects and eight Network Research Programmes. In addition, four Outreach programmes and three mega seed projects (poultry, sheep and pig) are also being operated in different parts of the country at different ICAR institutes, State Agricultural / Veterinary Universities and Non-Governmental Organizations.

The institutes are having state of the art facilities like bio-safety and bio-containment laboratories, nuclear laboratories, semen evaluation and quality control, residue analysis, feed analysis / quality control, embryo transfer, animal cloning, stem cell research, reverse genetics, RNA interference, molecular diagnostics, nanotechnology, pathogenomics, comparative pathology,

molecular epidemiology, molecular genetics, rumen biotechnology, milk and milk product processing unit, meat and meat processing unit, wool analysis, blending dying and processing unit, model dairy plant, vaccine production unit, germplasm conservation unit, sera, semen, dairy rumen microbes and veterinary pathogens repositories / banks.

The main vision of the Division is to develop technologies to support production enhancement, profitability, competitiveness and sustainability of livestock and poultry sectors for food and nutritional security with the mission to facilitate need-based research in livestock and poultry sectors in on-going and emerging areas to support productivity enhancement, reducing the gap between potential and actual yield and to prepare the country to face the challenges of globalization and climate change.

An attempt has been made to present here some of the promising technologies developed by the animal science institutes in different facets of animal husbandry for adoption, up-scaling and wider use. The document is '**one stop shop**' where discovery is translated into technology and technology to application. Judicious use of technology by various stake holders would help in addressing to a greater extent the issues of livestock productivity, reproduction and sustainability in the globally competitive market in delivering quality and safe animal protein.

The material and support provided by the institutes in bringing out this publication is duly acknowledged.

Place: New Delhi
Date: July 9, 2012

(Prof. K.M.L. Pathak)

Contents

INDIAN VETERINARY RESEARCH INSTITUTE

Izatnagar, Uttar Pradesh

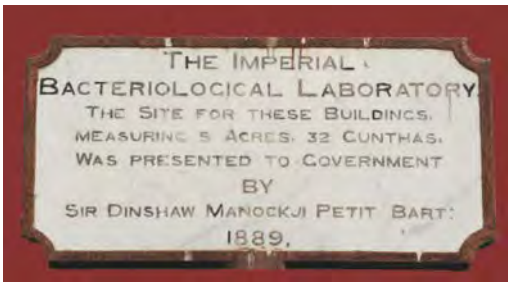
Year of Establishment: 1889

Regional Stations/Campuses **:** Mukteswar (1893)
Palampur (1959)
Eastern Regional Station, Kolkata (1970)
Southern Regional Station, Bangalore (1971)
Srinagar (1973-Functional till 1992)
HSADL, Bhopal (1998)

IVRI Campus, Izatnagar

The Indian Veterinary Research Institute (IVRI), originally known as Imperial Bacteriological Laboratory, had its genesis on December 9, 1889 at Pune. It was later relocated to Mukteswar in Kumaon Hills of Uttar Pradesh (now Uttarakhand) in 1893 to facilitate segregation and quarantine of highly contagious organisms. The Izatnagar Campus, came into existence in 1913 as the necessity for expansion was felt. In 1925, the former Imperial Bacteriological Laboratory was redesignated as Imperial Veterinary Research Institute. Biological Products Section was

established first followed by other sections. Animal Nutrition Division and the Poultry Research Division were established in the year 1936 and 1938, respectively. To deal with the fundamental problems connected with animal production, breeding and management, a core Animal Genetics Section was created in 1944. By the dawn of Independence in 1947, the institute had already served the Nation for full 57 years, and the name of institute was changed to Indian Veterinary Research Institute. The institute was conferred the Deemed to be University status in 1983 by University Grants Commission, Govt. of India.



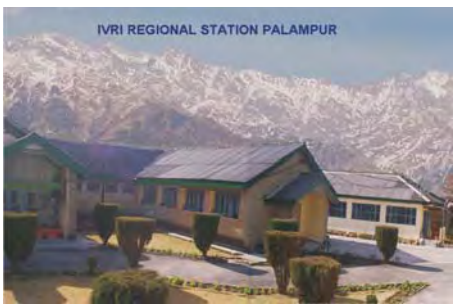
Plaque of Imperial Bacteriological laboratory


Historical visit of Robert Koch in 1897

A Centre for Wildlife Conservation Management and Disease Surveillance, and Krishi Vigyan Kendra were established in 1984 and 1986, respectively. Communication and Computer Centres were created in the year 1986 to provide the necessary support in teaching, training and research. The National Biotechnology Centre (now Division of Veterinary Biotechnology and Immunology), Agricultural Research Information System (ARIS) Cell and a Centre for Animal Disease Research and Diagnosis (CADRAD) were established in 1986.


IVRI Campus, Mukteswar

Regional Station at Palampur and Eastern Regional Station at Kolkata, were established in the years 1959 and 1970, respectively to cater to the needs in the respective regions.



IVRI Regional Station, Palampur


IVRI Regional Station, Kolkata

IVRI Campus, Bangalore

IVRI Station, Srinagar

Bangalore campus of IVRI came into existence in 1971 to cater the need of FMD vaccine production in the country. A P2 facility for FMD vaccine quality control was created in 2001 at Animal Experimental Station, Yelhanka at Bangalore Campus. A sheep lungworm vaccine production centre was established at Srinagar (J&K) in the year 1973.

A High Security Animal Disease Laboratory (HSADL) with biosafety level- 3+ containment facility at Bhopal was established in 1998 and dedicated to the nation in 2000. This laboratory achieved the distinction as an OIE approved Referral Laboratory for Highly Pathogenic Avian Influenza diagnosis in the year 2009, which is the seventh such referral lab in the world and the third in the whole of Asia after Japan and China.

High Security Animal Disease Laboratory, Bhopal

Technologies Developed

Vaccines

Anti-rinderpest serum

Use of anti-rinderpest serum was an important approach for the treatment of rinderpest infected animals. The first batch of anti-rinderpest serum was produced for use in the field in the year 1899. The requirement of anti-rinderpest serum for the entire country was met by IVRI.

Huge mortality caused by rinderpest

Rinderpest vaccine

Goat tissue vaccine (GTV) was developed for active immunization against the rinderpest in the year 1927. Production of lamb kidney cell culture vaccine was initiated later. This technology was passed on to all the state veterinary biological units of the country. The impact of rinderpest eradication since 1990 resulted in a massive increase in market access for buffalo meat in particular, as trading partners have accepted buffalo meat from rinderpest free country like India. The research on rinderpest at IVRI has led to eradication of the disease. For recognizing scientific contribution of the personnel and the organizations, a commemorative pillar was unveiled at IVRI Mukteswar on 2nd July 2012.

Commemorative pillar at Mukteswar

African horse sickness vaccine

African horse sickness is a highly infectious and deadly disease, which commonly affects horses, mules and donkeys. Using attenuated African horse sickness virus strains of the Onderstepoort Veterinary Research Laboratories, Pretoria, large scale vaccine production was started in 1961. The control and eradication of African horse sickness was accomplished through the use of appropriate diagnostics, vaccines and control strategies between the years 1960–1965.

Canine distemper vaccine

Canine distemper is a dreaded viral disease of young puppies. The canine distemper vaccine was developed and large scale production of the vaccine was carried out. Application of this vaccine in the target population significantly reduced mortality in young puppies.

Fowlpox vaccine

Fowlpox is characterized by proliferative lesions in the skin, which progress to upper gastro-intestinal and respiratory tracts leading to diphtheritic form of the disease. The vaccine against fowlpox was developed in the year 1950. The technology of vaccine production was transferred to the state veterinary biological units of the country for its production at large scale.

Peste des Petits Ruminants (PPR) vaccine

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. The mass scale use of PPR vaccine developed by IVRI resulted in reduction of >75% disease incidence (< 300 outbreaks as against 1200 outbreaks/annum) thus saving an annual loss of about Rs. 1200 million. The application of this vaccine has a very high impact on livelihood security of poor people, who depend on sheep and goat rearing. The technology has been transferred to four industries.

PPR Vaccine

PPR Infected Goat

Foot and mouth disease vaccine

Foot-and-mouth disease (FMD) is the most important infectious disease of Cattle and buffaloes causing an economic loss of Rs. 20000 crores /annum. FMD vaccine production technology in India was first implemented at IVRI, Bangalore campus in late 1970s. About 52 million doses of trivalent vaccine has been produced and supplied till date for FMD prophylaxis throughout the country. The vaccine produced by IVRI and other private manufacturers has contributed in reducing incidence of the disease. For example 180 outbreaks were recorded in 2010-11 as against 2962 outbreaks in 2005-06.The reduced incidence of the disease has ultimately impacted on livelihood security of poor people, who depend on these animals for milk and draught purposes.

FMD infected animal

FMD vaccine

FMD vaccine manufacturing at IVRI campus, Bengaluru

New Generation FMD Vaccine

With an objective of increasing the duration of immunity and thus to support the FMD control programme, new generation vaccines using potent vectors (eg., Adenovirus vector) as well as new generation adjuvants are being developed.

Goatpox vaccine

Goatpox is an economically important viral disease of goats. The vaccine developed against goatpox is vero cell based. The technology for production has been transferred to three industries for its large scale application. Mass immunization with this vaccine is expected to bring down the disease incidence. This will contribute to improved goat rearing.

Goatpox infected animal

Sheeppox vaccine

Sheep pox is similar to goatpox, affecting sheep population. The cell culture vaccine technology for sheeppox vaccine was perfected and large scale production was carried out to meet the farmers' demand. The technology was transferred to the state veterinary biological units for upscaling. This vaccine has contributed immensely to control the disease.

Sheeppox infected animal

Swine fever vaccine

Swine fever is a highly infectious viral disease of swine manifested by septicaemia and generalized haemorrhage. Lapinized swine fever vaccine technology was developed and large scale production of vaccine is being done. The vaccine application boosted pig husbandry, which is a source of livelihood in North-Eastern states. The newly developed cell culture based vaccine is easy to produce and cost effective in comparison to the existing lapinized vaccine.

A pig affected with swine fever

Swine fever vaccine

Rabies vaccine

Rabies is a highly fatal zoonotic viral disease of all warm blooded animals. To control rabies, vaccines such as 5% sheep brain vaccine for post-bite immunization, live Flury-strain vaccine for prophylactic immunization of the dogs and rabies cell culture vaccines were developed. The large scale, good quality product rabies vaccine was produced to meet out the national demand until commercial houses took up the production. The prophylactic immunization and post-bite immunization resulted in the control of rabies.

Rabies affected dog

Ranikhet disease vaccine

Birds affected with Ranikhet disease

Ranikhet disease is a contagious viral disease of poultry and wild birds characterized by gastro-intestinal, respiratory and nervous signs. IVRI developed technology of Ranikhet 'F' strain and 'M' strain vaccines suitable for immunization in two different age groups of poultry. The application of the vaccine against this dreaded disease reduced the incidence of the disease and contributed tremendously to develop poultry industry. This has created livelihood and nutritional security to millions of people.

Black Quarter (BQ) vaccine

BQ affected cattle

Black Quarter is a soil borne acute infectious and highly fatal, bacterial disease of cattle, buffaloes, sheep and goats. BQ vaccine was developed from indigenous strains of *Clostridium chouvei* and its large scale production was done. The technology of vaccine production was transferred to the state veterinary biological units of the country for large scale production and application in the field. This reduced the incidence of BQ significantly.

Contagious caprine pleuropneumonia (CCPP) vaccine

Contagious caprine pleuropneumonia is a fatal disease of goats caused by Mycoplasma. The killed vaccine against this disease was introduced in the year 1971 and large scale production was initiated. The vaccine production was discontinued after no incidence of the disease was reported.

Brucella strain 19 vaccine

Brucella vaccine

Brucellosis is a zoonotic disease causing high economic loss in livestock population. IVRI has adopted and perfected the vaccine technology of live Brucella strain 19 vaccine. Large scale production of the vaccine is being done by the IVRI for decades. Application of the vaccine at large scale has reduced the incidence of abortion and thus helped to strengthen the rural economy of the country.

Haemorrhagic septicaemia (HS) vaccine

HS vaccine

The haemorrhagic septicaemia (HS) is a major disease of cattle and buffaloes occurring as catastrophic epizootics in several Asian and African countries. IVRI developed the HS alum precipitated and HS oil adjuvant vaccines. To control the disease, HS alum precipitated vaccine was transferred to the state

veterinary biological units. It is now being produced on a large scale by these units. HS oil adjuvant vaccine the best known vaccine in world. Use of these vaccines in the target population has reduced the incidence rate of the disease in cattle and buffaloes, and contributed to livelihood security of livestock owners by increasing the milk and meat production.

Anthrax vaccine

Anthrax is primarily a disease of domesticated and wild animals with zoonotic potential. The large scale production of vaccine was done by IVRI. The technology was transferred to the state veterinary biological units for large scale application in livestock.

Enterotoxaemia (ET) vaccine

Enterotoxaemia is one of the most important diseases as it causes death of sheep following feeding on carbohydrate rich diet. The technology of enterotoxaemia vaccine production was developed and perfected at IVRI. Further, an improved comprehensive antigenic formulation in the form of multi component clostridia vaccine was also developed and the vaccine technology transferred to the state biological units and to the commercial houses for large scale application.

ET vaccine

Diagnostics

Brucella diagnostics

The brucellosis in cattle and buffaloes is primarily caused by *Brucella abortus*; and has zoonotic potential. Serodiagnostic tools in the form of diagnostic antigens were standardized and technologies of Abortus Bang Ring (ABR), Rose Bengal Plate Test (RBPT) and SAT antigens were perfected. Large scale production and human resource development for up-scaling of these products at state veterinary biological units were done. The application of this innovation resulted in the reduction of incidence of brucellosis and abortions.

Brucella diagnostic antigen

Purified protein derivatives (PPDs) as diagnostics for Tuberculosis, Johne's disease and Glanders

The institute has developed PPDs namely Tuberculin, Johnin and Mallein. Use of these diagnostics, reduced the incidence of tuberculosis and Johne's disease as these antigens were widely used for testing animals throughout the country.

Glanders affected horse

Salmonella antigens and antisera

Salmonellosis is an important problem in several livestock species including poultry. IVRI developed various diagnostic antigens viz *Salmonella abortus equi* antigen, *Salmonella pullorum* plain and coloured antigen and various antisera like Salmonella 'O' sera and *Salmonella pullorum* sera. The use of these biologicals helped in developing the Pullorum free status in the country, which has resulted in increased poultry production. Diagnostic antigens were used to identify serologically positive birds for *Salmonella pullorum*.

Salmonella coloured antigen

Mycoplasma gallisepticum (S6) antigen

Chronic respiratory disease in chickens, turkeys, game birds, pigeons and other wild birds is caused by *Mycoplasma gallisepticum.* Rose bengal colored antigen was developed in the year 1972. Large scale production of this antigen was started for diagnosis of chronic respiratory disease of poultry. The antigen was widely used for serodiagnosis and segregation of infected birds.

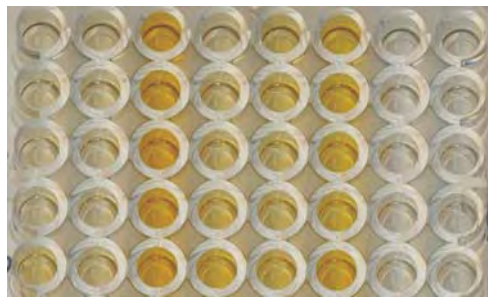
Monoclonal antibody based PPR ELISA kits

PPR is an important viral disease of sheep and goats. IVRI developed monoclonal antibody based competitive-ELISA and sandwich ELISA kits for PPR. Successful application of these kits provided baseline data on the actual prevalence/intensity of the disease in India. This helped to launch nationwide control programme for PPR.


PPR diagnostic kit

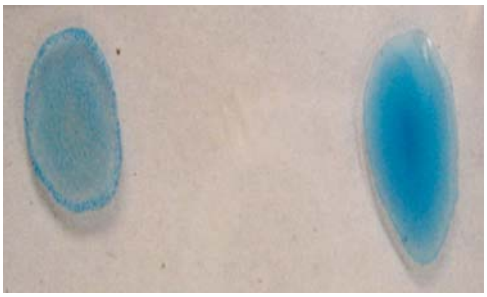
Recombinant antigen based Leptospira detection kit

Leptospirosis is an important zoonotic disease. The recombinant antigen based ELISA test detects leptospira infection effectively. It is a simple test suitable for field use, easy to scale up and cost effective.


ELISA for leptospira

Diagnostic kit for contagious caprine pleuropneumonia (CCPP)

CCPP is an economically important disease of goats. The diagnostic kit is based on slide agglutination test using coloured antigen prepared from *Mycoplasma mycoides* sub sp. capri and Rose Bengal dye as colouring agent. The kit is very simple to perform, quick and economically viable.



Agglutination test

Recombinant antigen based rapid immunoassay for sero-diagnosis of infectious bursal disease

Infectious bursal disease has been a constant problem for the commercial chicken industry. The latex agglutination test is a rapid immunoassay. This allows the user to rapidly interpret the immune status of the bird and the test can be performed at the door-step of the farmers. It is an useful assay for screening of birds for IBD antibodies.

Recombinant antigen based ELISA kit for the sero-diagnosis of newcastle disease

Newcastle/Ranikhet disease is responsible for huge economic losses in village poultry and the disease is highly contagious. The developed ELISA kit was found sensitive, specific and accurate for vaccine monitoring. The kit has a shelf life of at least 6 months at 4^0C. It is suitable for large scale screening of birds for NDV antibodies.

LAMP-based assay for detection of infectious bovine rhinotracheitis (IBR) virus in bovine semen

A Loop-mediated isothermal amplification (LAMP) test for the rapid detection of IBR virus in bovine semen was developed. The test has the sensitivity of 10 fg viral DNA or 0.2 $TCID_{50}$/ 0.4 infective virus particles per reaction. The whole assay can be completed within 90 minutes and the results can be visualized with naked eye by differentiating positive and negative visual colour development. The test can be carried out using a simple water bath/heat block which excludes the use of costly instruments like thermal cycler or real time PCR. This is a user friendly diagnostic procedure for field use.

Bluetongue antibody detection kit

Recombinant VP7 antigen-based indirect ELISA for detection of bluetongue virus antibody

Bluetongue is an economically important viral disease of sheep widely prevalent in the country. The test kit is meant for detection of bluetongue virus group-specific antibody in sera samples. The diagnostic sensitivity and specificity of the assay is 96% and 91%, respectively, which is at par with the

commercially available imported diagnostic kits. The cost of the assay is one third of imported kits. In the past five years this kit has been supplied to different centers (AINP-BT) for screening of more than 30,000 samples.

Herbal Formulations

Post milking teat dip for the prevention of bovine sub-clinical mastitis

Mastitis is a disease of economic significance in dairy animals affecting quantity and quality of milk produced. This polyherbal post milking teat dip, 'Mastidip' was found effective in cows and has the potential to reduce the antibiotic residues in the milk. This technology has become popular and the product is being sold to the end users.

Post milking teat dip

Olinall skin lotion

A herbal product has been developed with trade name of "OlinAll", which was commercialized to M/S Inovety's Pharmaceticals and marketed by the Wockhard Ltd., Mumbai. It is a skin ointment having antifungal, antibacterial, antipruritic, anti-inflammatory and anti-histaminic actions. This lotion is usefull in conditions like mange, dermatitis, pyoderma and ringe worm.

Olinall skin lotion

Herbo-mineral acaricide formulation

Herbo-mineral acaricide formulation has a potent acaricidal activity against tick infestation in livestock. There is very little chance of developing resistance. There is no residual effect on animal products, by-products, and no toxicity and health hazards to the host. It is a low cost and user friendly therapy.

Herbo-mineral acaricide formulation

Herbal formulation for treatment of mange in animals

The synthetic drugs available in the market have adverse effects. The developed herbal formulation is effective for the treatment of mange in different species of livestock, without any side effects.

Herbal preparation for mange

A formulation for treatment of diarrhoea in animals

A herbal formulation was developed for the treatment of non-specific diarrhoea in different species of livestock. The formulation would improve quality of health of livestock and reduce economic loss due to diarrhoea.

Herbal formulation for treatment of diarrhoea

Herbal formulation for treatment of haemonchosis in sheep and goats

The herbal formulation developed for the treatment of haemonchosis in sheep would improve the health an reduce economic losses due to haemonchosis, a common parasitic disease.

Herbal formulation for treatment of haemonchosis

Surgical techniques/devices

Epoxy-pin external skeletal fixation technique

The epoxy-pin fixation is a novel technique of fracture fixation, wherein the fixation pins are bend and joined using an epoxy material like M-Seal. This technique can be used to treat a variety of fractures

in different long bones in small animals like dogs, cats, goats, sheep, calves, foals and birds weighing at least up to 100 kg. The technique is very useful for the management of open contaminated fractures. The total cost of fixation is about one tenth of conventional fixation systems available in the market.

A calf with open fracture of metacarpus applied with epoxy fixator

Circular external skeletal fixation device for large animals

Management of long bone fractures in large animals is a great challenge to veterinary surgeons. The circular external fixator developed using aluminum or mild steel is economical and easily fabricated. It provides stable fixation with excellent mechanical properties, leading to early return to function of the affected limb. The service allows drainage and dressings of open-infected wounds associated with fractures. The device can be applied in compound, infected fractures of different long bones in large animals.

A calf with open fracture of radius treated with circular external fixation device

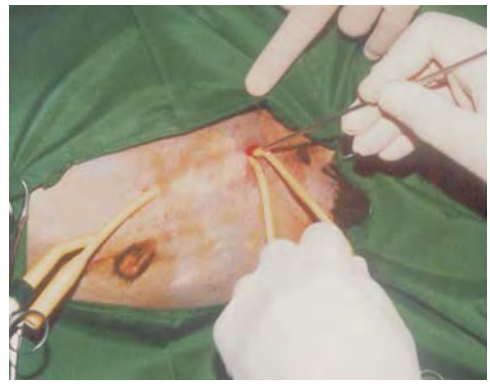
Bilateral linear fixation device

The fracture fixation device has opposite threading on both ends of the side bar to facilitate bone reduction and compression. It provides rigid fixation of fractures, allows full weight bearing on the limb immediately after fixation. The device has relatively few components, light in weight, less expensive, and can be easily and quickly attached to the bone fragments. It allows fixation of small bone fragments by transarticular fixation. The postoperative dressing of wounds and the care of fixation device is easy.

Fixator applied for radial fracture repair in a cattle

No scalpel tube cystostomy for surgical management of urolithiasis in goats

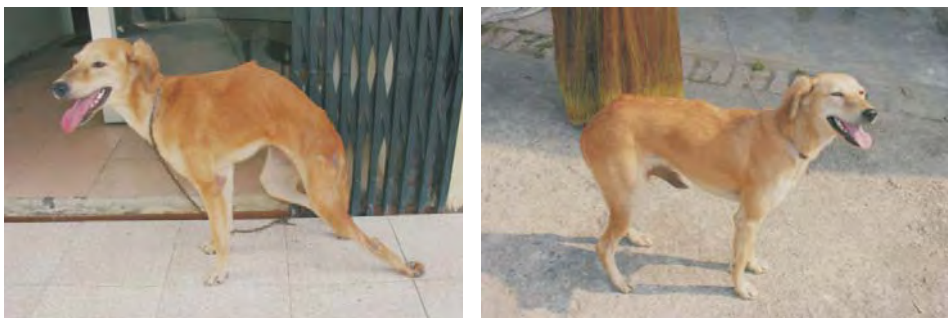
Obstructive urolithiasis in goats is a life threatening condition, unless treated immediately, leads to bladder rupture and even death of the animal. No-scalpel tube cystostomy, a minimally invasive technique, gives excellent results in >90% cases. The technique is economical, needs minimal postoperative care, and easily performed at the field level with minimal facilities.



Tube cystostomy technique

Acupuncture therapy for management of neuromuscular disorders in animals

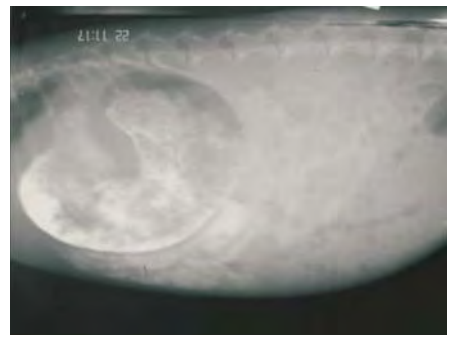
Hind quarter paresis and weakness are serious problems of domestic animals, especially in dogs. Acupuncture therapy has been shown to provide quick relief and recovery of animals with no side effects.



A dog with posterior paresis before and after treatment

Novel technique of epidural analgesia using ketamine and xylazine in ruminants

A novel combination of ketamine and xylazine was used for the first time for hind quarter analgesia in different species of animals. This combination provides excellent hind quarter analgesia with minimal ataxia and cardiopulmonary depression.



Gastrography using calcium carbonate

Alternate contrast radiography of urinary and gastrointestinal tracts

It was established that calcium carbonate (80%) and potassium iodide (15%) are effective alternate contrast agents to delineate stomach and large intestines,

and urinary tract, respectively, in animals. These agents are more economical and easily available as compared to conventional contrast agents.

Feed Technologies

Urea-molasses liquid feed (UMLD)

An uniform mixture of 2.5% urea dissolved in 2.5 litre water, 1% common salt in 94.6% sugarcane molasses. *Ad-libidum* feeding with wheat straw provides more than 50% digestible energy. The UMLD can be supplemented with an intact protein in the form of oil seed cake (250-300 g/head/d) and green fodder (2-3 kg/head/d). It supports 350-500 g average daily gain in body weight of crossbred cattle. It can be used as a life saving food during floods.

Urea-molasses impregnated straw

Bhusa and chaffed straw are impregnated with 1% urea and 10% molasses dissolved in 25-30 litres water. Solution of 1 kg urea and 10 kg molasses is prepared in 25-30 litres of water. 100 kg wheat bhusa is spread on a clean floor and urea molasses solution is sprayed with a garden hajara and mixed with the help of a rake. Lactating bovines and growing calves are fed 2 and 1 kg concentrate mixture, respectively for life saving during drought and flood or any other calamity.

Area specific mineral mixture for the livestock of Uttarakhand and Uttar Pradesh

In this formulation, the combination of minerals is provided in proportion to mineral deficiency in these states. It is cost effective formulation, fortified with vitamins and probiotics, and has no common salt. Its feeding improves production and reproduction performance in dairy animals.

Area specific mineral mixture

Urea molasses mineral block (Pashu Chocolate)

Urea molasses mineral block (UMMB) supplements the deficiencies of crop residues, straws and stovers, the staple feeds of bovines in larger part of India. The blocks are suitable during droughts and floods, and are cheaper than the conventional source of intact proteins (oil cakes). UMMB has a long shelf life on storage at a dry place.


Urea molasses mineral block

Compressed complete feed block (CCFB)

Suitable amount of complete feed mixture consisting of wheat straw, molasses, crushed maize, deoiled groundnut meal, mineral mixture, salt and vitablend fed into compaction chamber of the machine and compressed at 250 kg/cm^2 pressure to form CCFB. The CCFB containing partial roughage and wheat bran can meet the requirement of growth up to 400-500 g/day in buffaloes and can reduce transportation cost and scarcity of feeds in developing countries.

Compressed feed block

Technologies for feeding livestock in Himachal Pradesh

Oak (*Quercus leucotrichophora*) leaves, which form the major fodder in the upland areas of Himachal Pradesh, are injurious to cattle when fed alone due to the presence of high levels of tannins. The supplementation of wheat straw-based maintenance diet with mature oak leaves (straw:oak leaf as 55:45) in cattle results in increased animal productivity.

Oak leaves

Biul (*Grewia optiva*), bamboo (*Dendrocalamus hamiltonii*), khirk (*Celtis australis*), tooni (*Cedrela toona*) and kachnar (*Bauhinia variegata*) tree forages are suitable for incorporation up to 35% level in the whole concentrate diets of Angora rabbits for enhanced wool production. Rabbits for meat production can be raised economically on diets consisting of cereals and their byproducts supplemented with locally available tree leaves - biul (*G. optiva*), mulberry (*Morus alba*) and bamboo (*D. hamiltonii*).

Instruments and Devices

Crystoscope

Crystoscope is a field tool for determining optimum time for fertile insemination. It is based on observing the crystallization pattern of cervical mucus. It has been commercialized to four industrial houses. The device is being used extensively under field conditions.

Crystoscope

Multi-nutrients block making machine (pashu chocolater)

Pashu chocolater is a machine which can be used to prepare urea molasses mineral blocks very efficiently at farmers' door. The novelty of the design resides in its shape, configuration and easy operation.

Pashu Chocolater

Electric grass cutter

A very effective machine was developed for cutting of grasses. This machine is easy to handle and has less vibrations and therefore easy to operate. The maintenance of lawn is easy with reduced break down and drudgery of work as compared to other machines. The machine design is ready for commercialization. Several units of this machine have been manufactured and supplied to various agencies.

Electric grass cutter

Thresher cum treatment machine

This machine can be used simultaneously to thresh out grain from wheat crop as well as urea ammonia treatment of wheat straw. Using this machine, straw can be treated without involving any extra labour cost. Further, it can be used for uniform mixing of urea and other chemicals with crop residues, there by better quality of product can be produced. This treatment of straw reduces the chances of urea toxicity in ruminants.

Thresher cum treatment machine

Meat and Milk Products

Functional chicken nuggets

The ready-to-eat chicken meat product (with 6% dietary fibre) has 50% less common salt and 35% less fat than the traditional products. It has indigenous flavour, and refrigerated (4±1^{0}C) shelf life of 3 weeks and frozen (-18±1^{0}C) shelf life of 3 months. The consumption of these products may retard/prevent the chances of development of obesity, hypertension and will improve bowel movement. The incorporation of plant based extenders will decrease the production cost.

Functional chicken nuggets

Hurdle tech meat pickle

It is a tasty and nutritious food adjunct. The product is shelf stable at room temperature for more than four months and can be packed in PET or glass bottles. It is suitable for those consumers, who avoid use of excess salt and acidic products.

Hurdle tech meat pickle

Chicken meat chips

Chicken meat chips require low capital investment and easily adoptable by small and medium entrepreneurs. The product is highly nutritious as compared to the other available crisp products in the market. The product contains nearly 29% protein in comparison to protein empty potato chips. The product has a storage life of 4 months at ambient temperature under nitrogen packaging.

Chicken meat chips

Incorporation of vegetables in meat products

These are highly acceptable, tasty and nutritious. Emulsion based meat blocks, nuggets and patties are processed from mutton/goat meat/chicken/pork and buffalo meat along with seasonal vegetables. Partial substitution of costly meat with seasonal vegetables helps in reducing cost of production of meat products.

Vegetables incorporated meat products

Meat crackles

It is a value addition to abundantly available raw buffalo meat. It is a ready-to-eat puffy crisp snack and highly acceptable containing nearly 29% protein. The process requires low capital investment.

Meat crackles

Premium chicken soup

Premium chicken soup **c**an be prepared from leftover chicken frames after deboning in processed chicken meat factories. It is highly palatable, nutritious (3% protein) and contains low salt and only traces of fat and can be stored as a broth under refrigeration for one week.

Premium chicken soup

Designer pork sausages

It contains less calories and colesterol, and is stable for more than 35 days without any loss of sensory properties in vacuum packaging at refrigerated temperature. It is a product with tailored specifications and contains half the quantity of salt compared to usual 2% without any effect on palatability. The dietary fibre is more than 6% as compared to usual less than 1% in traditional sausages.

Designer pork sausages

Milk chips

The product has been developed from skimmed milk coagulum. It is very low in fat, nutritious and rich in milk protein (48%). The product is ready-to-fry and acceptable with shelf stability of three months at room temperature.

Milk chips

Milk nimki

Skimmed milk coagulum is used in its preparation. It is ready-to-eat and highly acceptable. The product is nutritious, with abundant protein (43%). It has a shelf life of three months at room temperature.

Milk nimki

Indigenous garbage processing earthworm strain "Jai Gopal"

A new Indian earthworm species "Jai Gopal" (*Perionyx ceylanesis)* was developed through selection and mating plan, which is better than exotic earthworm *Eisenea foetida, Eudrilus eugeneae* in characters of fecundity, heat tolerance and feeding of animal and farm waste. It is rich in protein with superior quality of vermicast and nutriwash and has heat and cold tolerance ability (0 to 44^0C) with the smallest interval from hatching to maturity with long life span.

'Jai Gopal' earthworms and Cocoons

Services being provided to different stakeholders

The Centre for Animal Disease Research and Diagnosis (CADRAD) established in 1986, extends diagnosis of animal diseases across the country. The centre is also recognized as the Central Disease Diagnostic Laboratory by the Department of Animal Husbandry Dairying and Fisheries, Ministry of Agriculture, Govt. of India. It is extending diagnosis by performing tests as prescribed by OIE.

An elephant is being treated

Centre for Wildlife provides diagnostic, therapeutic and consultancy services for captive and free range wildlife as a National Referral Center on wildlife health care. It prepares standards, guidelines and protocols on disease diagnosis and cure of wild animals in Indian zoos.

Referral Veterinary Polyclinic provides clinical diagnosis, treatment and preventive services for diseases of livestock as well as companion animals, and extends consultancy services for disease management. Services provided by polyclinic are general health check-up, critical care and management of internal disorders, management of reproductive disorders, general and specialized surgery, obstetrical surgery, acupuncture and physiotherapy. Diagnostic facilities such as ultra-sonography, electrocardiography, endoscopy, laparoscopy, X-Ray, image intensifier and clinical pathology are also available.

Indian Veterinary Research Institute also provides investigation/diagnostic support to the medical authorities during the outbreaks of zoonotic diseases like rabies, Japanese encephalitis, leptospirosis, dengue etc. The institute's National Referral Lab sponsored by APEDA, helps in monitoring of veterinary drugs and pesticide residues in foods.

Agricultural Technology Information Centre (ATIC) acts as a 'single window' support system linking the various divisions/units with the farmers. Intellectual property and technology management is taken care by Institute Technology Management Unit. Fostering entrepreneurial spirit among scientists, farmers, grass root innovators and start-up companies is done by Zonal Technology Management & Business Planning Development Unit of IVRI.

ATIC Building

Krishi Vigyan Kendra of IVRI is serving as resource and knowledge centre in the country in various fields, especially in livestock development. It is playing an important role both for technology transfer and generating the feedback for research. Entrepreneurship development programmes, group dynamics, drudgery reduction programmes and motivational trainings are being provided focusing group approaches.

Trainees at KVK

Bengaluru Campus of IVRI provides technical backstopping to DADF, GOI for having an effective FMD vaccine quality control mechanism for the country and the SAARC region. At this campus, all the required infrastructure and expertise in this area is available and the work on testing of the vaccine sent by DADF is undertaken.

Eastern Regional Station Kolkata caters to the needs of livestock health and production services of Eastern and North Eastern states of the country. It is mainly involved in the activities related to veterinary public health and extension activities.

Regional Station at Palampur looks after the nutritional aspects of livestock in the temperate hill region and conducts extension services for better livestock health and production.

High Security Animal Disease Laboratory Bhopal, Madhya Pradesh

(*OIE Reference Laboratory for Avian Influenza*)

The High Security Animal Disease Laboratory (HSADL) is country's premier facility for handling exotic and emerging pathogens of animals by virtue of its **bio-safety level-III containment laboratory and animal experimentation facility**.

Over last 12 years, HSADL has contributed significantly by controlling many animal diseases of exotic origin from entering our country including the deadly avian influenza virus (AIV) popularly known as bird flu in poultry. So far, HSADL has proved the existence of low pathogenic (LPAI) and highly pathogenic avian influenza (HPAI), Bovine viral diarhoea (BVD), Malignant Catarrhal Fever (MCF), Porcine Reproductive & Respiratory Syndrome (PRRS), Porcine parvovirus (PPV) and porcine circovirus (PCV) in India.

Entry of the following diseases into the country has been efficiently prevented after prompt laboratory confirmation at HSADL:

- Rabbit Haemorrhagic Disease - By detecting infected rabbits imported from Germany in 2001.
- AIV(H7N7) - By detecting smuggled infected pigeons in 2001

- MCF - By detecting infected cattle imported from Australia in 2003
- BVD (exotic strain) - By detecting infected cattle imported from Australia in 2003

Research Accomplishment

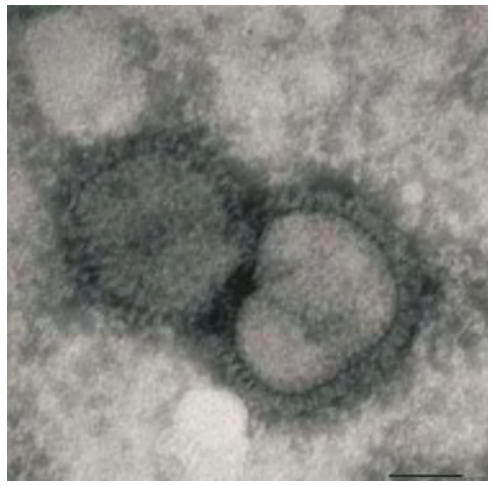
Avian influenza

- The recognition for High Security Animal Disease Laboratory as OIE Reference Laboratory for Avian Influenza by Office des International Epizooties (World Organization for Animal Health) came into effect at the at 77th General Session held at Paris on 28th May, 2009.
- HSADL has been engaged in validation of field AI diagnostic kits. As an OIE Ref Lab, HSADL participated in "OIE Proficiency Testing (PT) for Diagnosis of AI." The PT panel was from FLI, Germany and was tested using molecular and sub-typing assays. Only eight labs throughout the world were selected for this program. Second such testing will be carried out in July, 2012.
- HSADL catered to the need of the Nation for screening of a large number of samples under biosafety conditions suspected for exotic and emerging high risk pathogens with major contributions on avian influenza virus (AIV) from all over the country. So far, H5N1, H9N2, H4N6 and H11N9 subtypes of AIV have been isolated from Indian poultry.
- The phylogenetic and molecular analysis revealed that the Indian H5N1 viruses belonged to clades 2.2 and 2.3.2.1. Investigations on the H9N2 viruses revealed that these are reassortant viruses. Molecular studies indicated that a few H5N1 virus isolates have been resistant to antiviral drugs viz. Amantadine and Tamiflu.
- Pathogenic characterization of AIV isolates (H5N1 & H9N2) showed that all the H5N1 isolates are highly pathogenic with intravenous pathogenicity index (IVPI) between 2.63 and 2.90 out of 3.00 whereas H9N2 isolates are low pathogenic with IVPI 0.00 out of 3.00. Low pathogenic H9N2 viruses were demonstrated in the brain of chicken naturally infected with the virus for the first time.

Personal safety is an important component of biosafety, A lab worker having personal protective equipment is carrying out AI virus inoculation

A chicken infected with highly pathogenic avian influenza (H5N1) showing classical clinical signs of the disease

- Monoclonal antibodies against non-structural protein (NS1) and nucleoprotein (NP) of AIV have been developed and characterized that can be further used in immunoassay diagnostics for AIV Infection. The Matrix (M1), NS1, NP proteins of AIV have been cloned and expressed in *E. coli*. Yeast-expressed recombinant antigen having application in diagnosis and immunoprophylaxis of AIV have been successfully developed.
- The effects of various physico-chemical parameters on the infectivity of the AIV (H5N1) virus were elucidated to enable the development of biosecurity measures for avian influenza.



Electron micrograph of Indian AIV isolate

- Crow mortality investigations revealed involvement of H5N1 and absence of West Nile Fever virus (WNV) for the first time in the country.
- Initial wet bird market surveillance in Jharkhand indicated involvement of duck as the carrier of H5N1 HPAIV. The low pathogenic avian influenza viruses of type H11N9 and H4N6 detected in ducks during the market surveillance were also the first isolates found in the country.
- Assessment of ethno-veterinary use of herbal extracts on avian influenza: This is the first study which revealed that bark and leaves of *E. jambolana (Jamun)* possessed prophylactic potential whereas the leaves of *Acacia indica (Babul)* and *Ocimum tenuiflorum (Tulsi)* revealed therapeutic potential against H5N1 virus and provided a scientific basis to the ethno veterinary use of these identified extracts.
- MicroRNA profile of chicken lung during H5N1 virus infection: 126 pulmonary miRNA were identified to be differentially expressed and 97 were shut down in response to H5N1 virus infection. These were predicted to target genes involved in influenza A pathogenesis pathway in chickens.
- Small interfering RNAs directed against various gene segments of avian influenza H5N1 virus having potential to inhibit viral replication have been identified.

Pestivirus infections in ruminants

- First isolation and identification and molecular epidemiology of BVDV-1 and BVDV-2 in cattle in India.
- First isolation of border disease virus (BDV) in Indian sheep and determination that border disease in sheep and goats occurs in India due to BVDV-1 and BVDV-2.
- Molecular epidemiology revealed prevalence of BVDV 1b in cattle, BVDV 1b, 1c in buffaloes, BVDV 1b, 1c and BVDV 2 in sheep and goats.

- First report of glomerulonephritis in calves due to acute BVDV infection.
- Participation of HSADL in contractual research project under PPP mode with M/s. Pfizer Pharmaceutical India Ltd. for joint BVD surveillance programme.

Swine influenza

- Nationwide surveillance from pigs revealed 115 sero-reactors along with two H1N1 virus isolates.
- The two isolates have been sequenced and analysed for HA & NA genes. Sequence analysis of HA and NA genes confirmed that this virus is a H1N1 influenza virus and is closely related to pandemic H1N1-2009 isolates from India, Canada, Argentina, Taiwan and China.

Nipah

- Diagnostic tests developed for detection of Nipah virus infection (RT-PCR and Real time PCR) and indirect ELISA for detection of NiV antibody in pigs.
- Testing of around 1500 fruit-bat urine samples and 657 pig samples by RT-PCR did not reveal NiV infection.

Malignant Catarrhal Fever (MCF)

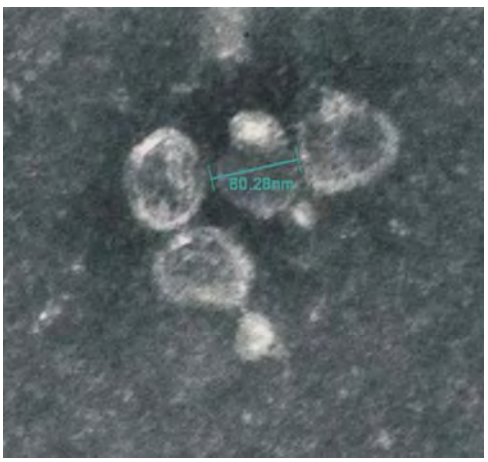
- A real time PCR test has been developed for diagnosis of MCF infection in cattle and sheep. Recently, it has been diagnosed in bison for the first time in the country.

Caprine arthritis encephalitis (CAE)

- RT-PCR and Southern hybridization tests have been standardized for diagnosis.

Porcine Reproductive and Respiratory Syndrome (PRRS)

- Porcine pulmonary alveolar macrophage culture system for PRRSV isolation and RT-PCR for PRRSV genome detection were optimized for diagnosis of PRRS.
- PRRS virus infection in Indian pigs was confirmed by isolation, nested-PCR and transmission electron microscopy for the first time in India.
- Sequence analysis showed that the Indian PRRSV isolates belong to PRRSV type-2, bearing characteristics of highly pathogenic variants (HPPRRSV) reported in China.



Electron micrograph of Indian PRRSV isolate

Bovine immunodeficiency virus (BIV)

- First report of the detection of proviral DNA of BIV in 10 blood samples and one milk sample of cattle by Southern hybridization followed

by PCR conducted using oligonucleotide primers specific for the p26 genomic region of the virus.

Crimean Congo Haemorrhagic Fever (CCHF)

- Lab diagnostics of Crimean Congo Hemorrhagic Fever has been standardized**.** The CCHFV was detected in tick samples from Gujarat in 2011-12 following human infections.

Reagents/Techniques/Technologies developed

- At present, diagnostic reagents for agar gel immuno-diffusion (AGID) test are being produced in the laboratory. The diagnostic reagents for identification of various heamagglutinins (HA) viz. H1, H3, H4, H5, H9 and H11; and neuraminidase (NA) viz. N1, N2, N6 and N9 subtypes are also being produced in the laboratory.
- The NA-inhibition test which is the requirement for FAO/WHO regional referral laboratory was standardized and is being used for identification of the NA subtype.
- A nucleoprotein gene based RT-PCR has been developed for diagnosis of avian influenza. This test could be used by peripheral veterinary laboratories for active surveillance of AIV since the positive and negative agreements of this test to isolation was similar to real time RT-PCR test.
- A recombinant nucleocapsid protein based indirect ELISA was developed to detect antibodies to PRRSV in field samples. The test has a sensitivity of about 93% and a specificity of 96%.
- ELISA developed for the diagnosis of BIV infection in Cattle.
- Monoclonal antibody and recombinant antigen-based ELISA have been developed for BVDV infection diagnosis in Cattle.
- Technology for the generation of recombinant antibodies that may replace hybridoma technology, has been developed.
- Development of an immunoperoxidase linked neutralization assay for the detection of neutralizing antibodies to BVDV.
- Real-time RT-PCR for the diagnosis of AIV H5N1, H9N2, BVDV-1&2, PRV and MCF have been standardized and are in routine use.
- A single tube RT-PCR was developed for diagnosis of BVDV in clinical samples and a multiplex PCR was developed for diagnosis and typing of BVDV isolates.
- An immunoperoxidase monolayer assay was developed to detect BVD viral antigen and neutralizing antibodies.
- A micro-plaque-reduction neutralization test was optimized for detection of WNV neutralizing antibodies in migratory and resident wild birds.
- A Real-Time RT-PCR was optimized for rapid detection of West Nile virus using previously reported TaqMan probes and primers corresponding to WNV 3'-NC region.
- RT-PCR and Real-time RT-PCR for diagnosis of CCHF have been developed and standardized.

Disease database management system (DDMS) for AIV

- DDMS was developed as an electronic platform for managing the data of AIV and a single point of access to data, reports and status of AI diagnosis. The software has been installed at HSADL by October 2010 and is being routinely used since then.

State of the art facilities

- The biosafety level 3+ laboratory facility is supported with air-handling unit (AHU) including AC plant, effluent treatment plant (ETP), boilers, 33 KV electrical substation, incinerator and other engineering support system.
- The animal facility comprises receiving animal quarantine unit, holding animal house and containment animal wing comprising air-locked biosafety animal experimentation rooms for large animals, small ruminants, lab animals as well as poultry.
- Transmission Electron Microscopy unit- It was established in 2009. Since then, field and experimental samples have been screened for the presence different viruses including for avian influenza virus, pestiviruses, CCHFV, RPV, PRRSV etc.
- Specific Pathogen Free (SPF) facility for influenza research- SPF facility for poultry was commissioned in year 2007-08 and is being used for raising SPF chicken for influenza testing (IVPI test) and SPF eggs for AI virus isolation and research. The SPF chicks are being reared in HEPA filtered positive air pressure under sterile conditions and are being regularly monitored for disease-free status 23 different pathogens.

Super isolators (BSC Cl. III) for poultry

Barrier (double door) autoclaves, one door opens in containment area.

Air-handling unit is equipped with HEPA filtration of the outgoing air.

Incinerator for burning the infected lab waste with environmental protection

Training / Human resource development

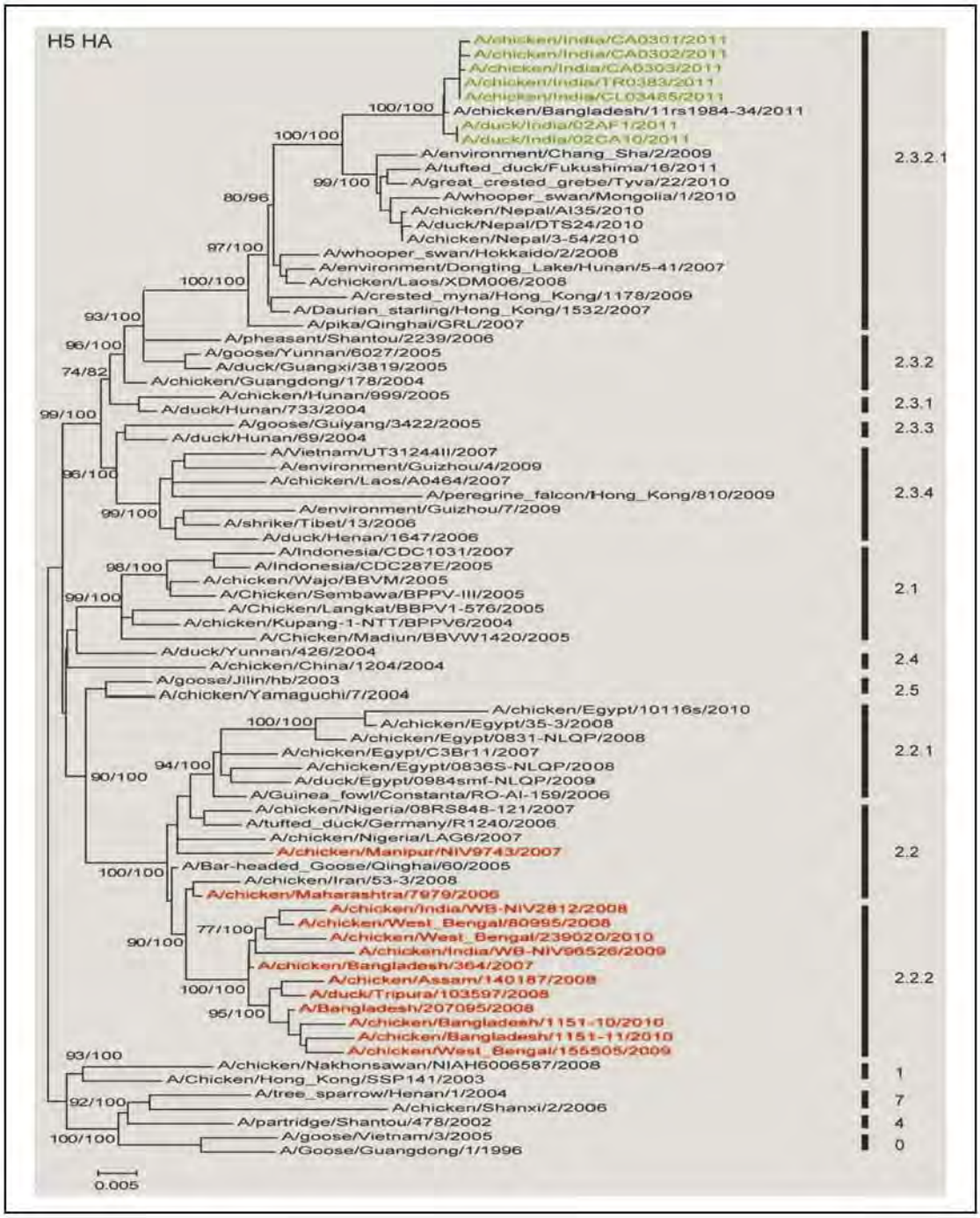
HSADL has laid the foundation for laboratory biosafety and biosecurity in India and has contributed significantly in spreading the awareness about laboratory biosafety. As the only biocontainment lab of this type in the subcontinent, HSADL has the authority and capacity for imparting training on biosafety and biosecurity at national as well as international level for various organizations, institutions and field/lab officers working in the field.

- Major initiative for training on laboratory diagnosis of Avian Influenza and biosafety for VCI nominees (Trainers trainings), State Animal Husbandry Departments' lab personnel and officers from newly upcoming BSL-3 labs of the state departments.
- Several trainings on HPAIV and biosafety & biosecurity were undertaken at HSADL for SAARC and other neighbouring countries (FAO-sponsored). Joint training programmes were undertaken on biosafety & biosecurity for experts from medical and veterinary fields sponsored by WHO.
- Training to Bangladesh scientists on Sequencing and Biosafety were conducted during 2008 and 2009.

Dr. Michael Johnson, Head, Pirbright Laboratory, UK delivering lecture on laboratory biosafety during WHO sponsored workshop on Laboratory biosafety and biosecurity at HSADL, Bhopal

Presentation by participant from Nepal during FAO sponsored training program on Avian influenza diagnosis at HSADL, Bhopal

Training on biosafety procedure while handling high risk pathogen



Phylogenetic relationships of the coding sequences of hemagglutinin (HA) genes of Indian H5N1 avian influenza viruses.

NATIONAL DAIRY RESEARCH INSTITUTE

Karnal, Haryana

Year of Establishment : ***1923 as Imperial Institute of Animal Husbandry and Dairying at Bangalore***

1955 as National Dairy Research Institute, Karnal

Regional Stations : Southern Regional Station, Bangalore (1923)

Eastern Regional Station, Kalyani, West Bengal (1964)

NATIONAL Dairy Research Institute (NDRI) is the premier institution of dairying in Asia. The Institute has its origin from Imperial Institute of Animal Husbandry and Dairying, which was established in Bangalore in 1923. In 1936, the Institute was expanded and renamed as Imperial Dairy Institute. In 1955, its headquarter was shifted to Karnal and was renamed as National Dairy Research Institute. The Southern Regional Station at Bangalore and the Eastern Regional Station at Kalyani in West Bengal are providing region specific R&D support for dairy development. For further strengthening of academic programmes of human resource development, status of Deemed University was grantred to the Institute in 1989. The Institute undertakes research, teaching and extension activities towards dairy development in the country. It also conducts basic and applied research with the objective to enhance animal productivity, develop new products and practices for the benefit of millions of farmers and consumers. Over more

than eight decades of its existence, the Institute has shown remarkable development and expertise in different areas of Dairy Production, Processing, Management and Human Resource Development.

Improved germplasm for Enhancing Animal Production and Productivity

Karan Fries Cattle

The Karan Fries was developed by crossing Holstein Friesian with Tharparkar. The Karan Fries is a high milk producing breed and is especially suited for northern and north western regions of the country. The average age at first calving is 32-34 months and 305 day lactation yield is about 4000 kg.

Karan Fries cow

Karan Swiss Cattle

The Karan Swiss was developed by crossing Brown Swiss with Sahiwal. The Karan Swiss is good milk producing animal and especially suited for eastern, central and the coastal regions of the country. The average age at first calving is 34 months and 305 day lactation yield is about 3400-3600 kg.

Karan Swiss cow

Technologies Developed

Embryo Transfer Technology (ETT)

Embryo Transfer Technology was optimized for cows. Numerous calves from crossbred and zebu cows were produced using this technology. The production of ten calves from a single donor cow through embryo transfer was also achieved in a single calendar year. This technology was also successfully adopted to buffaloes with production of many buffalo calves.

Ten calves from single donor cow by ETT

In vitro fertilization and production of buffalo and goat offsprings

For salvaging the quality germplasm from high yielding buffaloes which go for slaughter, the technology of *in vitro* fertilization was standardized. Briefly, the technology involves collection

of eggs (ova) from ovaries of buffaloes which are then cultured for maturation and fertilized by bull spermatozoa *in vitro* followed by transfer of fertilized embryo into suitably prepared recipient. The World's first test tube buffalo calf 'PRATHAM' was produced at NDRI in 1991, which was followed by production of several buffalo calves using this technology.

Test tube buffalo calf "PRATHAM"

First *in vitro* fertilized goat kid in India

This technology was subsequently extended to goats also. The protocols for transferring IVF goat embryos to synchronized recipient goats using laparoscopy were developed, resulting in the birth of first *in vitro* fertilized goat kid in the country.

Embryo splitting

The embryo transfer technology was further improvised by splitting of embryos and two identical twin bulls were produced.

Birth of World's first cloned buffalo calf, through hand-guided technique

The world's first cloned buffalo calf 'GARIMA' produced through the "hand guided cloning technique" was born on February, 6, 2009 at NDRI, Karnal. The "hand guided cloning technique" is an advanced modification of the 'cloning technique' which was used for the production of the cloned sheep ´DOLLY´. This technique is much simpler to perform and does not require the use

GARIMA

GARIMA - II

of sophisticated and expensive equipments like micromanipulators. In this technique, the oocytes isolated from abattoir ovaries were matured *in vitro*, denuded, treated with an enzyme to digest the zona pellucida and were then enucleated with the help of hand held fine blade. Somatic cells from the ear of a donor buffalo were propagated to be used as donor-nuclei.

SHRESTHA

The enucleated oocytes and donor-nuclei were electrofused, cultured, and the resultant embryos were produced *in vitro* cloned embryos were transferred to recipient buffaloes for the production of the offspring. Besides being the fastest way for multiplication of superior males and females, this technique offers the added advantage of gender pre-selection. Now NDRI has two cloned buffalo calves produced through this technology (i) GARIMA-II and SHRESTHA. GARIMA-II is presently pregnant and SHRESTHA is producing good quality of semen.

NOORI, the World's first cloned Pashmina goat, was produced using the same technology of hand guided cloning technique at Shere Kashmir University of Agricultural Sciences and Technology (SKUAST-K). For producing NOORI a consortium of scientists from SKUAST, Srinagar and NDRI Karnal worked under the project entitled **"**A Value Chain on Zona Free Cloned Embryos for Quality Animal Production from Elite Buffaloes and Pashmina Goats**"** funded by National Agricultural Innovation Project (NAIP) of the Indian Council of Agricultural Research (ICAR). Ovum pick up – *in vitro* fertilization

NOORI

India's first cattle calf produced using Ovum Pick-Up-IVF technology was born at NDRI, Karnal for which oocytes were collected from the ovaries of a live Sahiwal cow using ultrasound-guided needle. The oocytes were matured, fertilized and cultured for 7 days for producing blastocysts. The transfer of a blastocyst stage embryo to a surrogate mother led to the birth of a female calf with a normal birth weight of 23 kg on March 7, 2012. The female calf was named 'HOLI'.

This technology will be useful for obtaining calves from those animals which do not respond to the conventional embryo transfer program.

HOLI

Endocrine techniques for fertility enhancement

Induction of parturition in crossbred cows and buffaloes using exogenous administration of dexamethasone

This texhnique involves inducing parturition in pregnant cows and buffaloes by dexamethasone administration (25 mg for cows and 30 mg for buffaloes) not earlier than 1 month pre-term. Calving occurs within 3 days of administration in cows. For most buffaloes a second injection is generally required 4 days after the first injection and calving occurs within 20 h after the second injection. This technique was applied for the first time in buffaloes and holds considerable potential for practical application in reproduction management. The advantages of parturition induction are a) as a clinical tool in animals suffering from eversion or prolapse of vagina/uterus during advanced stage of pregnancy, b) in clinical cases of maternal ill-health, e.g. limb fractures, pericarditis, reticulitis, hydroamnios, hydroallantois etc., c) for increasing calf viability by minimizing the level of perinatal mortality due to foetal oversize, and, d) to terminate prolonged gestation in animals as late calving affects economic returns from animal.

Application of milk progesterone for reproductive status monitoring and treatment of rural anestrus and repeat breeding cows and buffaloes.

Progesterone determination from milk/blood plasma sample is useful for reproductive status monitoring of livestock. Farmers are asked to supply milk samples (from lactating bovines or buffaloes) or blood samples (from non-lactating animals) which have not reported in heat for several months and hence not inseminated. Reproductive problems in such animals are first identified using progesterone determination in samples collected twice weekly for 3 weeks, and subjected to GnRH or PGF2α therapy. The technology was successfully demonstrated for treating reproductive disorders and making the animals to conceive.

Three anestrus buffaloes belonging to Sh. Suba Singh, resident of village Phusgarh, Karnal District which were monitored by milk progesterone assay and were subsequently treated for successful pregnancies.

Development and practical application of the novel Ovsynch and Heatsynch protocols for enhancing fertility in rural anestrus/repeat breeding buffaloes.

Infertility problems in buffaloes is usually very high ranging from 30-50%. Buffaloes generally exhibit silent heat which often goes unnoticed. Two novel protocols viz. 'Ovsynch' and 'Heatsynch' were developed for estrus synchronization followed by set time artificial insemination in buffaloes, based on control of both follicular growth and ovulation using gonadotropin releasing hormone (GnRH) and prostaglandin F2α. Ovsynch protocol involves the combination of GnRH - PGF2α - GnRH injections regime to synchronize estrus and ovulation. An injection of GnRH

(Receptal; 10µg intramuscularly) is given at a random stage of estrous cycle or during anestrus followed by an injection of PGF2α (Lutalyse; 25mg intramuscularly) 7 days later. Ovulation is synchronized by a second injection of GnRH (Receptal; 10µg intramuscularly) 2 days after PGF2α. The animals are then inseminated at a fixed time of 12 h and 24 h post second GnRH injection. The technology was demonstrated in two separate trials involving a total number of 191 buffaloes belonging to farmers from many villages, which had not conceived for at least 6 months prior to treatment due to either repeat breeding or anestrus. The overall success rate in terms of pregnancies was 47%. Additionally, among the buffaloes which had not conceived following treatment a large number of those which were initially acyclic exhibited estrous cyclicity.

Buffalo which had not conceived for 5 years belonging to Mr. Suresh Pal S/o Mr. Mahiram, Village - Pundrak was treated with ovsynch and declared pregnant

Further, to reduce the cost of treatment from Rs. 520 for ovsynch application, to only Rs. 320 the Heatsynch protocol was employed in which 1 mg of estradiol benzoate is administered in place of the second GnRH injection 1 day after lutalyse with similar success rates in terms of establishment of pregnancies. Out of a total number of 285 buffaloes belonging to farmers from several villages, suffering either from anestrus or repeatbreeding, 138 buffaloes conceived following heatsynch treatment giving a success rate of 48%.

Buffalo heifer (5 years old) belonging to Sh. Jaswant S/o Sh. Hari Singh of village Narukheri which was treated with heatsynch and declared pregnant.

Production and Characterization of a Sensitive Antiserum against Progesterone

A highly sensitive indigenous progesterone antiserum has been developed and is being regularly used in estimating progesterone by radioimmunoassay. In commercial terms the antiserum is very precious and is tentatively worth nearly a crore of rupees if it were to be imported. The indigenous progesterone antiserum production makes the hormone assay less expensive and obviates the requirement of its importation from commercial sources thereby resulting in foreign exchange saving to the country. The hormone assay can therefore become highly practical for cost effective estimation of the progesterone in body fluids (milk and blood plasma) of livestock and help the field veterinarian in identifying ovarian disorders and take measures for fertility improvement. The hormone estimation is also very useful as a management tool for monitoring the cyclicity, as well as pregnancy detection in an organized farm.

Nutrition technologies

Area specific mineral mixture

NDRI has formulated area specific mineral mixtures after studying the status of various minerals in different areas. There are two types of formulations of mineral mixture, one is with salt and the other is without salt. It should be mixed in the concentrate mixture @ 2kg per 100 kg (without salt) and @ 3 kg/100 kg (with salt) or can be supplemented @ 50 g per day per adult animal mixed in feed.

Use of anionic mineral mixture for controlling of milk fever

Initiation of lactation induces great stress on calcium homeostasis and this is associated with milk fever among high producing dairy cows and buffaloes. It was established that feeding a negative-charged ration for 3-4 weeks prior to calving, with properly balanced calcium, phosphorus and magnesium reduces the incidence of milk fever after calving.

Degcure mixture for the prevention of d degnala disease

Degnala disease is a chronic selenium toxicity disease and causes high mortality in cattle and buffaloes in some areas of U.P., Punjab and Haryana. Degnala disease is caused by feeding of paddy straw, or any fodder which has high organic form of selenium. For the treatment of Degnala disease, an antidote mixture known as 'Degcure' was evolved. The recommended dose is 30g/day for 30 days in affected animals.

Degcure mixture

Manufacturing process for complete feed blocks

Complete feed ensures the availability of all nutrients uniformly in balanced and adequate amount. It also avoids wastage of feeds during handling at the time of feeding, transportation and storage, besides saving the labour and transportation expenditure. This system also provides wide scope for the manipulation of diets, particularly those based on agro-industrial by-products for making effective and economic feed formulations.

The complete diet containing roughage and concentrate can be compressed using a hydraulic press after their mixing in a uniform blend. Use of binder compounds helps to obtain the diet in block form, of desirable weight, shape and size. Compression increases the bulk density by about three times which reduces cost of transportation by 70% and saves area for storage.

Urea molasses mineral block lick

The solid blocks containing mainly urea and molasses along with mineral mixture and some organic materials have been developed. These blocks contain urea, molasses, mineral mixture, binder, salt, cake and bran. Urea is dissolved in molasses at an optimum temperature and other contents are mixed and put into the blocks to set. Animal can consume up to 0.5 to 0.6 kg of the brick in 24 hours. These blocks provide nitrogen and energy requirement of the microbes in the rumen, improves urea utilization by microbes for protein synthesis, maintains energy and protein ratio in the diet, maintains the animal without any other supplement, and improves their straw intake.

Urea-ammonia treatment of crop residues to improve their nutritive value

The use of urea as a source of ammonia for treating cereal straws and various crop residues has been successfully carried out and also demonstrated in various villages. The methodology is simple, practically feasible and economically viable. In this new technology, four kg fertilizer grade urea in 30-40 litre of water is dissolved and sprinkled on 100 kg dry cereal straws viz. wheat, paddy, barley or oat or any other crop residue. It is mixed well and stacked by making layer after layer till 20-30 quintals of straw are stacked. It is pressed thoroughly so that treated material/lot becomes compact, which is required for better reactivity and cover with a layer of untreated straw. Finally, it is covered with either gunny bags/polythene sheets or plaster with mud such as “Dhar” (commonly used in Haryana and Punjab). After allowing to react for 3 weeks in winter and 7-10 days in summer season, it can be fed to any ruminant of above six month of age. This technology enriches protein content by 2.5 - 3 folds than untreated crop residues and also increases energy value of feed by 10-15% unit after treatment. Further, it also increases palatability and dry matter intake from 0.9 - 1.0% body weight to 2.0% body weight in large ruminant animals and also increases the digestibility of organic matter and crude fibre by 10-15 units and 30-40 units in crude protein as compared to untreated crop residues.

By-pass fat and by-pass protein for high producing animalþ

The supplementation of by-pass fat to high yielding crossbred cows and buffaloes at the rate of 2.5% of dry matter (maximum 6-7%) improved reproductive and productive performance. Similarly, to ensure that the protein is adequately protected against ruminal degradation, highly degradable feeds were converted into by-pass proteins through formaldehyde treatment (1.5% of CP). It was also ensured that there is no over protection of protein and the treatment has no adverse effect. These technologies have improved feed conversion efficiency of nutrients and have been adopted by feed manufacturers.

Milk somatic cell count (SCC) measurement for monitoring udder health

The basal reference values of milk SCC have been established in Murrah buffaloes and cows (Karan Swiss, Karan Fries, Tharparkar and Sahiwal). These reference values· can be used for determination of subclinical cases and prevention of mastitis in dairy animals. Monitoring of SCC at fortnightly or monthly intervals in a herd can help in preventing substantial loss of milk.

Work rest cycle for draught animals

Organized rest pauses to draught animals during work ameliorates level of stress, delays fatigue onset and animal performs work with ease without any adverse effect on health. The rest pauses suggested are of either half an hour or one hour period in a work session. Light working at low temperature during early hours rest pause reduces cardiopulmonary activity to satisfactory levels and reduce body temperature by about 0.5ÚC depending upon ambient conditions. During heavy work provision of one hour rest will lower the physiological reactions moderately and animal will be able to sustain work for about 2-3 hours further. At the end hour rest, though the animals will not recover fully, and will begin work at high physiological reactions but further rise over prolonged hours in physiological reaction will be less. Animals involved in work of moderate to high intensity do not recover physiological processes even after a rest pause of 6-8 hours and fatigue effect get accumulated; such animals should be used for 2-3 days and given one day rest and work: rest days be regulated to 2:1 or 3:1 depending on level of work and need.

Animal fatigue assessment

Animal exhibiting fatigue

For animal fatigue assessment a score card was developed which makes use of physiological reactions namely heart rate, respiration rate, rectal temperature, scored on a 5 point basis. For heart rate each 10 beats/min rise above initial resting rate was assigned a score of +1. For respiration, a rise at 15 breaths/min. and for rectal temperature 0.5°C rise above resting values meant a score of +1 point. Animal excitability was given a score of 5 point. Appearance of froth was scored, froth first appearing to full mouth frothing considered in an ascending manner. Tongue protrusion was taken into account from occasional appearance to full mouth open, and tongue out continuously. The fatigue score totalled 40 points, out of which animals were to be evaluated; animals which attained a value of 20 were declared fatigued.

Dairy processing equipments

Continuous ghee making machine

There were several problems and limitations of conventional method of manufacture of

ghee viz. (a) Low heat transfer coefficient causing bulky equipment, (b) Formation of tenacious scale of residue on the heating surface adding to poor performance of equipment and making cleaning and sanitation strenuous, (c) Equipment and processes are unsuitable for large volume of production, (d) Long residence time and product inventory in the equipment presenting greater risk of bulk spoilage of the product, (e) Excessive strain and fatigue on the operators, (f) Unsanitary operations, product exposed to environment thereby increasing the channels of contamination, (g) Product spillage around the equipment making the floor slippery and causing accident. Hence a new technology for continuous ghee making machine has been developed which is versatile and economical to adopt.

Mechanized conical process vat

Processing of milk into milk products involves various unit preparations like heating, cooling, mixing and concentration. These processing operations are normally performed in jacketed kettles in dairy plants and in open pans. The equipment presently being used for above processes has several short comings viz. (a) Energy and labour intensive operations, (b) Low heat transfer coefficients, (c) Formation of hard scales on the heating surface due to absence of positive scrapping, (d) Difficult scrapping profile due to hemispherical bottom of the kettles, (e) No provision for continuous mechanized outlet of viscous products from the kettles. To overcome the above difficulties, a mechanized conical process vat has been designed at National Dairy Research Institute, Karnal. The stainless steel stationary vat has a jacketed conical configuration and the jacket is partitioned to provide variable heat transfer area. The durable, spring loaded blades sweep the vat surface and a mixing spiral on the central shaft helps in mixing/ blending the products. The vat is equipped with product re-circulation system and a continuous mechanized product outlet. The power for scrapping, mixing and discharge assembly is provided from a variable speed/fixed speed drive. Vat is provided with the insulation to minimize the heat losses.

Paneer making machine

Paneer making machine

Presently, paneer manufacturing is not mechanized to be handled by organized sector, resulting in non-uniform quality. The technology has been developed for paneer making machine for small scale applications. This provides hygienic and uniform quality product at domestic and restaurant level. The variable capacity paneer making machine converts 2.5 to 15 litres of

milk into paneer cake of thickness of 2.5 cm in 10 to 12 minutes. The benefits of this technology are low capital investment, hygienic and uniform quality product and higher returns to the farmer.

Continuous khoa making machine

Presently, khoa is made by conventional method in jacketed kettles or open trays, which have several disadvantages viz. (a) batch process and not suitable for large scale production, (b) unsanitary operation, (c) Bulky equipment due to low heat transfer co-efficient, (d) formation of hard scale of milk protein on heating surface resulting low efficiency, (e) long residence time in the equipment causing greater risk of spoilage of the product, (f) spillage of the product which makes the floor slippery causing accident, (g) excessive strain and fatigue on the operator.

Continuous khoa making machine

Keeping in mind these disadvantages, a new continuous khoa making machine has been designed on the basis of heat transfer and hydrodynamics in non-Newtonian mechanically agitated thin film. It is a cascade system comprising of three horizontal straight sided thin film scraped surface heat exchangers. The equipment is fabricated and tested for the manufacture of khoa from standardized buffalo milk. In this heat exchanger, milk is concentrated to about 40% total solid which then flows into the second heat exchanger.

Value added dairy products

Low cholesterol ghee

The new technology has been developed for preparation of low cholesterol ghee. The technology is simple & rapid and 80-85% of cholesterol is removed from ghee. Final product has flavour comparable to that of original desi ghee. Low cholesterol ghee offers a better choice to the consumers who want to restrict the intake of dietary cholesterol. The technology was successfully transferred to Quality Dairy India Ltd., New Delhi and marketed by the name of LivLite.

Low cholesterol ghee

Rasogolla mix powder

Chhana from cow milk is usually used as a base product for its preparation. The shelf life of chhana is few hours at room temperature and cold stored chhana produces rasogolla with inferior quality properties. Moreover, fresh cow milk is not available at all times and everywhere in India.

Traditional method of rasogolla making leads to lot of inconsistencies in textural quality. To overcome these limitations, the technology for an instant dried rasogolla mix has been developed. The average yield of the mix powder from cow milk is 7% which will produce about 55 kg of sweet (drained weight). This is 20% higher than that obtained by traditional method. Dried rasogolla mix can be stored without spoilage for about five months at 30°C and for 10 months at 5°C in sealed containers.

Instant kulfi mix powder

A technology has been developed for the manufacture of kulfi mix powder by spray drying process. Mix is formulated from milk fat, MSNF, sucrose and isabgol husk. The concentration of solids is adjusted in the mix and only 25% of the total sugar required is added before drying. The mix is homogenised and heat treated in a tubular heat exchanger. The mix is spray dried. The remaining sugar in ground form is dry blended with the powder and packaged in the tin cans. The approximate chemical composition of kulfi mix powder is : fat- 25.41%, MSNF- 36.98%, isabgol 0.46% sugar 34.65% and moisture 2.52%. The product has a shelf-life of 7 months at 30°C in tin cans. The shelf-life can be extended upto 10 months with the addition of butylated hydroxy anisole and nitrogen gas flushing. The cost of production of kulfi mix powder is Rs.95/- per kg. Kulfi mix powder can be instantly reconstituted and frozen to get kulfi of consistently good quality all the year round at an affordable price.

Ready-to-reconstitute kheer mix

The new formulation is a dry mix comprising ready-to-rehydrate rice particles in powdered milk/cream fraction. It can be rehydrated by dispersing in boiling water and cooking for 4 to 5 min before cooling and serving.

Dry mix comprising ready to rehydrate rice particles in powdered milk

Rehydrated k*heer* ready for serving

Ready-to-reconstitute rasmalai mix

The technology for new formulation has been developed in a dehydrated form (ready-to-reconstitute rasmalai mix). The two major components of the mix are patty and syrup portions

which have been prepared by an osmo-air dehydration process. Dehydrated patties and dried syrup mix are immediately vacuum packed and put together in a retail carton. Rehydration of patties and syrup mix powder is to be done by heating in boiling water for 4 to 5 min.

Vacuum-packed

Dehydrated patty, powder portion and garnishing for ready-to-reconstitute rasmalai

Reconstituted rasmalai

Arjuna herbal ghee

The traditional product manufactured by a few ayurvedic pharmaceutical manufacturers uses a highly guarded technology which is very energy intensive to extract the herb and convert cow ghee into herbal ghee.

Arjuna ghee

The technology, which is restricted to a few traditional manufacturers, offers the product at exorbitant prices. The product is generally dark in colour or has colour of herb. The flavour is astringent or dominated by the herbal flavour and taste. It is, therefore, promoted as a herbal medicine rather than a product for culinary dishes. The new technology and product developed at NDRI, Karnal has been obtained by processing cow cream into herbal ghee wherein extraction of herb is achieved by a modified clarification-extraction process. Thus, there is less energy requirement and the process can be adopted for large scale production. The product has colour, flavour and taste similar to the market ghee.

Ready to reconsitiute mix for low fat oven baked gulabjamun

The new product formulation in a ready-to-rehydrate form or in a mix form offers a technology wherein **c**onventional frying process is replaced with oven drying-cum-cooking. Fat in the resulting gulabjamun is, thus, reduced to nearly half of that in the conventional product.

Rehydrated low fat oven baked

Kunda

Kunda is a semi-solid delicacy prepared by the heat-concentration of milk and subsequent desiccation accompanied by addition of sugar. It is popular in northern regions of Karnataka. The conventional manufacturing process is labour intensive and time consuming as it involves slow desiccation of milk and repeated dilution with water after addition of sugar. The new technologies do away with much of these problems.

Kunda developed by the new process

Low fat dry mix gase-gase payasam (poppy, papavoer somniforum)

The traditional Gase-gase payasam is a popular delicacy of Karnataka. It is a free flowing, light cream colour with cardamom flavour. Traditional method of preparation is a long drawn process and the shelf life of the product is low (<24 hour at ambient temperature). It, therefore, restricts its commercial marketability. The new formulation is a dry mix with consumer convenience and a shelf life of more than three months. The product is comparable to traditionally prepared product in its 'eating' quality.

Reconstituted Gase-gase payasam

Palada payasam

Palada payasam is a famous delicacy of Kerala. It is a pasty homogenous product with pleasant caramelized flavour. The manufacturing process requires long heating with sugar, which brings about the characteristic flavour. It has poor keeping quality (<24 hour) at room temperature. To overcome the poor shelf life, a new technology for instant dry mix was developed.

The features of the new process are (a) modification in *Ada* preparation, (b) dry mixing of ingredients, (c) Saving in energy, and (d) Shelf-life more than six months at ambient temperature. This technology has been commercialized and product is being marketed under brand name Milma.

Milma

Iron fortified biscuits from a composite dairy-cereal mix

Iron fortified whey-bajra biscuits

The technology was developed to manufacture the biscuits from a composite wheat-pearl millet flour in combination with valuable whey solids and enriched with iron selected on the basis of sensory evaluation. The iron fortified biscuit contained 6.53 mg iron per 100 g. The other nutrients present were 18.81% fat, 12.23% protein, 1.13% ash, 1.42 crude fiber, 3.2% moisture and 63.28% carbohydrates. The product showed storage stability up to 4 months without any significant change in the sensory as well as nutritional attributes. The cost of manufacture of the product was estimated as Rs.17 per 100 g.

Technologies for quality evaluation

Lactometer for milk solid estimation

During eighties a lactometer was developed for quick assessment of solids in milk. The lactometer was approved by Bureau of Indian Standards and nearly about half million of lactometers are in use at the field level.

Hansa serum test to detect adulteration of buffalo milk in cow milk

The liking for cow milk by many people as well as for manufacturing quality products e.g chhana based products and ripened varieties of cheese, a dairy has to ensure that there is no buffalo milk is mixed in cow milk. If buffalo milk is manipulated in terms of fat percentage and addition of (pale yellow) coloration, it is very difficult to distinguish the milk with regards to its species of origin. Therefore, to overcome the problem of such manipulation or admixing of milk, technology based on immunological principle (antigen-antibody reaction) has been developed to detect adulteration of buffalo milk in cow milk. The test has been named as Hansa test.

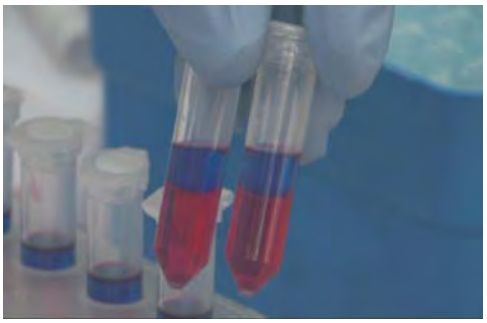
The method involves the production of antiserum by immunizing rabbits with buffalo casein or casein may be from any other origin whose adulteration in any given milk sample is to be detected. This antiserum when mixed with buffalo milk makes visible reaction in the form of curdling of milk within 30 seconds. No precipitation confirms that there is no admixing of buffalo milk in the sample.

Rapid method for the detection of detergent in milk

Chemical quality of milk suffers due to intentional adulteration of milk with various types of adulterants. Detergent has been found to be the latest entry among the list of adulterants in milk; used for the emulsification of externally added vegetable fat. The other ingredients being used for preparing milk like formulation are urea, salt, soda, sucrose, vegetable oils, skim milk powder,

water etc. The liquid thus formed has similar appearance as of genuine milk (i.e. colour, consistency) and it is reported to be used for the adulteration of dairy milk. Consumption of such preparation may prove to be injurious for human health and can lead to gradual impairment of the body.

A platform test has been developed for the detection of detergent in milk within 2 minutes. The developed test is simple and detects all types of commercial detergent available in the market at a minimum level 20 mg/ 100 ml (in milk). A clear colour differentiation between pure and adulterated milk with detergent can be seen using this method which doesn't require any instrument and cost of the consumables is only Rs. 3.10 for analysing one milk sample. The method also works in the presence of formalin (a preservative used by regulatory body to store samples) and other adulterants.



Test for the rapid detection of detergent in milk

Colour differences in pure (purple) and detergent containing (blue) milk in lower layer

Miniaturized spore based assay on biochip for aflatoxin M1 in milk

A miniaturized spore based assay for detection of aflatoxin M1 in milk on functionalized gold chip has been developed. It requires minimal quantity of milk (25 µl) and other reagents (0.5 µl). The new assay has higher sensitivity (0.5 ppb).

Novel features: (a) New innovation over existing one where gold chip has been used for monitoring. Aflatoxin M1 in milk based on unique spore germination principle, (b) Miniaturization of assay achieved with 25 µL of milk, 0.5 µL of substrate and 1 µL of spores, (c) Minimal pre-treatment of milk, and (d) Principle works under natural condition of milk production and processing with specific interaction with the analyte.

State of the art facilities developed

New biotechnology building commissioned

A state-of-the-art biotechnology research facility has been created to consolidate the biotechnology research at NDRI. The new lab facility offers a working space of more than 20,000 sq. ft. and has specialized laboratories on Embryo Biotechnology, Regenerative Biotechnology, Animal Genomics, Proteomics Research etc.

Technology business incubator

The Technology business incubator (TBI) has been established at NDRI campus as a prized facility and is promoted by Society for Innovation and Entrepreneurship in Dairying (SINED). TBI helps in technology-based start-up businesses with all the necessary resources/support that the start-up needs to evolve and grow into a mature business. TBI has the broad objective of promoting knowledge-based and innovation-driven dairy enterprises in the country.

So far, the TBI has conducted 22 EDPs & Short Term Training Programs. An incubatee company is also operating under the incubation program of SINED (TBI) to manufacture Colostrum Powder and is in the process of signing agreements with other entrepreneurs in the area of Mineral Mixtures, Bakery & Food, Dehydration of Vegetables, Fruits & Spices under the incubation program.

NATIONAL BUREAU OF ANIMAL GENETIC RESOURCES

Karnal, Haryana

Year of Establishment: 1984

NATIONAL Bureau of Animal Genetic Resources and National Institute of Animal Genetics were established on 21st September, 1984 with a mission to protect and conserve indigenous farm animal genetic resources for sustainable utilization and livelihood security. These twin Institutes started at Southern Regional Station of National Dairy Research Institute Bangalore and were shifted in 1985 at NDRI Karnal before shifting to its own campus at Makrampur, Karnal in 1994. The Institute of Animal Genetics and Bureau were merged in 1995 to function as a single unit as National Bureau of Animal Genetic Resources (NBAGR). The National Bureau of Animal Genetic Resources, Karnal is the Nodal organization in the country that undertakes the responsibility of Identification, evaluation, characterization, conservation and sustainable utilization of livestock and poultry genetic resources of the country and their documentation.

National GeneBank

National Animal Gene Bank has been established at the Bureau with the objective of maintaining the indigenous livestock biodiversity of the country. A total of 97,835 deep frozen semen doses belonging to 257 breeding males (Bulls/Rams/Bucks/Stallions) from 31 breeds comprising of seven livestock species have been preserved at National Genebank for posterity. The semen of Amritmahal, Dangi, Gir, Hariana, Kangayam, Kankrej, Kherigarh,

Krishan Valley, Ongole, Ponwar, Punganur, Rathi, Red Sindhi, Sahiwal, Tharparkar and Vechur breeds of cattle, Bhadawari, Jaffarabadi, Murrah, Nilli-Ravi, Pandharpuri, Surti, Tarai riverine and Assamese swamp buffalo, Black Bengal and Chegu goat, Garole sheep, Marwari and Zanskari horse, Jaiselmeri camel and Arunachali yak is available. The Animal Gene Bank has also collection of genomic DNA from more than 130 breeds of livestock and poultry. There is a buffalo mammary gland cDNA/EST library also.

Technologies/Methodologies developed

Database Information System

Information System on Animal Genetic Resources (AnGR) of India

NBAGR has developed an Information System on Animal Genetic Resources of India (AGRI-IS 2.0). This database provides information on various breeds of livestock and poultry which includes general information, utility, geographical distribution, population, morphology, performance parameters, management practices along with two photographs of each breed. In addition, district-wise livestock & poultry census data from 1961 onwards for each census year with age, sex and utility-wise details. One can obtain information on district-wise infrastructure facilities i.e number of veterinary hospitals, dispensaries, stockman centres, extension centres for poultry, sheep & wool, pig, livestock farms of all species, gaushalas, villages & area per veterinary institute; and A.I. done in cattle & buffalo. The database also provides comprehensive information on district-wise production statistics of milk – cow (indigenous & crossbred), buffalo and goat, wool, egg, number of slaughter houses, species-wise no of animals slaughtered and meat production, state-wise per capita availability and utilization pattern of animal products like milk, egg and dung. Information about semen banks, vaccine production, import and export of animals and animal products for the country as a whole.

CD Version of AGRI-IS 2.0 has been developed using MS-Access which is being supplied on demand.

Database on genetic characterization of AnGR

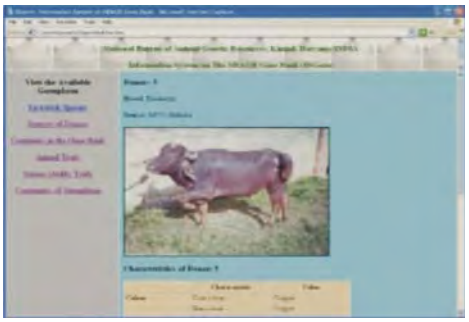
An integrated database on genetic characterization of animal genetic resources has been developed. It stores data on relevant published literature, microsatellite loci, statistical methods and software for data analysis, locus-wise, within-breed and inter-breed genetic diversity. User-interface of the database has been developed using ASP.NET with Visual Basic Script and it is internet ready.

A livestock protein database has been designed to contain information on protein sequences in breeds and domesticated species, domain, 3-D structure, pathways, functions, and literature.

A livestock Expressed Sequence Tag (EST) database has been designed to store information on the reported ESTs in livestock species. It consists of the following database tables: (i) EST: provides a unique ID to every entry in the database, (ii) clone Information: contains clone information that has been used by the submitter, (iii) primers: the primer sequence, (iv) sequence: the EST sequences in text format, (v) library: describes source of the sequence, (vi) submitter: contains the contact information of the submitter, (vii) literature: contains information on references.

Information system for the management of GeneBank

A computerized information system (ISGerm) has been developed for management and use of information on germplasm in the NBAGR Gene bank. ISGerm includes the information on semen characteristics, health status, along with photograph, of donating bulls, and on semen collections.



A page showing characteristics of semen

Methodology for phenotypic characterization of AnGR

NBAGR has developed species-wise questionnaires, breed descriptors and technical protocols for conducting systematic survey for characterization of farm AnGR. The technical protocol is quite comprehensive and envisages conducting of scientific surveys by following modern sampling designs and suitable formats, descriptors and questionnaires for collecting all possible relevant information for a particular breed inhabiting a defined zoo geographical zone. On the assumption that the breeding tract of a breed is spread over adjoining/contiguous districts in one or more states, stratified two stage sampling design is adopted. Such surveys of breeds/animal types ensure mandatory recording of the following types of information:

i) Demographical and geographical distribution.
ii) The native environment.
iii) Enumeration of breeds in terms of age, sex in a population.
iv) Management practices and utility.
v) Qualitative and quantitative characterisation of breeds in relation to morphological, production potential and reproductive traits etc.
vi) Qualitative and quantitative description of unique, rare and elite animals.
vii) Photographic documentation of typical adult male and female and other categories of animals in different production environment.

The methodology has been used in the country for characterization and documentation of Farm AnGR and so far over 120 breeds/ populations of different livestock and poultry species have been characterized.

Registration of livestock and poultry genetic resources

A mechanism for registration of livestock and poultry germplasm has been initiated at NBAGR to protect and check the biopiracy of indigenous AnGR. This would provide protection to the valuable animal genetic diversity and facilitate its access for genetic improvement of animal breeds. A Breed Registration Committee has been constituted at the national level to oversee this process. Guidelines and procedure for registration of new breeds/varieties/strains/lines have been developed. Accession number consisting of an alpha numeric code has been given to each of 129 extant breeds of various species. Fifteen new breeds (3 buffalo, 7 cattle, 2 goat, 2 pigs and one donkey) have been registered. Thus so far there are 144 registered breeds of livestock and poultry in India.

Models for conservation

Conservation models for various livestock species have been developed, tested and standardized for implementation.

Farmer's herds/flocks based in-situ conservation

A total of 100-150 unrelated elite females in the farmer's herds/flocks, spread over the breeding tract are identified, registered and partial maintenance cost is given to the farmer / stakeholder. Minimum of 50 unrelated young males for future breeding are produced and raised till maturity with farmers. These male progeny are used for further breeding in the tract. It is useful for breeds having economic potential. It results in breed improvement and enhanced livelihood security.

Beetal goat conservation in its breeding tract in Punjab emerged as a success story for reviving the breed by this model.

Flocks of Beetal goats at farmer's door

Institutional organized farm based conservation

Twenty (20) unrelated young male progeny of elite animals from the breeding tract are procured and maintained at the organized farm. These breeding males are trained to donate semen for cryostorage at gene bank. The target is to produce the desired number of progeny in

the tract either by AI or through natural service depending upon the species, demand and facilities. It is useful to revive breeds from critical stage and also results in genetic enhancement, conservation and sustainable utilization of breed.

Conservation of Kilakarsal sheep of Tamil Nadu by natural service and Krishna Valley cattle of Karnataka by use of AI are the success stories with this model.

Krishna Valley breeding bull

Farmers' flocks of Kilakarsel sheep

Parentage verification protocols in different species

Parentage verification in camel

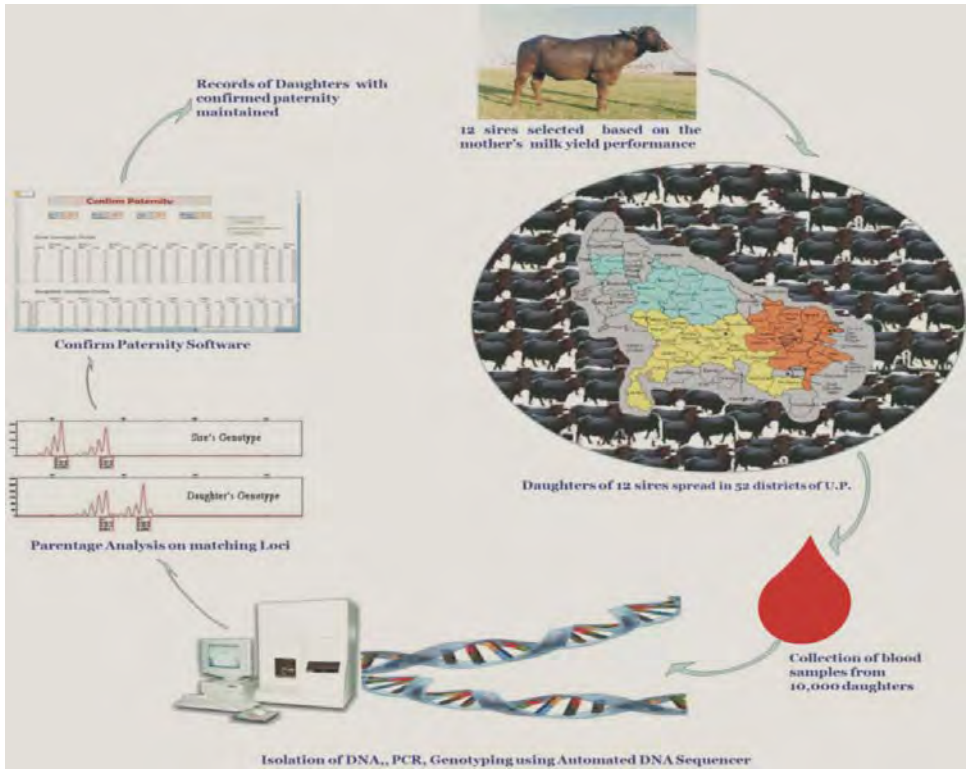
The protocols of using DNA based markers for parentage/paternity testing in camels has been developed for first time in India. It utilises a single multiplex PCR reaction of 15 microsatellite markers which results a high probability of exclusion. The PCR reaction has been tested on diverse camel populations and has performed well as all markers are found polymorphic and exhibit heterozygosity.

Parentage verification in zebu cattle

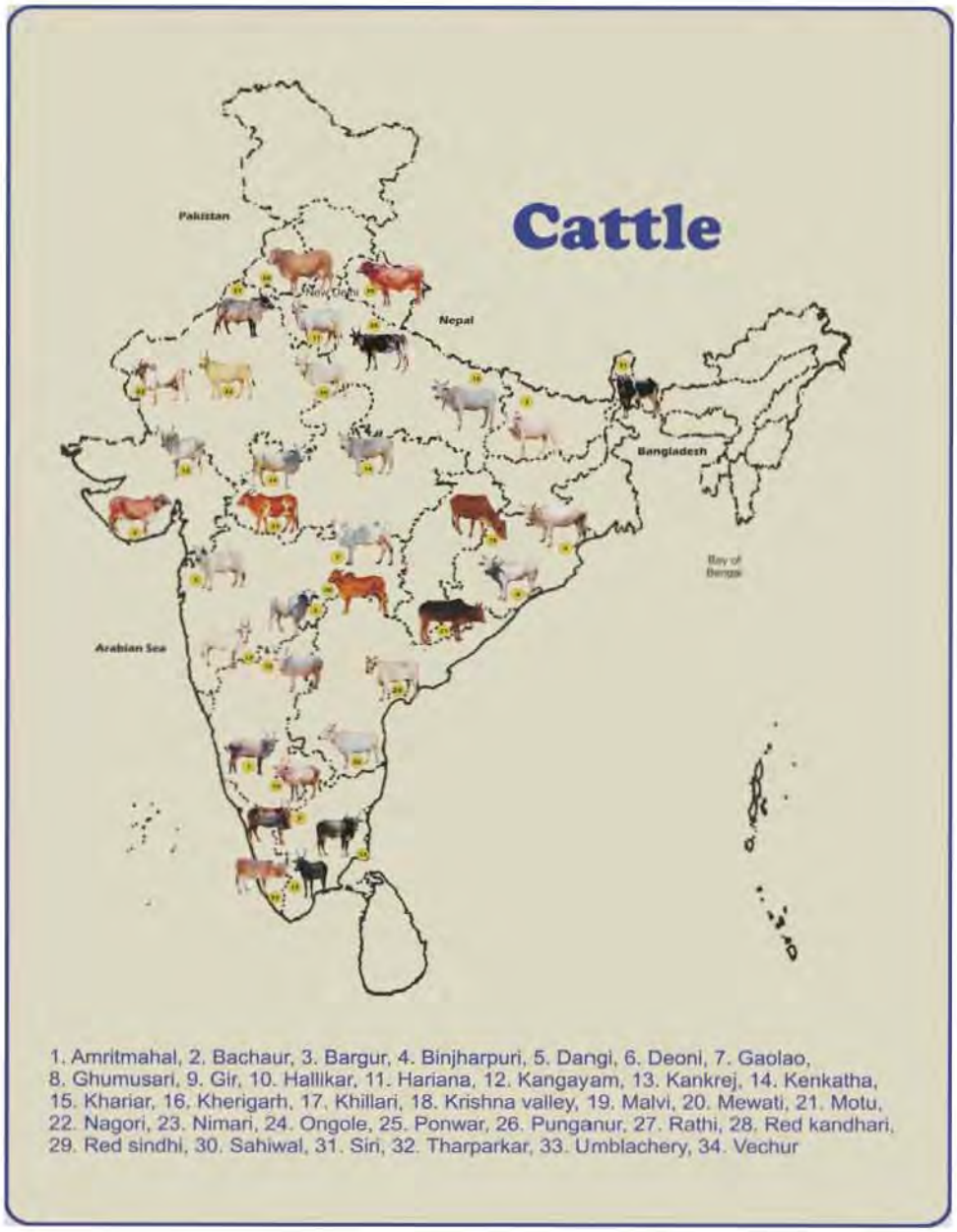
The protocol is based on microsatellite markers for parentage/paternity testing in zebu cattle. It utilises a single multiplex PCR reaction using 15 markers and provide a high probability of exclusion. The methodology was tested on indigenous cattle from different geographical regions of the India. All markers selected for the test are highly polymorphic and exhibit high heterozygosity.

Parentage verification in buffaloes

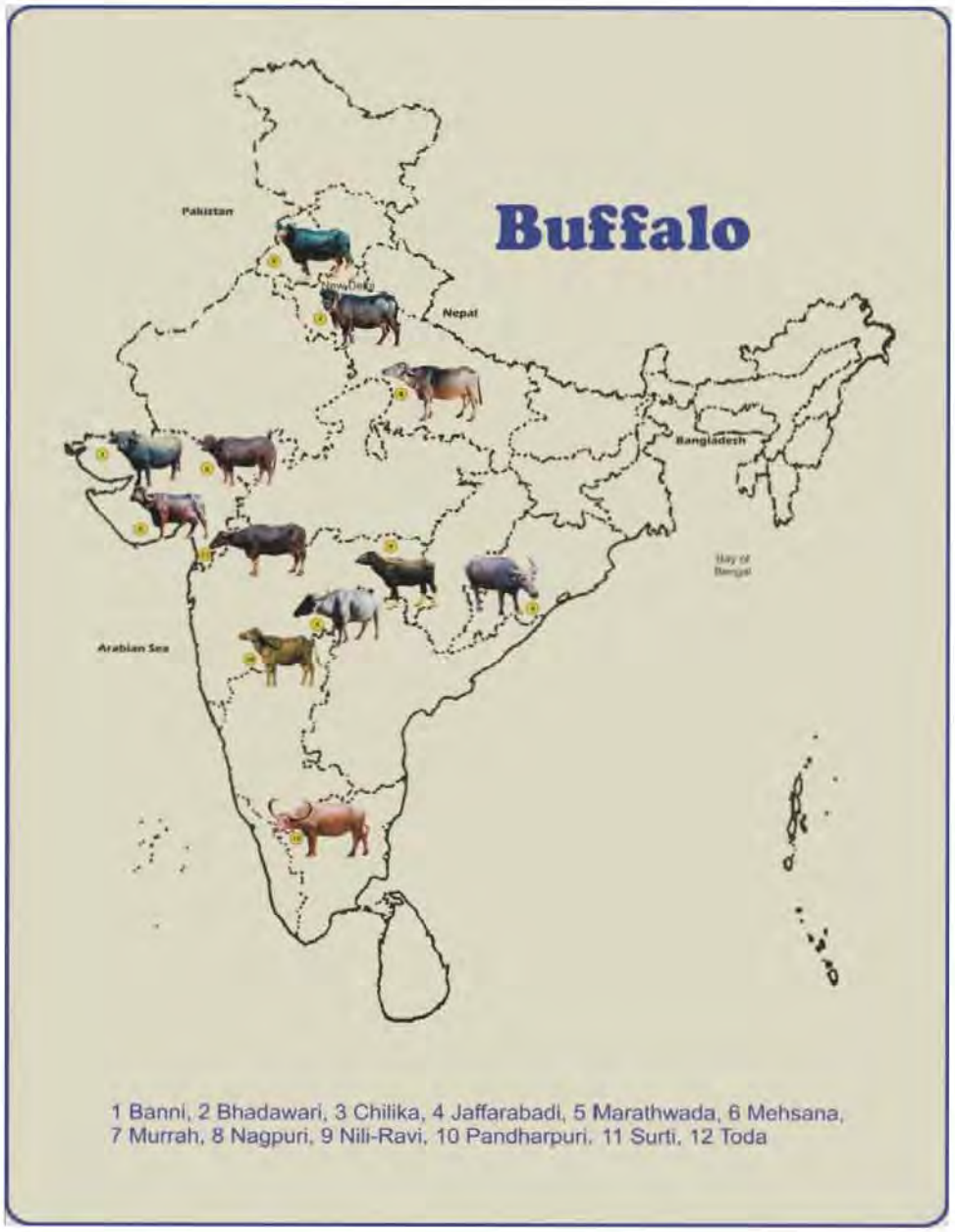
This is the first DNA based markers system for parentage testing in buffaloes. The developed protocol utilizes a single multiplex PCR reaction using 15 genetic markers and it has a very high probability of exclusion (>0.99). All markers are polymorphic and exhibit heterozygosity. The methodology has been validated by testing on 350 daughters belonging to 10 sire families.



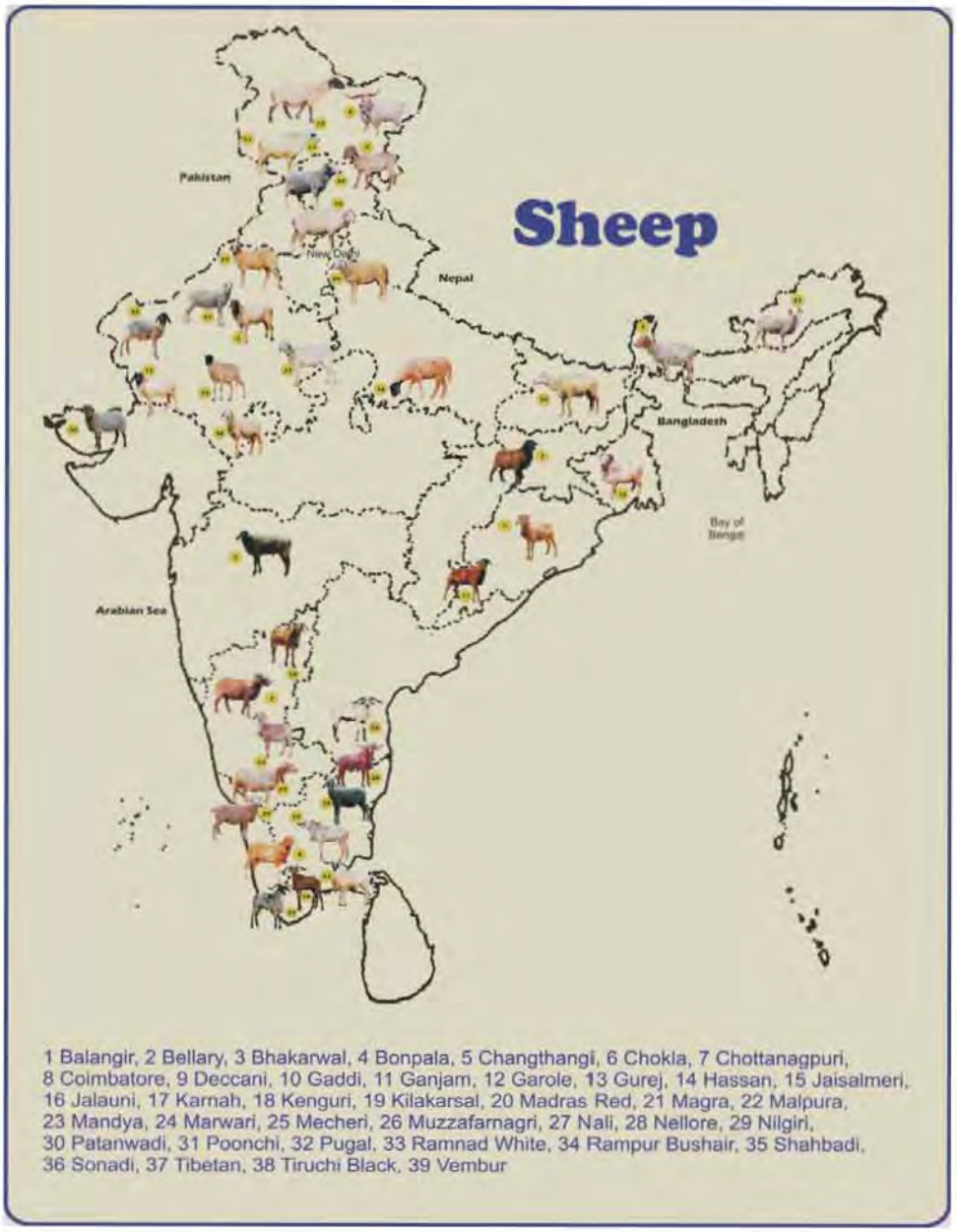
Schematic diagram of parentage verification steps



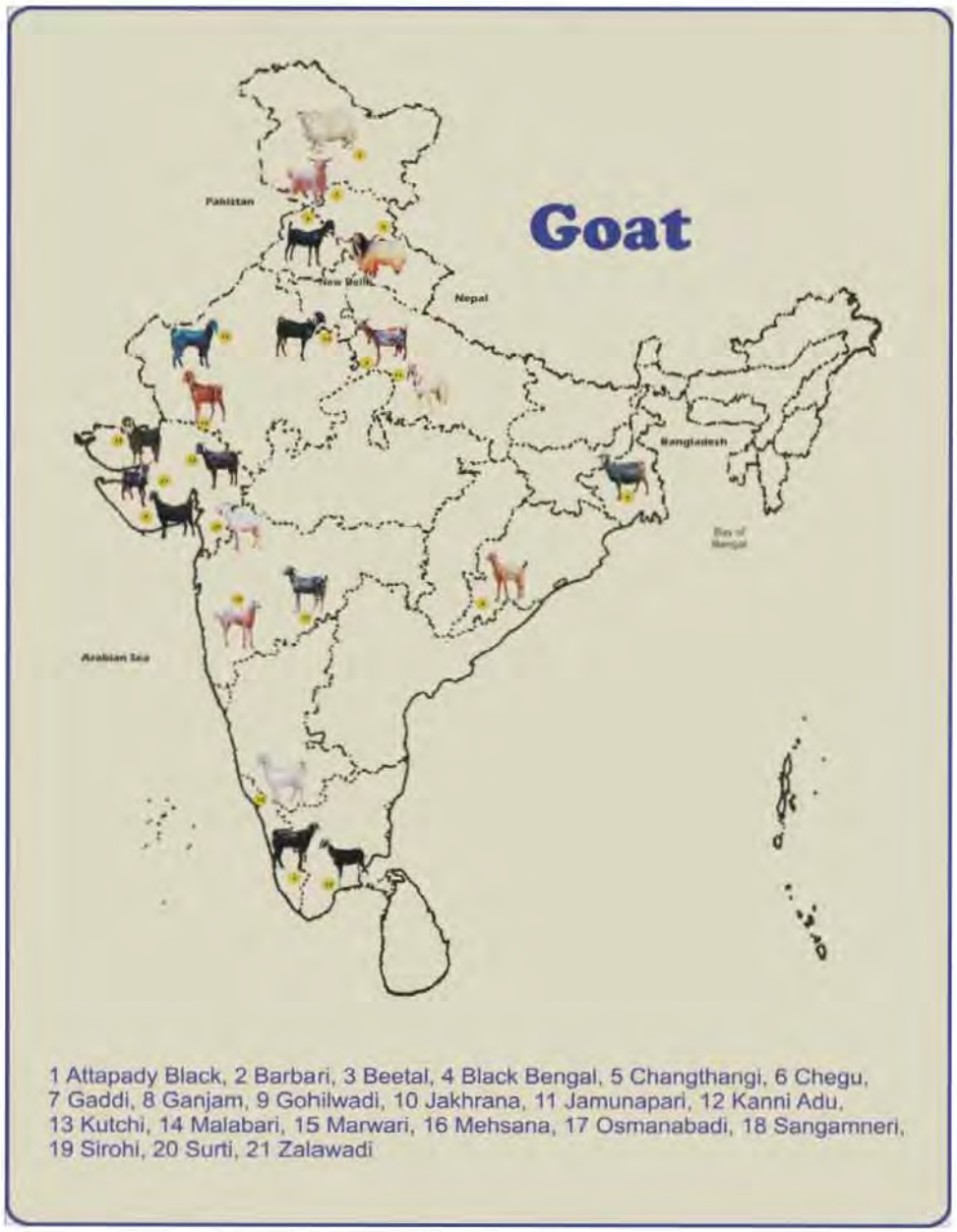
Distribution of cattle breeds



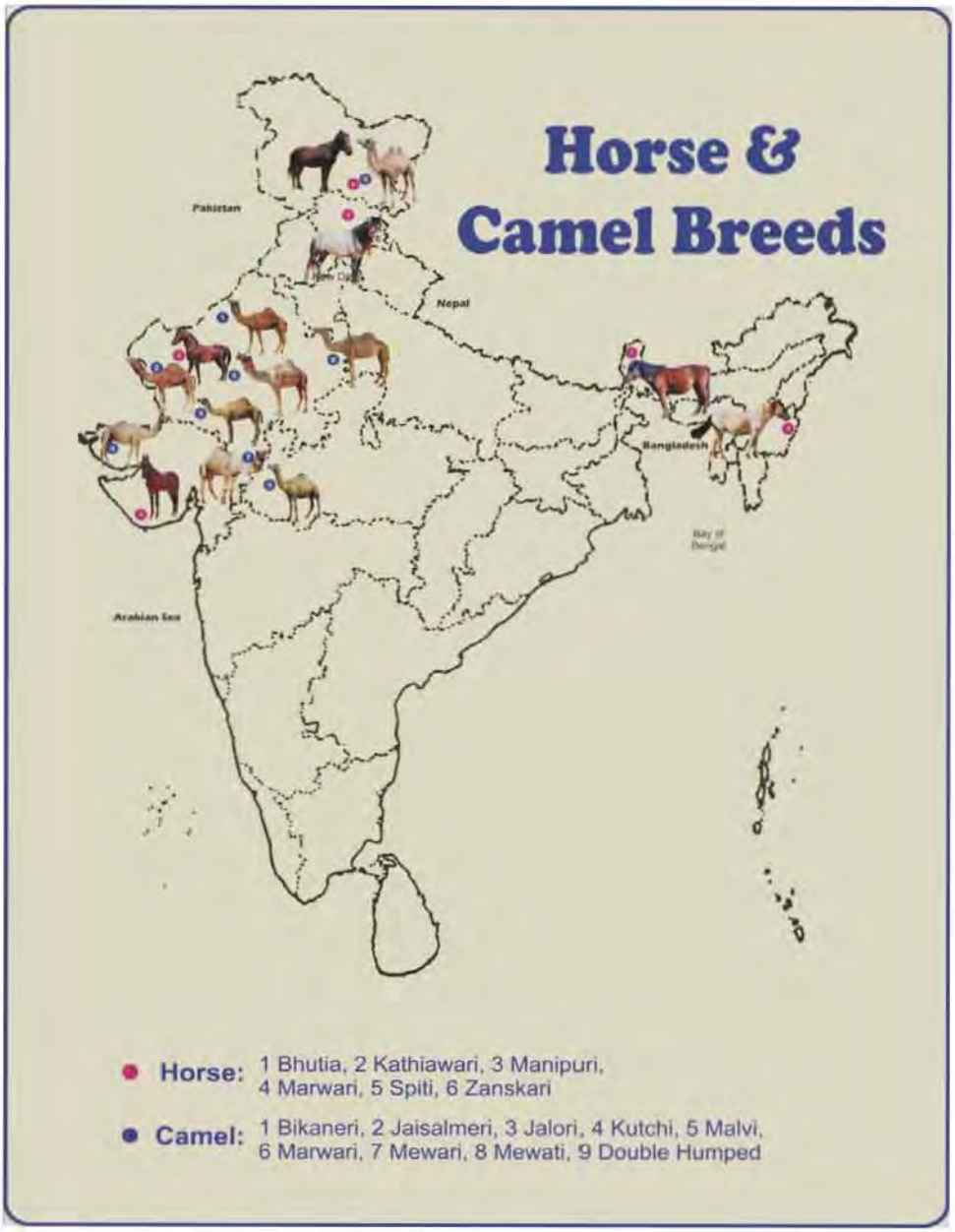
Distribution of buffalo breeds



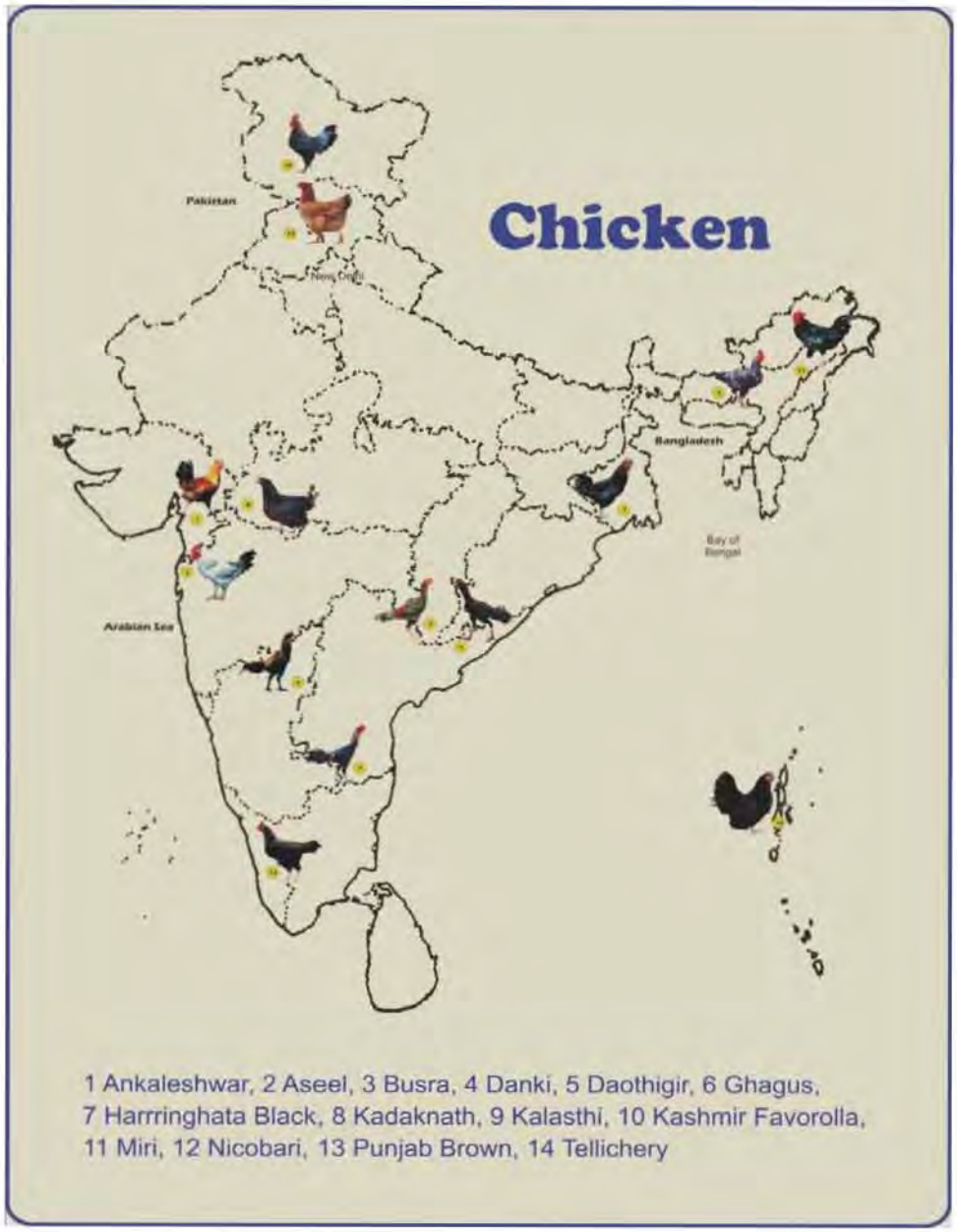
Distribution of sheep breeds



Distribution of goat breeds



Distribution of horse and camel breeds



Distribution of chicken breeds

Services being provided to livestock stakeholders

- Farm animal breed registration.
- Semen of endangered breeds of different livestock species.
- DNA sequencing.
- Parentage verification testing and pedigree analysis.
- Breed assignment of individual animal to breeds/ populations.
- Skill development trainings to different categories of stake holders in the areas of evaluation, characterization, conservation and utilization of AnGR.
- Consultancy, planning and policy making related to characterization, conservation and utilization of AnGR.

Karyotyping of breeding males

At NBAGR, the basic cytogenetic parameters of different species and breeds of various livestock species have been established. Cytogenetic screening service for cattle and buffalo breeding males belonging to different organizations associated with animal husbandry in the country is being provided to stake holders. Almost 2000 breeding males/male calves earmarked as future bulls have so far been evaluated for chromosomal abnormalities. About 1% of the bulls have been detected to be afflicted with chromosomal anomalies. Based on cytogenetic screening results, the bulls with chromosomal defects have been eliminated from breeding programmes. This service has been contributing significantly in weeding out chromosomal abnormalities from the breeding males.

❑

NATIONAL INSTITUTE OF ANIMAL NUTRITION AND PHYSIOLOGY

Bengaluru, Karnataka

Year of Establishment: 1995

The National Institute of Animal Nutrition and Physiology (NIANP) was established with the mandate of conducting fundamental studies on basic physiological and nutritional problems related to biophysical translation of nutrients for productive functions. The research work carried out and contemplated hold key for providing solutions to the existing and emerging problems in livestock production and productivity by understanding the mechanisms at cellular and molecular level.

Technologies developed

Area specific mineral mixture for livestock

Deficiency and or imbalance of micro- nutrients is one of the most important factors responsible for low productivity. As they are required in small quantities, can be supplemented more easily without affecting the existing feeding practices. Area specific mineral mixture (ASMM) was developed based on the micro-nutrient content in water, soil, feed and fodder and biological materials of animals. This technology has been commercialized and has a great potential in improving the reproductive efficiency and immunity in dairy animals.

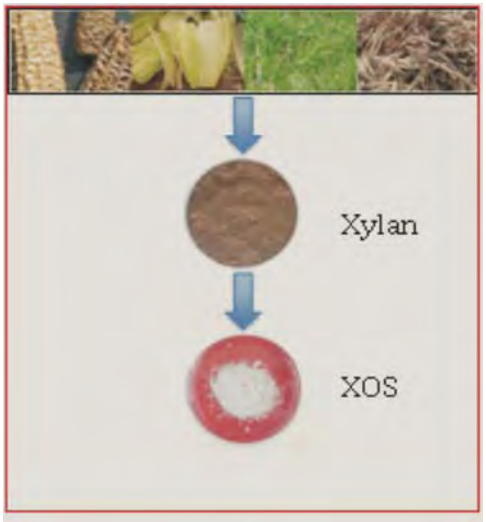
ASMM for four agroclimatic zones of Karnataka

Specific mineral mixture for small ruminants

The requirement of minerals for small ruminants vary considerably as compared to large ruminants due to their physiological needs. Specific mineral mixture for small ruminants was also developed for in improving productive efficiency and immunity.

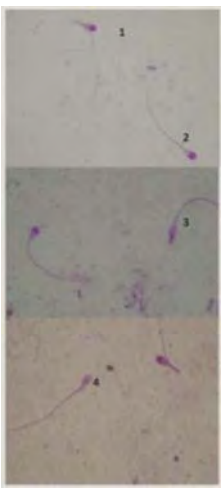
Production of prebiotics from agro-industrial by products

Protocols for prebiotic formulations have been developed from agriculture wastes like finger millet straw, corn by products and natural grass by production of xylo-oligosaccharides (XOS), which would be cost effective source for improving production and health in livestock.



Combination test for identifying sub-fertile semen

Conception rates following artificial insemination are poor especially in buffaloes (~30%). One of the reasons for this is the inability to identify subfertile bulls and thus the quality of the semen used in the AI programs. Routine tests of sperm concentration and mass activity that are used by the semen collection centers are not able to detect semen of subfertile quality. To address this problem, a highly reliable advanced combination test that can detect semen of subfertile bulls has been developed, which involves assessing acrosomal and functional membrane integrities of the sperm. Semen with sperms having both of these attributes have been shown to be highly correlated with fertilization ability in vitro. These tests can be adopted by semen collection centers to detect and discard the semen from subfertile bulls to overcome the low conception rate associated with poor quality semen.



Detoxification of castor, neem and karanja cakes

Due to shortage of concentrate feeds, there is a need to explore newer unconventional feeds. Most of these feeds contain antinutritional factors. A simple cost effective detoxification method using the process of dehulling, defatting and chemical treatment has been developed for neem seed cake, karanja cake and castor seed cake, which can replace 50% of crude protein of soya bean meal in the concentrate mixture. This would enable in reducing the feed cost and as well enhance the feed basket.

Neem cake

Karanja seed

Strategic supplementation of limiting nutrients

Strategically supplementing locally available energy rich sources like ragi and maize enhances the milk yield by 1 liter/ animal/day with concomitant reduction in the feed cost and increase return of Rs 15/cow/day.

Red spectrum of light enhances egg production

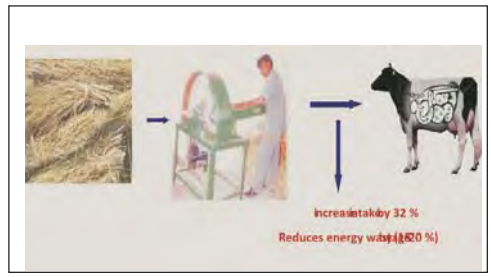
Egg production is dependent on the relative activation of two pathways. The inhibitory pathway is activated by stimulating retinal photoreceptors by the incandescent band of the spectrum, and the stimulatory pathway is activated by direct action of the red band on photoreceptors in the brain. Use of near red (675 nm) of the spectrum using red bulbs increased egg production during 72 week period from 77.89 to 85.21%. This technology will help in augmenting the existing management procedures in commercial poultry farms for enhancing egg production without additional cost.

Areca sheath - a promising roughage source

Over the years the availability of paddy straw has been reduced in some coastal regions and cultivation of areca as a commercial crop has increased. The areca sheath, a by-product of areca tree is found to contain less lignin and silica and nutritionally superior to paddy straw. However its use has been limited due to the physical structure. Technology developed to process areca sheath in total mixed rations which reduces the cost of feeding dry fodder by 50% with increase in milk yield and mitigate shortage of dry fodder.

Areca sheath chaffing and grinding process

Energy saving by chaffing of coarse roughages



Chaffing of coarse roughage

In India, the ruminants thrive mostly on the roughage and poor quality forages, which have higher content of lignocelluloses and thus are poorly utilized by the animals. Chaffing is the simplest and easiest process for reduction of particle size of roughages. Systematic studies carried out at NIANP has established that chaffing of low quality roughages has definite advantage in terms of not only increasing the DM intake by decreasing the time taken for ingestion but also in reducing the energy cost of eating in ruminants. Ruminants spends 50.0% of the metabolizable energy ingested in chewing when fed un-chaffed paddy straw ad lib, 44.0% when fed after chaffing (ad lib) and 41.0% when it was fed at restricted level after chaffing.

Data base on animal and feed resources

The Institute has developed district and state level database of animal and feeds and fodder resources available in the country. The databases are updated and refined for predicting the requirements of feeds and fodder in different parts of the country. Prediction equations are developed to project future production and demand of the feeds. Remote sensing technology is being used for assessment, which would help in devising necessary strategies to address the shortages of feed resources for improving productivity of livestock.

Generation of a database on enteric methane emission from ruminants

Based on a common protocol, the database on the methane production potential (MPP) from different feeding management has been generated. The feedstuffs have been catalogued based on their MPP. A model has been generated to derive MPP based on their nutrient composition.

Services offered to stakeholders

- Proximate analysis of feed and fodders (Moisture, Crude Protein, Ether Extract, Crude Fiber, Ash, Insoluble ash, NDF, ADF and LIgnin)
- Estimation of macro-minerals (calcium, phosphorus and magnesium)

- Estimation of Micro-minerals (Zinc, Copper, Iron, Sulphur, Manganese, Cobalt and Selenium).
- Estimation of heavy metal (Lead, Arsenic, Cadmium and Mercury).
- Estimation of Metabolizable energy by In-vitro gas production technique.
- Estimation of amino acids through HPLC.
- Estimation of aflatoxins (B1, B2, G1 and G2).
- Estimation of steroid hormones (progesterone, Estradiol and testosterone).
- Estimation of peptide hormones (FSH, LH, Prolactin).
- Estimation of T3 and T4.
- Estimation of Fluorine, Urea, Nitrate and iodine.
- Microbial tests including total microbial count and fungal count.
- Probiotic organism count (aerobic bacteria/yeast).
- Anaerobic count.

CENTRAL INSTITUTE FOR RESEARCH ON GOATS

Makhdoom, Farah-Mathura, Uttar Pradesh

Year of Establishment: 1979

THE Central Institute for Research on Goats (CIRG) was established with a vision to develop poor man's cow- the goat, as a source of livelihood security, poverty alleviation and employment generation for the smallholders. The institute is located between two famous cities, Mathura (22 Km) and Agra (32 Km) in the village Makhdoom of Mathura district at about 1.3 km from National Highway No. 2 on the bank of river Yamuna. CIRG is mandated to undertake research, training and extension education programmes for improving milk, meat and fiber production in goats and to develop processing technologies.

Establishment of elite flock of goat breeds

To improve the genetic potential of Indian Goat Breeds, the Institute established farms of Barbari breed, a native of Agra region, and Jamunapari breed, a native of Chakarnagar block

Barbari flock

Jakhrana flock

of Etawah district, during the year 1982. Presently 1200-1400 goats are reared annually of both the flock. The Jakharana flock was established during the year 2004. The goats were selected for higher body weight at 9 m of age, fecundity and dam's milk yield. Fourteen to 18 generations of intensive selection in Barbari and Jamunapari breeds has brought significant improvement in milk production, body weight and in reproductive traits. Ten breeds are covered under AICRP on Goat Improvement. The farmers flock of Marwari, Sirohi, Black Bengal. Ganjam, Assam Hill Goat, Surti, Osmanabadi, Malabari, Sangemneri and Gaddi were also established in phased manner to improve the productivity.

Shri Sharad Pawar, Hon'ble Union Minister of Agricuture and Food Processing Industries visiting animal flock at CIRG, Makhdoom

Superior germplasm to improve and conserve goat genetic resources

Superior germplasm flocks of Barbari, Jamunapari and Jakhrana goat breeds were established to improve native goat genetic resources at CIRG. Selective breeding has resulted in significant improvement in body weight, kidding rates, milk yield and population growth both under farm and field conditions. The improved flocks maintained at institutional farms gain 25-45% higher body weight at 12 month age than the base population.

Barbari

Jamunapari

Jakhrana

Introduction of superior germplasm has enhanced body weight (up to 79%), population growth (up to 63.26%), and kidding per cent (up to 84.58%) in farmers' flocks as well. Record number of 13 kids including two quintuplets born to a Barbari doe in 3 kiddings under field conditions indicated phenomenal impact of CIRG superior germplasm on fecundity of goats. Introduction of superior genetic resources has also facilitated conservation of indigenous goats with considerable enhancement in the income of goat keepers ensuring better nutritional and livelihood security. The superior germplasm of Barbari, Jamunapari and Jakhrana is available at CIRG for farmers, state government and other agencies to improve the native goat population.

Technologies developed

Frozen semen based artificial insemination

It is difficult to perform artificial insemination (AI) in goats due to complex anatomy of their reproductive tract. CIRG has optimised frozen semen technology for AI in goats. The technology has been successfully tested on 30 Sirohi and 27 Barbari goats. Insemination using frozen semen dose of approximately 50 million sperm is performed within 24 hours of heat. The conception rate achieved in the trial was 23.33 % in Sirohi and 25.92 % in Barbari goats. Frozen semen

based AI technology has great potential for improving native goat genetic resources and farmers flocks through use of elite buck semen from organized farms. CIRG also maintains frozen semen bank of Barbari, Jamunapari, Jakhrana and Sirohi goat breeds.

Pelleted complete feed technologies for sustainable goat production under intensive feeding system

Pelleted complete feed

Declining feed and fodder resources and grazing area is a major challenge to goat rearing. To address this challenge, complete feed technologies to cater to the nutritional requirement of goats under intensive feeding system was developed. The technologies include tree leaves based complete feed pellets and monsoon herbage based complete feed pellets. Different combinations of dry leaves of Anni (*chlorodendron phlomides*), Heens (*Capparis horrida*) and Neem (*Azadirachta indica*), and Arhar (*Cajanus cajan*) straw have been used with concentrate mixture in 60:40 ratio. The herbage based complete feed consists of *Tephrosia purpurea, Cenchrus ciliaris and Dactylotennium aegypticum* plant foliage with concentrate in 60:40 ratio. The nutritive value (digestible crude protein) of the complete feed pellets is between 5.42% and 13.63% on dry matter basis. The cost of complete feed is Rs. 6-7 per kg with an average weight gain of 58 to 80 g/day in growing kids. The technologies have been adopted by several commercial, small and marginal goat farmers for sustainable goat production with considerable financial benefit.

Goat feeders for better feed utilization

Hexagonal feeder

Goat feeders have been developed which are suitable for feeding concentrates, dry and green fodders simultaneously, thereby reducing the cost of labor and feeding time under semi-intensive and intensive goat production systems. The height of feeder trough is designed at the shoulder point of goats considering their feeding/grazing habits. The technology has been effective in reducing feed wastage (from 35-40% in conventional ground level feeding method to 5-10%) and chances of contamination of feed with animal excreta. The rectangular feeder can accommodate 10-12 goats, whereas hexagonal feeder can feed 12-15 goats.

Approximate cost per feeder is Rs. 5000-6000. The adoption of technology reduces cost of feed by 25-30%, which is estimated about Rs.30.00 per day for ten goats. Use of this technology under intensive feeding condition also reduces pressure on natural resources, mortality and morbidity facilitating sustainable goat rearing with better economic returns.

Rectangular feeder

Annual preventive goat health calendar for better health and optimal production

In order to control devastating goat diseases, a goat health calendar for routine screening, timely vaccination, strategic deworming and other preventive measures has been developed by CIRG. This protocol is being adopted widely under farm and field conditions with considerable reduction in goat mortality to less than 5% at organized farms and about 10% in farmers' flocks. Unique features of the technology include immunization at four month age for PPR, goat pox, FMD and ET, followed by annual booster, observance of a minimum of post- immunization cool-off period of 15 days for transport/shifting of animals and pre and post- monsoon strategic deworming. Implementation of preventive goat health calendar in adopted villages under varied agro-climatic conditions has been effective in preventing occurrence of diseases like PPR, goat pox and ET and 2-3 times enhancement of annual family income of goat keepers.

Elisa based diagnostic kits for effective control of brucellosis and johne'e diseases in goats

Diagnosis is the most crucial aspect for effective control of diseases. CIRG has developed immune-diagnostics for timely detection of brucellosis and Johne's disease (JD) in goats. Both the diseases cause considerable economic losses. Brucellosis causes abortions, still births and diminished levels of milk production. JD is associated with chronic loss in body weight. Following timely detection of the diseases, the incidence of brucellosis was reduced to less than 3% from

BRUCHECK kit for Brucellosis

ELISA kit for Johne's disease

13% under the farm conditions. The use of JD diagnostic helped in minimizing the incidence of the disease to a minimal level in the goat flocks. These diagnostic techniques are easy to perform and are better than the conventional diagnostic methods being rapid and more specific. The cost of single test for brucellosis and JD is calculated to Rs. 12 and Rs. 25, respectively, which makes the testing eight times cheaper than the imported kits. Both the technologies have been tested at multi-locations in the country and used under farm and field conditions leading to minimizing the production losses with better financial returns to goat keepers.

Value added products from goat meat and milk

Emulsion based value-added nutritious goat meat product technologies

Range of emulsion based goat meat product technologies such as nuggets, sausage, patties, slices, kofta and shammi kebab have been developed by the institute. The products are rich in protien, fibre, polyunsaturated fatty acids including omega-3 fatty acids and are highly acceptable by the consumers. The protein and fat content of the products vary from 14 - 22% and 10-12%, respectively. The cost benefit ratio is 1:1.25. The shelf life of the products under refrigeration is 20 days, which can be extended up to 120 days under frozen conditions. The products

Goat meat sausages

Goat meat nuggets

Goat meat cubes

are highly valued for their health promoting attributes and also for better utilization and marketability of goat meat thereby generating better income to the goat farmers.

Non-emulsion based meat product technologies from spent animals

CIRG has developed non-emulsion based meat technologies such as meat pickle, cutlets and samosas by using cheaper meat cuts and also from spent animal meat. Goat meat pickle is

a shelf-stable value added product prepared using pre-cooked spent meat. Product is highly acceptable among consumers. It has good market potential even in remote and difficult areas where fresh goat meat availability is limited. The pickle contains 12% protein and 18% fat and can be stored at room temperature for 60 days. The technology provides an important tool to ensure nutritional security. Cutlets and samosa are ready to eat meat products. These are prepared using cooked and minced goat meat chunks, blended with fried green and dry spices mix, refined wheat flour, cooked mashed potatoes etc. The protein content of the products is 12-14% with 8% fat. These can be stored for 10 days in refrigeration. Commercialization of these technologies requires small financial investment and therefore offers good opportunity for unemployed youths and women to initiate small scale commercial venture.

Goat Meat Samosa

Goat Meat Murukku

Goat Meat Nimkee

Value added nutritious crispy goat meat products

Highly nutritive goat meat based functional snack product technologies *Nimkee* and *Murukku* have been developed. These products are rich source of protein, dietary fiber and beneficial unsaturated fatty acids and maintain the status of snack food. The shelf life of products packed in modified atmospheric packaging conditions is 4 months under room temperature. These crispy food products are highly acceptable by consumers. At commercial scale, the production cost of *Nimkee* and *Murukku* is Rs. 20-35 per 100 g with a cost benefit ratio of 1:1.40 and 1:30. The technologies are available for commercialization.

Value added nutritious goat milk technologies

Goat milk is known for its medicinal properties and as a promising functional food. The market value of goat milk can be enhanced by developing value added products. Range of such products including goat milk paneer, milk based biscuits, shrikhand, milk pops, ice-cream etc have been developed. These products contain higher amount of medium chain fatty acids, which are known to be beneficial for human health. Goat milk paneer is preferred

Goat milk paneer

Goat milk biscuits

by the consumers and is in much demand. Goat milk paneer contains 18-22% protein and 25-30% fat, and can be stored for 7 days under refrigeration condition. Approximately 120-140gm of paneer can be obtained from one liter of milk.

A safe moisturizer goat milk based beauty soap

An ecofriendly safe moisturizer soap formulation using goat milk and fatty acids has been developed. Goat milk soap has many distinctive advantages over conventional beauty soaps. The pH of soap is almost equivalent to the pH of human skin. Goat milk soap doesn't contain additives like alcohol, petroleum and preservatives, thus reduces the risk of skin irritation and allergic reactions. Goat milk soap has been found useful for people with acne-prone skin. The evaluation of soap on the basis of various parameters such as lather, moisturizing ability, fragrance and texture has been highly encouraging. The production cost at small scale for 80g cake is approximately Rs.15/ . The technology is available for commercialization.

Goat milk based beauty soap

Shelter requirements for goats for better productivity

Environmental factors, animal shed structures, appliances and management practices influence the performance of goats especially under intensive and semi-intensive systems of management. Due to

Goat shed

stocking of large number of goats at one place impact of housing becomes more pronounced on the production parameters, morbidity and mortality. In the intensive system of management the economic viability of the farms is largely dependent on the expenditure incurred on feed and fodder. Shelter requirements of goats for different agro-climatic zones in the country vary widely. The Institute has worked out the optimum floor space requirements for different categories of goats.

Milk replacer for pre-weaning kids

Most of the prolific goat breeds in India are poor milk yielders. Milk replacer/substitute supplies essential nutrients to multiple birth kids and to the kids having no or minimum accessibility of mother' milk. Milk replacer with 24%CP can maintain the growth performance of kids (2 or 3 weeks-13 weeks) which is cheaper than mother's milk.

Formulation of area specific mineral mixture

An Area Specific Mineral Mixture Technology, developed under the AICRP programme, was released by the Hon'ble Union Minister of Agriculture and Food Processing Industries, Shri Sharad Pawar during his visit to the institute on January 24, 2011. The area specific mineral mixture was formulated on the basis of micronutrient status in soil, water, feed and fodder and animals of different livestock species in South- Western semiarid, Central and Eastern Plain zones covering 30 districts of Uttar Pradesh. The use of the mineral mixture resulted in significant improvement in the fertility as well as productivity of different livestock species under field conditions. The commercialization of this technology is under process.

Listserv for instant help in goat research and production

Email conferencing system

The *listserv* is the e-mail mailing system which automatically sends/forwards mails to a group of people. It keeps the mail address of the members in a database mail are received by the list. The first list <aris-net@cirg.res. in> is dedicated to discussion related to information system and technologies available in Agriculture Research and Production system of India. Another list named <agri-net@cirg.res.in> is dedicated to discussions, queries, and information flow on any branch of Agriculture, Animal and Fishery Sciences. The memberships to the two lists are on request and automatic. The first line is for 'aris-net' list membership and next is for 'agri-net' list membership:(Subscribe aris-net@cirg.res.in ,Subscribe agri-net@cirg.res.in). Then any mail received by list name is forwarded as per the membership list available in the file.

Services provided to stakeholders

CIRG provides genetically selected and performance evaluated goats of 11 breeds at 14 locations across the country to improve the farmers flock under AICRP on Goat Improvement programme to state governments, NGOs, progressive farmers and entrepreneurs. Semen of superior bucks is preserved for multiplication of elite animals in farmers flock through artificial

insemination technology .The Institute provides disease diagnostics services, and attends disease outbreaks in different parts of the country. The health camps are being organized at regular intervals at farmers' door to reduce morbidity and mortality, and to create awareness regarding the importance of immunization schedule amongst goat keepers. Consultancy on feed formulation, feed resource development and use of locally available feed for better productivity of goats is being provided to farmers. The institute also organizes training programmes for farmers and other stake holders with modular training model and need based programme.





Help line

The Institute also maintains a helpline service at +91-565-2763320 for goat farmers to provide instant solutions for their day to day problem. The institute receives on an average 20 calls per day through helpline service.

CENTRAL SHEEP AND WOOL RESEARCH INSTITUTE

Avikanagar, Rajasthan

Year of Establishment: 1962

Regional Stations : Northern Temperate Regional Station Garsa, Kullu, Himachal Pradesh (1963)

Southern Regional Research Centre, Mannavanur Kodai Kanal Dindigal, Tamil Nadu (1965)

Arid Region Campus, Beechwal, Bikaner, Rajasthan (1974)

CENTRAL Sheep and Wool Research Institute (CSWRI) is a premier institution, mandated to conduct basic and applied research on all aspects viz., breeding, reproduction, nutrition, health, wool and meat production and product utilization. The campus is spread over an area of 1510 hectare. It has three regional research centres in different agroclimatic zones of the country to develop region specific technologies. The institute has well developed sheep production units having quality germplasm of indigenous sheep breeds.

Establishment of elite flocks

The institute has well developed sheep flocks of Malpura (750), Chokla (550), Avikalin (350), Patanwadi (100), Patanwadi crosses (200), Garole (40), Kendrapada (100) and Garole crosses (300) for genetic improvement and other technology development. In addition a unit of broiler rabbit having strength of 350 rabbits of Soviet Chinchilla, White Giant, Grey Giant, Black Brown and Dutch genotype is being also maintained.

Bharat merino flock at SRRC, Mannavanur

Improved germplasm developed

Malpura, a promising breed for mutton production

Malpura, an indigenous sheep for mutton has been improved through intensive selection. Body weight at six month of age has been improved from 13.84 kg in 1974-75 to 25.74 kg in 2010-11. High genetic merit rams are being supplied to the farmers for genetic improvement of animals in the breed tract. The improvement in the farmer's flock was 7.63 and 14.92 per cent at 6 month's body weight and in first six monthly greasy fleece yield (GFY), respectively.

Malpura Ram

Chokla, best carpet wool breed

Chokla sheep has been improved through intensive selection for fine carpet wool production. It produces 2.4 kg wool per annum with average fiber diameter of around 30m and medullation of around 30%. The staple length of more than 6.0 cm makes it ideally suitable for carpet.

Chokla ram

Prolific sheep

Highly prolific sheep were created by introgression of *FecB* gene from Garole sheep into the non-prolific and large sized mutton breed Malpura. In GMM crosses multiple births has reached to 40% as compared to single births in Malpura. Increased prolificacy will boost the total mutton production in the country.

Prolific crossbred ewe with triplet

Technologies developed

Artificial insemination (AI) in sheep with liquid semen

The technique for AI in sheep using liquid semen has been developed. AI has direct impact on the production level of the progeny and improves the desirable production traits like body weight, wool quantity and quality and fecundity in a very short span of time. This technology has been used both in organized farms and in farmer's flock using semen of elite rams.

AI in sheep at farmer's door

Indigenous intra-vaginal sponges for oestrus induction and synchronization

Progesterone impregnated intra-vaginal sponges have been developed indigenously for oestrus induction and synchronization in sheep and goats. These sponges are being utilized for fertility management and artificial insemination programme. This technology has been commercialized. Till date more than 15000 sponges have been supplied to different agencies including ICAR and SAU institutes, State Government, KVKs, organized farms and NGOs.

Indigenous intra-vaginal sponges

Intensive lamb rearing for maximizing mutton production

Intensive feeding protocols for lambs on (i) complete feed consists of roughage and concentrates mixture in ratio of 50:50 or (ii) free grazing and *ad libitum* concentrate mixture supplementation for mutton production has been developed for attaining finishing weight of 33.0 kg at 6 month of age in lambs of native breeds. The venture is found to be economically viable and would boost mutton production in the country. This would also enhance income of the farmers engaged in sheep rearing practices.

Intensive lamb rearing

Area-specific mineral mixture

Area specific mineral mixtures (ASMM) for cattle, buffaloes, sheep and goats of semi-arid region of Rajasthan have been developed for improving health, reproduction and production level. The ASMM is available in both pelleted and powder form. The later is having advantage of delivering the micronutrients in more complete and in quantifiable manner.

Mineral pellet supplements

Mineral supplement powder form

Complete feed block (CFB)

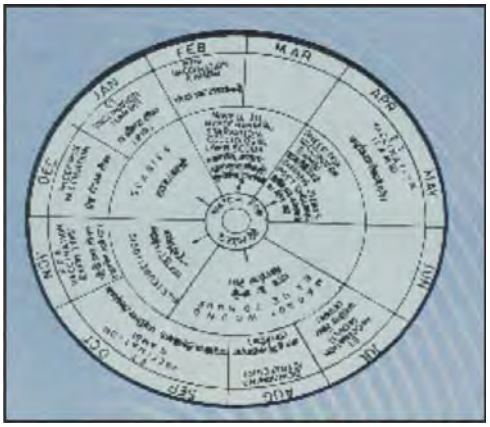
The complete feed block of roughage and concentrate mixture was prepared in 70:30 ratios with 5.0% of molasses for easy binding. The blocks have many advantages like ease in transport, palatable in nature, lower in space requirement for storage and reduced losses during transport. Use of feed block to sheep and goat reduces the cost per kg gain by 38% as compared to the control diet (grass hay and concentrate). CFB

Complete feed blocks

reduces bulk density by 33% and can be stored up to 2 yrs in dry weather without deterioration in nutrients.

Planned flock health calendar for sheep flocks in semi-arid Rajasthan

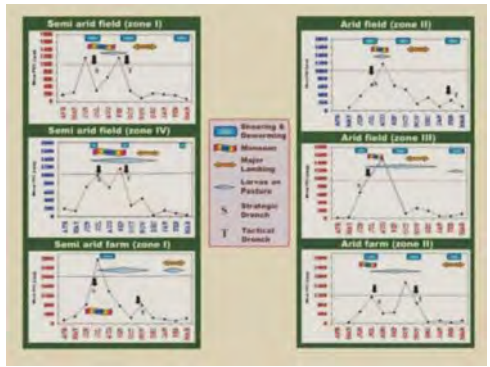
To reduce the losses caused by diseases in field flocks, an annual health calendar was developed through planned flock health approach following extensive studies on morbidity and mortality profile in field flocks of semi-arid Rajasthan. Prior to adoption of prophylactic health calendar the average mortality in farmer's flocks was over 20% (1975-76), which was brought down to about 11% in 1985 and then further reduced to about 5%.



Flock Health Calendar

Modified worm management technology for sheep in Rajasthan

Gastrointestinal nematode (GIN) infections are an important cause of lost productivity in sheep of Rajasthan state. Farmers drench their animals with anthelmintics usually 2-3 times in a year coinciding with shearing operation. This practice of worm control resulted in failure of worm control programme due emergence of anthelmintic resistant strain of parasites throughout the state. Based on real time epidemiology of parasites, managemental (reproductive, grazing practices etc) and climatic conditions region based worm management programmes were formulated. The programme includes one strategic drench during mid to late monsoon and one need based tactical drench during autumn/winter. The programme saves Rs. 12 / sheep / annum compared to conventional drench schedule without compromising the flock productivity. Comparative evaluation of conventional (2-3 drench/annum) and modified technology (one drench/ annum) in sheep naturally infected with GIN at farmer level yielded a net gain of Rs. 100.57 / sheep/yr as direct benefit on application of modified technology. Further, indirect benefits of technology are reduction in selection pressure on parasites, delaying the emergence of anthelmintic resistance and extending the life of existing anthelmintics.

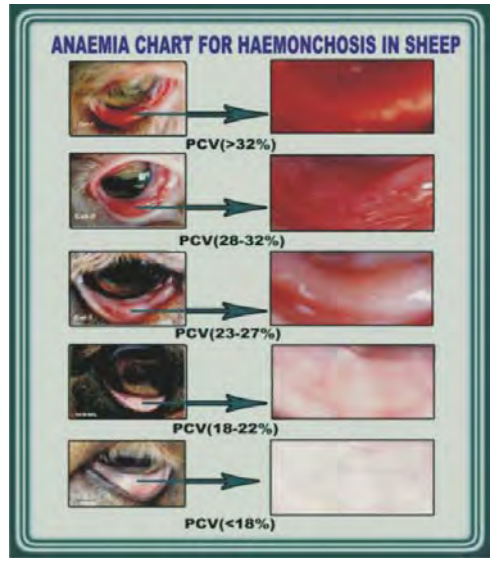


Modified worm management programme for sheep flocks of Rajasthan

Targeted selective treatment (TST) approach for management of haemonchosis in sheep

To increase quantum of refugia and decrease in selection pressure for anthelmintic resistance through harvesting the benefits of over-dispersion in faecal egg count, targeted selective technique was developed for management of haemonchosis in sheep.

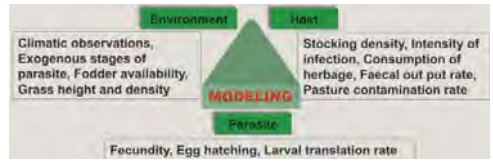
It is a simple system to categorize the anaemic status of sheep based on the conjunctiva mucosa colours on a scale from 1 (red) to 5 (white). Only those sheep categorized in group 4/5 were recommended for anthelmintic treatment particularly in wormy season. An average of 23% sheep in flock was given drench/annum through TST as against 100% in modified or 200-300% in convention approach. Direct benefit of TST application in sheep flock resulted in reduction in expenditure on anthelmintics from Rs. 7.0 to Rs. 0.81/head/yr.



Anaemia chart for haemonchosis in sheep

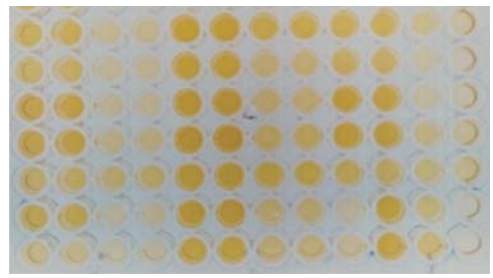
FROGIN: Software for forecasting gastrointestinal nematodiasis in sheep of Rajasthan

It is a computer based programme which simulates life cycle of *Haemonchus contortus* in sheep and on pasture for different agroclimatic conditions of Rajasthan. This programme is capable of precisely forecasting the magnitude of parasitism for 60 days in advance and is extremely useful in decision making to organize deworming camps for sheep. Further, the programme is capable of shifting the scheduled drench in face of changing weather pattern and managemental modifications made by farmer. It's implementation showed 70-80% similarity in predicted and observed intensity of strongyle infection in sheep flocks of Rajasthan.



Development of an ELISA for diagnosis of paratuberculosis (Johne's Disease)

An ELISA for diagnosis of Johne's disease developed and tested on natural sera of over 3000 small and large ruminant population in the country. The test has better sensitivity and over 95% specificity. The assay is rapid and easy to perform and can be used as screening test at organized farms as well as in field conditions. The detection of animals even several months before they die is a significant advantage for early removal of animals from the flock/herd to reduce further load of infection at the farm premises.


Diagnosis of Johne's disease by ELISA

Carpet from indigenous wool and its blends

Indian wool is graded as best carpet type wool providing excellent resilience, lustre and performance. In order to improve the abrasion resistance, a process in which the wool is blended with 10% nylon fibre has been developed at CSWRI, Avikanagar.

Functional carpet

Handloom weaving

The high productivity, low cost and profitable carpet manufacturing through handloom weaving has been introduced to weave plain and strips carpets for wall to wall covering. The technique has been standardized for important carpet parameters viz. pile height, pile density and ply of yarn.

Dyeing technology using natural dyes for wool and specialty fibres

The concern for the clean environment has created a deep interest in natural dyes. Several sources of natural dyes were screened for dyeing wool and specialty hair fibres. A comprehensive natural dyeing process is being standardized by which the wool can be dyed into all range of colours with good light and wash fastness properties.

Shawl dyed with natural dyes

Value added meat products developed from mutton

Diversified mutton products have been developed with a wide variety of flavors, textures, and shapes. Mutton nuggets are partially or completely emulsion based products, contain less fat. The mutton nuggets are also coated with suitable ingredients and then deep fat fried to give attractive golden brown color and to enhance palatability of the product. The other value added products

Meat product

prepared were sausages, petties, pickles, soap enrobed eggs, muuton loaves and mutton kofta.

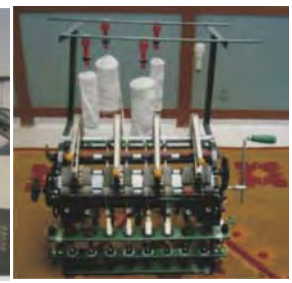
State of the art facility

A wool processing plant was commissioned at the institute under UNDP in 1968. The institute has complete set of machineries from scouring to finishing of woolen goods. A testing lab has also been established to carry out all kind of testing including latest testing equipment i.e. Fabric Assurance by Simple Testing (FAST) related to wool and woolen products. Presently, the plant is dealing with the research and development in various aspects of wool and animal hair fibers i.e. fiber quality evaluation, yarn manufacturing, product development along with chemical finishing. The institute provide consultancy for animal fibre evaluation, processing and product manufacturing techniques to various agencies dealing with animal fibre in the country.

Dehairing cum carding machine

Spining machine

Blanket finishing



Amber charka

Services being provided

Through three trasnfer of technology (TOT) centres, the institute is providing better quality germplasm in the form of breeding rams, accelerating reproductive performance in farmer's flocks through oestrus synchronization and articficial insemination, demonstrating benefits of concentrate supplementation to lambs and pregnanant / lactating ewes. The technologies related to fodder development and effective utilization of grazing resources are

regularly demonstrated. The flock health is being managed through timely vaccination and drenching as well as need based treatment by periodical visits and organization of health camps. The institute also provide training to local artisans for value addition of wool and actively engaged in creation of awareness among sheep farmers for scientific rearing and adoption of newer technologies.

Arid Region Campus, Bikaner, Rajasthan

The Arid Region Campus (ARC) of the CSWRI was established at Bikaner. The centre has 636 hectares of land. The centre has established elite sheep flocks of Magra and Marwari sheep with a strength of 700 and 800, respectively.

Magra, a lustrous carpet quality wool sheep

Magra sheep has been improved for lustrous carpet wool production. This wool is in great demand from carpet industry because luster in carpet fetches higher price. First six monthly GFY and annual GFY are 0.95 and 2.20 kg, respectively. Wool quality traits of this breed are most suitable for a standard carpet. Fibre diameter (32.0 ì), staple length (5.15 cm) and medullation (40-45%) of this wool are most suitable for excellent carpet. Every year nearly 100 superior breeding rams are being supplied to farmers/ Government agencies for genetic improvement in the animals in field.

Magra ram

Marwari, a robust sheep breed of arid zone

Marwari is one of important carpet wool producing sheep breed of North Western arid and semi arid region of India. The breed is hardy and well adapted to harsh and erratic climatic conditions of hot arid region. This breed is considered to be largest in number and distributed widely in Rajasthan and some parts of Gujarat. The body weight at six month improved by 41.94 % *i.e.* from 15.9 kg to 22.6 kg since the year 1993. The improvement (46%) in body weight at 12 month was from 20.8 kg to 30.4 kg. The adult annual GFY was improved from 1209 g to 1484 g (22.8 %) due to intensive selection and improved management of the sheep flock. The twining percentage was increased significantly due to better feeding and management practices followed at ARC Bikaner. The top ranked rams were selected and used in breeding to

Marwari ram

bring genetic improvement in the animals. A total of 981 superior breeding rams and 206 hogget males were supplied to the Government Agency/Farmers/ NGO/ Developmental agency since inception of Network Project.

North Temperate Regional Station (NTRS), Garsa, Himachal Pradesh

North Temperate Regional Station of CSWRI was started at Garsa, Kullu valley of Himachal Pradesh. This station is located at 1400-2100 meters above mean sea level on the right bank of Garsa stream. The centre is having a flock of 450 sheep and a unit of 550 Angora rabbits.

Gaddi Synthetic sheep

The centre maintains the high quality germplasm of Gaddi Synthetic for improvement of sheep for fine wool production. The management practices and health calendar has been prepared for improving health and production performance both in stationary as well as in migratory flocks.

There are three breeds of Angora rabbits, viz. British Angora, Russian Angora and German Angora. The german angora yields 900 g of fine specialty fibre annually and is very popular amongst farmers in the Kullu Valley.

Angora rabbit

Southern Regional Research Centre (SRRC), Mannavanur, Tamil Nadu

Southern Regional Research Centre of CSWRI is located 35 Km from Kodai Kanal (Tamil Nadu). This centre is situated at an elevation of 2030 meters above mean sea level. The average annual rainfall is 1055 mm, well spread throughout the year. The centre is mandated to undertake research on fine wool sheep and broiler rabbits under temperate climate and having a flock of Bharat Merino sheep and a unit of broiler rabbit with a strength of 350 and 400, respectively.

Bharat Merino sheep

Bharat Merino: A fine wool producing sheep of India

This fine wool crossbreed sheep was evolved by crossing halfbred ewes of Chokla, Nali, Malpura and Jaisalmeri with Rambouillet and/or Russian Merino rams and stabilizing the exotic inheritance at 75%. This breed is suitable for temperate and sub-temperate regions of the country and suitable

for apparel wool production. Adult annual GFY is more than 2.5 kg with 19.38 fibre diameter, less than 1 % medullation and 8 cm staple length.

Broiler rabbit

Broiler rabbit farming is good source of continuous income to farmers throughout the years. The centre provides quality germplasm which resulted in establishment of more than 450 viable rabbitries in Kerala, Tamil Nadu, Andhra Pradesh and Karnataka. More than 12000 rabbits have been sold by the institute for establishment of rabbit farms in southern states. The technical and germplasm support is regularly provided to farmers.

Broiler rabbits

CENTRAL INSTITUTE FOR RESEARCH ON BUFFALOES

Hisar, Haryana

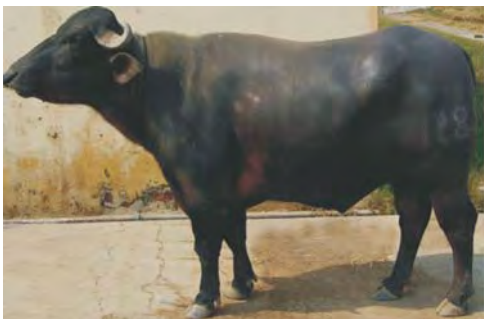
Year of Establishment: 1985

Sub campus: CIRB, Nabha, Punjab (1987)

CENTRAL Institute for Research on Buffaloes (CIRB) was established at Hisar Haryana to undertake research on all aspects of buffalo production including milk, meat and draft. A sub campus of the institute was established in 1987 at Nabha by acquiring 588 acres of land and other facilities from the Government of Punjab. The Institute has done significant work in buffalo improvement both at institute herds as well as in farmer's herds through institute based research programmes and Net Work project on buffalo improvement.

Improved germplasm developed

Twenty-two top ranking progeny tested Murrah bulls produced for elite mating and production of bull calves and progeny tested buffalo bull semen have become available for breed improvement in the country. More than 50,000 frozen semen doses from progeny tested bulls are available in the semen bank of CIRB. A total of 493 Murrah bulls of high genetic merit have been supplied to various developmental agencies and village panchayats in 12 States of the country for increasing milk production through genetic improvement in farmers buffaloes.



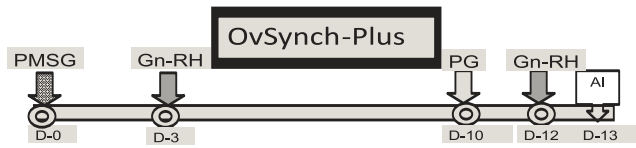
Progeny tested murrah bull

Establishment of elite murrah herd

A high pedigreed herd of Murrah buffaloes has been established at Hisar with current herd size of about 500 animals. 305 day or less lactation milk yield increased from 1500 kg during 1992-93 to 2374 kg during 2011- 2012.

Technologies developed

- Efficient buffalo bull semen freezing protocol has been developed, leading to improvement in average post-thaw sperm motility from 35% to more than 50%.
- Technology for freezing of static ejaculates – a problem peculiar to buffalo bulls – has been developed which allows successful freezing (over 87%) of static ejaculates with acceptable post-thaw motility.
- Developed protocol for induction of lactation in infertile buffaloes to overcome the problem of conception failures resulting approx 75% buffaloes lactating and producing on an average 4 to 6 kg milk.
- Developed 'Ovsynch Plus' protocol for oestrus induction and ovulation synchronisation in anoestrus buffaloes resulting in about 50% buffaloes in oestrus and 30% pregnancies.



- An area specific mineral mixture has been developed and its beneficial influence on reproductive and productive performance demonstrated through initiation of cyclicity in 70% of anestrous buffaloes.

- Developed package of practices for raising surplus male calves for buffalo meat production on conventionally available feed resources.
- Complete feed ration formulations have been developed using locally available agro-industrial by-products resulting in balanced feeding and reduction in the cost of feeding. Developed the technology for complete feed blocks for higher dry matter intake (23 – 26%) from poor quality roughages, reducing cost of feeding by about 10% and convenient transportation and reduced storage space.

Complete feed blocks

Feed block machine

- Developed ultrasonography technique for confirmatory early pregnancy diagnosis on day 30 post insemination and fetal sex determination on day 55.
- Standardized the protocol of super ovulation in buffaloes and produced 20 calves through ET at the institute. Recently, propagation of superior females through ET resulted in 1.5 progeny per elite dam in one reproductive cycle.

CIRB Sub Campus Nabha

Establishment of elite Nili-Ravi herd

A high pedigreed herd of about 400 Nili-Ravi animals has been established at Sub Campus, Nabha. 230 Nili Ravi bulls of high genetic merit have been supplied to various developmental agencies and village panchayats

Nili-Ravi bull

Network Project on Buffalo Improvement

Apart from the herds of Murrah at Hisar and Nili Ravi at Nabha, elite herds of Surti, Pandharpuri, Jaffarabadi, Bhadawari and Swamp buffaloes have been established at various centres to undertake genetic improvement through progeny testing

- A total of 177 Murrah bulls put to progeny testing in 13 sets. Test mating from 12 sets of bulls was completed in June 2011. 13th set test mating to continue till Dec. 2012.

- Progeny test evaluation first 8 sets have been completed on the basis of 305 day or less lactation milk yield, 22 top raking progeny tested bulls identified with percent superiority ranging from 3.53 to 24.89 percent over their contemporary daughters.
- Over 4.20 lakh doses of frozen semen from test bulls and over 88,000 doses from progeny tested bulls of Murrah breeds are now available under the Network Project.
- Approximately 5.20 Lakh semen doses and more than 1000 bulls of various breeds disseminated to the farmers/developmental agencies.
- Overall 45,00 farmers buffaloes associated with the project in about 225 villages under the field progeny testing program. More than 2 lakhs artificial insemination undertaken on farmers buffaloes in the field with 40.68% conception rate over all the centres and across various breeds.

CENTRAL AVIAN RESEARCH INSTITUTE

Izatnagar, Uttar Pradesh

***Year of Establishment*: 1979**

Regional Centre : Bhubaneswar (1992)

CENTRAL Avian Research Institute (CARI) was established at Izatnagar (U.P.) on November 2, 1979 as a premier Institute in the field of poultry research, education, extension and training in India for promoting productivity and profitability of Indian Poultry Industry. Later, a regional centre of the Institute was also established in Bhubaneswar in the year 1992. The Institute has played a pioneering role in transforming backyard poultry farming into a several billion rupee ago-industry.

Improved germplasm of diversified poultry species

Japanese quail varieties

Japanese quail *(Coturnix coturnix japonica)* farms have been set up throughout the country, for both, egg and meat production throughout the country. This Institute has been maintaining pure lines of quail (meat and egg types) and alternate plumage variants, and their consistent supply to both public and private sectors across the country for commercial exploitation.

- *CARI Uttam (meat type)*

  Production characteristics

Body weight (4th week)	150-155 g
Body weight (5th week)	240 g
Feed conversion ratio (4th week)	2.51
Feed conversion ratio (5th week)	2.60

Daily feed consumption	25-28 g
Hatchability on total egg set	70-75%

- *CARI Pearl (white egger)*

Production characteristics

Body weight (5th week)	140 g
Daily feed consumption	20-25 g
Age at 50% egg production	8 weeks
Age at 80% egg production	10 weeks
Hen day egg production	285-295 eggs
Hatchability on total egg set	70-80%

- *CARI Ujjawal (white breasted)*

Production characteristics

Body weight (4th week)	140 g
Body weight (5th week)	175 g
Feed conversion ratio (5th week)	2.80
Daily feed consumption	25-28 g
Hatchability on total egg set	65%

- *CARI Sweta (white feathered)*

Production characteristics

Body weight (4th week)	135 g
Body weight (5th week)	155-165 g
Daily feed consumption	25 g
Feed conversion ratio (4th week)	2.60
Feed conversion ratio (5th week)	2.70
Hatchability on total egg set	50-60%

- *CARI Brown (brown feathered)*

Production characteristics

Age at sexual maturity	38-41 days
Body weight (4th week)	148-160 g
Body weight (5th week)	180-185 g
Hatchability on total egg set	60-65%

- *CARI Sunheri (brown feather white breasted)*

Production characteristics

Age at sexual maturity	43 days
Body weight (5th week)	182 g
Feed conversion ratio (5th week)	2.8
Average egg weight	11 g
Age at 50% egg production	8 weeks
Age at peak egg production	12-13 weeks
Livability (0-5 weeks of age)	95%
Hatchability on total egg set	68%

Guinea Fowl varieties

Three improved varieties of Guinea fowl, viz., Kadambari, Swetambari and Chitambari have been developed through selective breeding for high disease resistance and better growth. It is a hardy bird suitable for any agro-climatic condition. It has excellent foraging capability and is more tolerant to mycotoxins. The thick egg shell provides minimum breakage and longer keeping quality. Guinea fowl meat is rich in protein, vitamins and low in fat and cholesterol.

- *Kadambari (white spot on black plumage)*

Production characteristics

Body weight at 8 weeks	500-550 g
Body weight at 12 weeks	950- 1000 g
Age at first egg	230-250 day
Egg weight	38-40 g
Egg production (Mar.-Sept.)	100-120 eggs
Fertility	70-73%
Hatchability on fertile eggs set	70-78%
Livability	Excellent

- *Chitambari (white spot on gray plumage)*

Production characteristics

Body weight at 8 weeks	500-540 g
Body weight at 12 weeks	970- 1000 g
Age at first egg	232-251 day
Egg weight	38-40 g
Egg production (Mar.-Sept.)	105-125 eggs
Fertility	70-73 %
Hatchability on fertile eggs set	70-78 %
Livability	Excellent

- *Swetambari (white plumage)*

Production characteristics

Body weight at 8 weeks	500-525 g
Body weight at 12 weeks	920- 980 g
Age at first egg	230-250 day
Egg weight	38-40 g
Egg production (Mar.-Sept.)	100-115 eggs
Fertility	70-75%
Hatchability on fertile eggs set	70-80%
Livability	Excellent

Turkey

Turkey is one of the choicest white meats known for its leanness, low fat and low cholesterol contents. It has been propagated in different parts of the country for meat purpose.

- *CARI Virat*

Production characteristics

Age (week)	Body wt. (g)	FCR
6	1054	1.85
8	1748	2.05
10	2101	2.37
12	2778	2.80
24	5270	3.78
32	7100	4.15
Fertility		94%
Hatchability		86%

Ducks

Four breeds of duck, *viz.*, Moti, *Desi (*native*),* Khaki Campbell and White Pekin are maintained and multiplied by the Regional Centre, Bhubaneswar for their propagation especially in Eastern and North Eastern Regions of the Country.

- *Moti (native meat type)*

Production characteristics

Body weight at 6th week	1300 g
Mature body weight	Drake 3300 g
	Hen 2100 g
Age at sexual maturity	30-35 weeks
Egg production	50-60 eggs/year

Egg weight	60-70 g
Feed conversion ratio (6th week)	2.75

- *Desi (native egg type)*

Production characteristics

Body weight at 6th weeks	950 g
Mature body weight	Drake 1500 g
	Hen 1200 g
Age at sexual maturity	18-20 weeks
Egg production	220-230 eggs/year
Egg weight	65-70 g
Feed conversion ratio (6th week)	3.2

- *Khaki Campbell (exotic egg type)*

Production characteristics

Body weight at 6th week	1050 g
Mature body weight	Drake 1600 g
	Hen 1350 g
Age at sexual maturity	19-20 weeks
Egg production	240-260 eggs/year
Egg weight	60-68 g

- *White Pekin (exotic meat type)*

Production characteristics

Body weight at 6th week	1850 g
Mature body weight	Drake 2900 g
	Hen 2500 g
Age at sexual maturity	22-24 weeks
Egg production	150-180 eggs/year
Egg weight	75-85 g
Feed conversion ratio (6th week)	2.10

Commercial layer chicken

The Institute has developed and propagated two commercial layer chicken varieties well adapted to diverse climatic conditions in the Country.

- *CARI Priya (white egger)*

Production characteristics

Age at first egg	17-18 weeks

Age at 50% production	150 days
Age at peak production	26-28 weeks
Peak Egg production	92%
Egg production (HH) to 72 weeks	298 eggs
Feed consumption /dozen of eggs	1.77 kg
Feed consumption /kg of egg	2.57 kg
Average egg weight	57 g

- *CARI Sonali (brown egger)*

Production characteristics

Age at first egg	18-19 weeks
Age at 50% production	155 days
Age at Peak production	27-29 weeks
Peak Egg production	90%
Egg production (HH) to 72 weeks	280 eggs
Feed consumption /dozen of eggs	2.3 kg
Feed consumption /kg of egg	3.8 kg
Average egg weight	54 g

Dual purpose chicken

The institute has developed a medium-size, dual-purpose bright plumage colour chicken suitable for rural /family poultry.

- *CARI Debendra*

Production characteristics

Body weight at 8 weeks	1100-1200 g
Body weight at 10 weeks	1400 to 1500 g
Body weight at 12 weeks	1700 to 1800 g
Feed conversion ratio (0-8 week)	2.5-2.6
Age at sexual maturity	155 - 160 days
Annual egg production	190-200
Livability (Growing)	97%
Livability (Laying)	94%

Commercial broiler chicken

The Institute has developed four commercial broiler varieties having different plumage colour and pattern suitable for diverse agro-ecological regions of the Country.

- *CARIBRO Vishal (white plumaged broiler)*

Production characteristics

Body weight at 6 weeks	1650 to 1700 g
Body weight at 7 weeks	2000 to 2150 g
Dressing percentage	75-80%
Livability percentage	97-98%
Feed conversion ratio (6th week)	1.85

- *CARIBRO Dhanraja (multicoloured broiler)*

Production characteristics

Body weight at 6 weeks	1500 to 1700 g
Body weight at 7 weeks	2000 to 2125 g
Dressing percentage at 6 weeks	73-75%
Livability percentage at 6 weeks	96-98%
Feed conversion ratio (6th week)	1.92

- *CARIBRO Mrityunjay (for hot and dry region)*

Production characteristics

Body weight at 6 weeks	1400-1500 g
Body weight at 7 weeks	1800-2000 g
Dressing percentage at 6 weeks	74%
Livability percentage at 6 weeks	97%
Feed conversion ratio (6th week)	1.95

- *CARIBRO Tropicana (for hot and humid region)*

Production characteristics

Body weight at 6 weeks	1300 g
Body weight at 7 weeks	1800 g
Feed conversion ratio at 6 weeks	1.90
Feed conversion ratio at 7 weeks	2.11
Dressing percentage at 7 weeks	74%
Livability percentage at 7 weeks	97%

Low input desi chicken variety

Four high yielding desi type chicken varieties suitable for backyard/ small scale poultry farming have been developed especially suitable for different climatic regions of the Country. These birds look like their original native breeds with about three times more egg production, bigger egg size, better tropical adaptability

and disease resistance along with capability of bearing the stress of sub-optimal feeding and management.

- *CARI Nirbheek*

It is a cross of Indian native breed Aseel with CARl Red. Birds are active, large in built, pugnacious in nature with high stamina and majestic gait. They are able to save themselves from their predators due to their fighting characters and activeness and are adapted to all climatic zones of the country.

Production characteristics

Body weight at 20 weeks (Males)	1847 g
Body weight at 20 weeks (Females)	1350 g
Age at sexual maturity	176 days
Annual egg production	198
Egg weight at 40 weeks	54 g
Fertility	88%
Hatchability (FES)	81%

- *CARI Shyama*

It is a cross of Kadakanath with CARl Red. Birds have plumage of various colours dominated by black. The skin, beak, shank, toes and soles are dark gray. Most of the internal organs including skeletal muscles, tendons, nerves, meninges, brain and bone marrow of these birds show black pigmentation. This variety is ideally suited for rearing in tribal areas due to preference for dark meat by the tribal population.

Production characteristics

Body weight at 20 weeks (Males)	1460 g
Body weight at 20 weeks (Females)	1120 g
Age at sexual maturity	170 days
Annual egg production	210
Egg weight at 40 weeks	53 g
Fertility	85%
Hatchability (FES)	82%

- *Upkari*

These birds have been developed by crossing Indian frizzle plumaged chicken with CARI Red. These multicoloured birds have single comb and medium body size. Presence of frizzle plumage helps in fast heat dissipation resulting in better adaptability to tropical climate, especially in arid zones.

Production characteristics

Body weight at 20 weeks (Males)	1688 g
Body weight at 20 weeks (Females)	1285 g
Age at sexual maturity	165 days
Annual egg production	220
Egg weight at 40 weeks	60 g
Fertility	90%
Hatchability (FES)	84%

- *Hitcari*

Hitcari birds have been developed by crossing the Indian native Naked Neck ecotype with CARI Red. The neck region is devoid of feathers and there is reduction of 30 to 40% feathers on the body which helps in internal heat dissipation leading to better tropical adaptability. These birds are highly suitable for rearing in the hot humid coastal region.

Production characteristics

Body weight at 20 weeks (Males)	1756 g
Body weight at 20 weeks (Females)	1320 g
Age at sexual maturity	178 days
Annual egg production	200
Egg weight at 40 weeks	61 g
Fertility	92%
Hatchability (FES)	81%

Production and reproduction technologies

Dietary modulation for designer egg and meat

Supplementation of Guggul (*Commiphora mukul*), alone or in combination with Arjuna (*Terminalia arjuna*), Cinnamon (*Cinnamomum verum*) and Amla (*Emblica officnalis*) in diet of hen result in reduction of yolk cholesterol by about 19% from 6th week onwards. Supplementation of 125 mg Cu/kg diet as copper sulphate is effective in reducing the egg yolk cholesterol content by 18% and supplementing layer ration with 300mg Cu/kg together with 3200 µg chromium per kg diet reduces cholesterol contents by 24%. The supplementation of Atorvastatin 0.03% + Niacin 375 ppm + ethylene diamine-tetra acetic acid (EDTA) 0.5% in diet of laying hens reduces egg yolk cholesterol by 35%.

New and simple diluents for chicken and quail semen

A new and simple diluent has been prepared for successful preservation of chicken semen at low temperature (2 to 4^{0}C) for 24 hr. This diluent is simple, requires minimum ingredients and no adjustment of pH as the composition of the diluent is prepared to obtain the desired pH (7.3)

and osmotic pressure (375 m. Osmoles) automatically. Using fresh semen with this diluent in White Leghorn chicken 90% fertility was obtained. Fertility of about 80% was also recorded even from 24 hr stored diluted semen. A new diluent has also been designed for the quail semen and evaluated. This diluent showed 77.5% fertility. The motility scoring and fertility was found higher at room temperature when compared to 4^0C.

Fertility prediction test for male Japanese quail

An indirect method for the evaluation of the fertilizing ability of the male Japanese quail based on the colour of foam produced by the cloacal gland and its size has been developed. Males with high fertility rate produce large amount of normal white foam whereas, birds with poor fertility status produce either less foam or yellow to brown colour of foam. In addition, smaller sizes of cloacal gland remain associated prominently with the infertility of birds as compared to those birds possessing large size of cloacal gland. This test is simple, cost-effective and can enhance fertility in quails up to 12%.

In-ovo feeding and vaccination technique for improved broiler production

A novel *in-ovo* technique to administer the critical dietary constituents (such as amino acids, glucose and vitamins etc.) and vaccines (such as Newcastle disease vaccine) into the amnion or yolk sac of the late term embryo has been standardized. *In-ovo* administration of nutrients increases the hatch weight by 10-12% and the profitability of broilers by 8%. The formaldehyde inactivated *in-ovo* vaccine for ND injected on 18th day of embryonic stage significant increases the vaccine titre and immunocompetence without adversely affecting the hatchability. This technique requires lesser vaccine dose and imparts less stress to the chicks, while being more effective than conventional vaccination methods.

Computer softwares for feed formulation

"MakeFeed Poultry" is a comprehensive Windows® based software useful for poultry feed manufactures/farmers/entrepreneurs for efficient and balanced feed formulation for a wide variety of poultry such as layer and broiler chicken, duck, turkey, quails, Guinea fowls, etc. MakeFeed software is user-friendly and persons having little computer knowledge can utilize it effectively. The

cost of the software package is Rs. 2600/- for individual (including postage) and Rs. 2.5 lakh for corporate clients. Over 250 copies of this software have been sold.

Design of low cost poultry shelter for small scale poultry farming

Five different types of low cost poultry houses have been designed for housing 120 broilers or 60 layers. These houses are eco-friendly and cost effective. The houses are made up of bamboo and tarpoline sheet roof, terracotta tiles, mud, brick and asbestos, bamboo or plastic sheet roof, wire net and hay roof and cost Rs. 6200/-, 4600/-, 8300/-, 6000/- and 4600/-, respectively.

Processing technologies

Shelf-life extension of chicken meat using natural preservatives

Shelf-life of minced chicken meat treated with 4% garlic extract or 2% cinnamon powder or 0.25% clove oil could be extended from 6 to 12 hr at ambient (27-34°C) temperature, while 4% cinnamon powder treatment almost doubled its shelf-life up to 8 days under refrigeration (4±1°C) storage. Similarly, dressed chicken carcass dipped in 4% cinnamon solution was found to remain fit for consumption up to 12 hr at ambient (18-20°C) and up to 10 days at refrigeration temperatures.

Tenderization of spent hen meat

A simple technique for the tenderization of tough meat of culled hens has been evolved. The process consists of soaking of eviscerated culled hen/culled breeding stock carcasses for 3 hr in 0.05% papain or 0.075% trypsin in combination with 1.0% sodium chloride and 0.05% sodium tripolyphosphate. This tenderization method is superior to other methods involving intravenous or intraperitoneal injection of enzymatic solution prior to slaughter of birds.

Oil-coating preservation of eggs

Fresh eggs are spray-coated with groundnut oil mixed with 200 ppm BHT as an anti-oxidant or liquid paraffin. About 7500 eggs can be coated with one litre of oil and such treated eggs can be safely stored for 30 and 120 days respectively, at mean ambient of 31°C and refrigeration temperatures as against about 7 and 30 days shelf-life under respective storage conditions for untreated eggs.

Processing technology for value added egg products

Albumen rings

Albumen rings are low fat egg snack food prepared by steam cooking blended egg albumen

in ring molds, battering and breading the coagulated albumen and deep fat frying. The ready-to-eat rings contained 11.5% protein and merely 3.2% fat. This product can be safely stored by refrigeration for 18 days in vacuum and 12 days in aerobic pack.

Egg rings

Egg rings are egg snack food prepared by steam cooking of blended liquid whole egg in ring molds, then battering and breading the coagulated rings and deep fat frying. The batter-breaded rings contained 12.3% protein, 11.2% fat and had a refrigerated shelf-life of 12 days in aerobic packaging in polyethylene (250G) pouches.

Egg pancake

It is a convenience egg-rich product and can be popularized as a complete breakfast meal at homes as well as at growing fast food outlets. Ingredients used for preparing highly acceptable, light, fluffy and spongy pancakes include liquid whole egg, milk, wheat flour, sugar and baking powder. The pancakes have a refrigerated shelf-life of 12 days in vacuum packaging without any detectable deteriorative changes.

Egg roll

Egg roll is a baked and breaded product with scrambled egg and chicken sausage filling. This product is suitable for either meals or in-between meal as snacks. The most acceptable recipe of egg filling consisted of 80% scrambled egg with 20% ground chicken sausage. This product can safely be stored by refrigeration for 8 days in vacuum and 6 days in aerobic packaging.

Pickled quail eggs

A simple, cost-effective and efficient technology for the development of ready-to-eat pickled quail eggs has been developed for commercial exploitation. The process consists of hard cooking and peeling of eggs, preparation of vinegar based pickling solution or oil-based pickle gravy, seasoning

and packaging in flexible monolayer or laminated pouches without the pickling solution. The product can be safely stored for about 4 months at room temperature and a year under refrigeration. The shelf-life of pickled eggs could be extended up to 8 months at room temperature under nitrogen gas packaging in laminated pouches.

Egg waffles

Process of preparing egg waffles was standardized. Egg waffles prepared from liquid whole egg, wheat flour and granulated wheat had a shelf-life of 4 days in vacuum and 3 days at ambient temperature in aerobic pack and 10 and 6 days at refrigeration temperature, respectively.

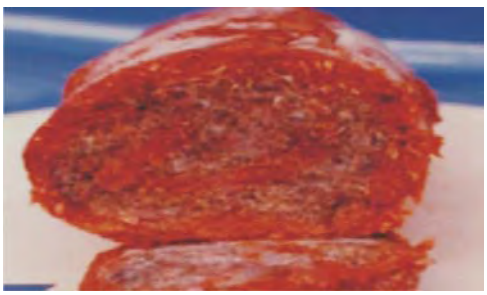
Processing technology for value added poultry meat products

Chicken steaks

The technology for development of restructured chicken steaks, utilizing spent hen meat, has been standardized. A combination of textured soy protein and milk co-precipitate was found much more acceptable as extender and could be incorporated up to 30% level in chicken steaks' formulation. The product has a refrigerated shelf-life of 9 days under vacuum packaging as against 6 days for those packaged in LDPE pouches. Under frozen storage (-18±1°C) the steaks of both packaging groups could safely be stored up to 60 days, however, vacuum packaged steaks were more acceptable throughout the storage.

Mixed chicken loaf

This product is made with dark meat of Kadaknath in combination with broiler meat, pulse as a binder and 5% hydrogenated vegetable fat, etc. On evaluation of physico-chemical, microbial and organoleptic properties, it was found that the product could be safely stored up to 5 months at freezing temperature (–10°C).



Chicken patties

Chicken patty can be prepared with meat from spent hens. The pre-cooked patties can be stored for 10 days under refrigeration (4°C) and 60 days in the frozen (-18°C) state.

Intermediate moisture chicken meat

An optimum infusion solution and processing technology for the preparation of intermediate moisture chicken meat (IMCM) for storage at room temperature has been standardized. The process standardized for manufacturing IMCM consisted of a combination of humectants and hurdle technology viz. dipping of dressed chicken in 2% lactic acid dip for 2 min, dicing of meat into chunks, soak equilibration for 12 hr in infusion solution and turmeric-garlic paste application prior to 4 hr of oven drying (80±2°C). The finished product packaged in flexible-HDPE pouches has a shelf-life of 2 months at mean room temperature (24°C).

Chicken gizzard pickle

This product is a comparatively cheap and shelf-stable. Small entrepreneurs may be attracted to produce and market the product by meagre financial investment. Gizzard pickle (oil based or vinegar based) contained about 22% crude protein and 9 to 10% total lipids. These pickles can be stored at ambient temperature (34°C) for 45 days during summer/ rainy season and for 75 days in winter.

Chicken-skin meat cutlet

Based on utilization of completely de-feathered chicken skin up to 30% level with minced meat, the formulation methodology for processing chicken-skin meat cutlet has been standardized. The product can be consumed till 14 and 28 days of refrigerated (4±1°C) and frozen (-18°C) storage, respectively.

Chicken chunkalona

A process for preparing delicious chicken chunkalona from a combination of minced spent hen meat (60%), pre-marinated tender broiler meat chunks (25%) along with binders, extenders and seasonings was optimized. The product packaged in retortable 3--ply laminated (polyester/foil/pp) pouches and then subjected to retort processing (1 kg/cm^2; 30 min.) had microbiologically safe and organoleptically acceptable shelf-life of 2 weeks under ambient (25^{o}C) storage.

Cooked chicken stock

It is an instant chicken meat product which can be reconstituted to curried chicken dish. It can be packed in LDPE or laminated aluminum foil pouches and can be stored up to 14 days refrigerated or 28 days frozen (-18°C) condition.

Poultry by-products based pet food

The process developed for the conversion of poultry offals into nutritious and highly palatable food for pet dogs consisted of autoclaving (1 kg/cm^2 ; 30 min) fresh inedible chicken offals (excluding feathers), mincing ,oven drying (70°C, 16 hr) and grinding to prepare poultry by-product meal (PBPM). The PBPM at 15% level could be mixed with leaker egg liquid (20%), bakery waste (20%), maize flour (24%), wheat flour (10%), defatted soy flour (5%), soybean oil (5%), common salt (1%) and permitted food additives (0.02% BHA), 0.5% STP, 0.2% citric acid, 0.05% vitamin and mineral mixture to prepare dough of thick consistency. Forced oven drying (100°C, 8 hr) of about 1.5 cm thick dough yielded pet biscuits rich in nutrients.

Services being provided

Consultancy

The Institute is providing consultancy in the following areas of poultry production, processing and marketing to beneficiaries from both, public and private sector organizations.

- Poultry layer and broiler production.

- Quail production.
- Turkey production.
- Backyard poultry production involving native fowls.
- Poultry nutrition and feeding.
- Poultry processing and products technology.
- Poultry diseases control and bio-security.
- Poultry hatchery management.
- Avian physiology.
- Poultry housing and management.
- Preparation of bankable projects for establishing poultry and allied units.
- Contract research projects.

Feed analysis

The Institute is providing feed analytical servies including estimation of moisture, crude fibre, crude protien, ether extract, ash content, calcium, phosphorous and aflatoxin etc. on payment basis. The cost details may be obtained from the Institute web site.

Farmers' and specialized trainings

It is an orientation training to start poultry farming. Three batches of short-term training on poultry production management (6 days duration) are being organized at the Institute every year. The specialized training programmes are offered by the institute to impart advanced training in the various specific fields of poultry production. The details may be obtained from the Institute web site.

Sponsored training courses

Sponsored training courses on poultry production management are organized time to time on demand for the farmers nominated by the State A.H. Deptt., ATMA, NABARD, Bank officials, veterinary Field Officers etc.

❑

PROJECT DIRECTORATE ON POULTRY

Hyderabad, Andhra Pradesh

Year of Establishment: 1988

THE Directorate was set up as a coordinating unit of All India Coordinated Research Project (AICRP) on Poultry in 1970 at Izatnagar, Uttar Pradesh and was elevated as a full-fledged Project Directorate in 1988 and shifted to Hyderabad, with the objectives to coordinate research at AICRP centers located across the country and conduct research on the development and improvement of chicken lines for commercial and rural poultry production. The ongoing research programmes at PDP are focused on research in the areas of poultry breeding, molecular genetics, applied nutrition, immunomodulation, disease diagnosis and health management.

Improved Germplasm

Vanaraja

A dual-purpose poultry variety developed for free range poultry farming in rural and tribal areas. These birds feed on kitchen waste, natural vegetation and insects like country birds and do not require any commercial feed. They are hardy and suited for rearing under harsh conditions. The birds have multi colored feathers and lay brown eggs with an adult body weight of 1.8 to 2.0 Kg for males at 12 weeks of age. The annual egg production is about 100-110 eggs in free range conditions. The variety is very

Vanaraja

popular among the rural and tribal people throughout the country. About 27 lakhs of *Vanaraja* chicks were distributed across the different states of the country from Jammu and Kashmir to Andaman & Nicobari Islands and Arunachal Pradesh to Gujarat. In addition, 1.72 lakhs of parents were also supplied for different Government institutions which in turn might have produced about 1.0 crore commercial *Vanaraja* chicks and distributed among the farmers in their respective areas. A unit of 20 birds will provide a subsidiary income of Rs. 4000-5000 for the family per year.

Gramapriya

A layer type variety developed for free range farming in rural and tribal areas. It has coloured plumage and lays brown sizable eggs. These birds feed on kitchen waste, natural vegetation and insects like native chicken and do not require expensive inputs in the form of feed but supplementation of minimal calcium sources (shell grit, stone grit and lime stone) is beneficial during laying phase. The body weight of males at 12 weeks ranges from 1.2 to 1.5 Kg. The annual egg production is about 160-180 eggs under field conditions in farmers backyards. The male bird's meat is tender and suitable for traditional *tandoori* preparations. About 24 lakhs of *Gramapriya* birds were distributed to the farmers. In addition, 1 lakh parents of *Gramapriya* (which in turn have produced about 70 lakhs of commercial chicks) were supplied to the CPDOs and government agencies. A unit of 20 birds will provide a subsidiary income of Rs. 6000-7000 for the family.

Gramapriya

Krishibro

Krishibro

A multi coloured broiler developed for small scale intensive farming in rural areas. The birds are known for their organoleptic qualities of the meat, which is close to that of country birds. These birds are well adapted for harsh climatic conditions, economical and perform well under low plane of nutrition and they fetch a premium price like country birds. The birds weigh about 2.0 Kg at seven weeks with feed conversion ratio of 2.1. About 6 lakhs of Krishibro birds have been distributed for smale scale intensive farming. Promising broiler variants of Krishibro (B-77, IBL80, IBB-83 & IBI-91) and layers crosses (ILI-80, ILM-90 & ILR-90) have been developed at different AICRP centers.

Technologies Developed

- Molecular characterization of all the poultry germplasm available at PDP was carried out.
- The tropical adaptibility the tropical adaptability of major genes i.e. naked neck and dwarf was established.
- Maize, the expensive energy source in chicken diet can be replaced with fox tail millet, pearl millet or tanning free sorghum in both broiler and layer diet with out affecting their performance.
- Similarly, soybean meal can be replaced *in toto* with sunflower cake or low glucosinalate mustard cake or up to 67% with til (sesame) cake without affecting the bird performance.
- Phosphorus from plant feed ingredients was made available for chicken by adding cost effective phytase, cholecalciferol or organic acids without affecting the skeletal integrity of birds.

Services being provided

The institute is providing scientific and technical services to the public and private sectors, farmers, non-government organizations, extension agencies and other stake holders in the society. These are

- Supply of chicks and fertile eggs to farmers and other user agencies
- Providing technical guidance to farmers on various aspects of poultry farming
- Imparting training on specialized poultry farm operations
- Supply of embryonated eggs suitable for vaccine for vaccine production




PROJECT DIRECTORATE ON CATTLE

Meerut Cantt, Uttar Pradesh

Year of Establishment: 1987

PROJECT Directorate on Cattle (PDC) was established at Meerut on November 3, 1987 to monitor, coordinate and support all research and development activities for cattle improvement, by upgrading the status of earstwhile. All India Coordinated Research Project (AICRP) on Cattle where it was concluded that Holstein Friesian exotic breed with exotic inheritance of 50 - 62.5 % was the ideal choice for producing crossbred cattle in most regions of the country. It was proposed to develop a new cattle breed "Frieswal" having 62.5% HF inheritance and capable of producing 4000 litres of milk with 4% butter fat in a mature lactation of 300 days by utilizing a large population of HF x Sahiwal available at different Military Farms of the country. Subsequently, keeping in view the importance of indigenous breeds known for their adaptability and disease resistance qualities, Indigenous Breeds Project (IBP) was initiated in the year 1989 in collaboration with the SAUs, State Govt. and Non-Government Organizations to conserve and improve the Indigenous breeds. Similarly, Field Progeny Testing (FPT) project was undertaken in 1991 to bring genetic improvement in HF crossbred cattle in farmers' herd. The Directorate is also undertaking basic research work related to cattle husbandry at farm and field level.

Germplasm Developed

Development of a new cattle breed "Frieswal"

Frieswal project was initiated in 1989 when Military Farms had a population of 2305 HF x Sahiwal crossbred with very low to very high Friesian inheritance. With the systematic breeding, the level of exotic inheritance was stabilized at around 62.5%. The population of Frieswal cows has increased to 16714 at the end of year 2011. The average milk yield in 300 days which was 2774 kg in year 1989 has now improved to 3273 kg in 2011.

Frieswal bull

The mature lactation milk yield has reached to the level of 3612 kg in fourth lactation. Age at first calving has been reduced from1126 days in 1985 to 969 days. Average peak yield of Frieswal has also crossed 15 kg. A total of 90 Frieswal bulls have so far been evaluated through progeny testing at various Military Farms spread over different agro-climatic conditions of the country. The dam's best lactation yield of majority of these bulls ranges from 4000 to 6000 kg, the highest value being 8073 kg in a lactation of 387 days. Detailed information with respect to progeny tested bulls are available in recently published Sire Directory.

Frieswal cow

Production of high quality cryopreserved semen

Superior quality frozen semen of meritorious crossbred (Frieswal) bulls of high production indices, is being made available to different govt and non-Govt agencies for genetic improvement of crossbred cattle. Till date, 22,988,46 frozen semen doses of Frieswal semen have been produced out of which 9,93,131 doses have been distributed to different Military Farms. Besides this a total of 1,71,627 doses of Frieswal semen have also been sold to para vets, farmers, SAUs, State Animal Husbandry departments and NGOs. Presently, the Directorate has more than 9.57 lakh doses of frozen semen of 138 Frieswal bulls in its gene bank for use under various cattle development programmes.

Doses of Frieswal semen

Genetic improvement of Indigenous cattle breeds

Genetic improvement of Hariana, Ongole, Sahiwal, Gir and Kankrej indigenous cattle breeds has been undertaken for progeny testing of bulls for production of superior germplasm for utilization in cattle development programs in the country.

Through sustained efforts, the average first lactation milk yield and peak yield in Hariana cows increased to 1066.22 kg and 6.44 kg, respectively. A total of 60 Hariana bulls were used under test mating in 7 sets, with the production of 2217 daughters. 33 Hariana bulls have been evaluated for their genetic merit based on first lactation yield of their daughters.

Sixty five (65) Ongole bulls have so far been used under test mating in 8 sets and 3410 daughters have so far been produced. 32 Ongole bulls have been evaluated on their genetic merit based on first lactation yield of their daughters. Draft studies of Ongole bulls using single harness plough with digital dynamometer showed that draught power varied from 0.52 to 0.63 H.P.

A total of 15 Kankrej bulls have been selected on the basis of their dams' milk yield which ranged from 2934 to 4200 lit. The first set of 8 bulls has been inducted for test mating under the programme.

Six Gir bulls have also been inducted in the first set with the production of 6534 doses of frozen semen of which 3780 had been used during the programme.

Seven Sahiwal bulls have been inducted in the first set and 1418 inseminations have been carried out that resulted in production of 93 daughters.

Kankrej Cow

Gir Bull

Gir Cow

Improvement of field cattle through progeny testing programme

The crossbred field cattle in different agro-climatic zones of the country are being improved through utilization of the semen from high quality breeding bulls under the Field Progeny Testing programme of the Directorate. The programme is being implemented in collaboration with Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana, Kerala Veterinary and Animal Sciences University (KVASU), Mannuthy and Bharatiya Agro Industry Foundation (BAIF), Urulikanchan, Pune.

In Field Progeny Testing Programme, 211 bulls have so far been used at GADVASU unit in 10 sets. Overall conception rate is 43.5 %. The milk yield has increased from 2697 kg in first set to 3388 kg in the progenies of 8th set. At KVASU unit, 150 bulls in 9 sets have so far been evaluated for their progeny performance. The overall conception rate has reached to 44.10% during current set (11th set)**.** The milk yield of the progenies has increased from 1958 kg in 1st set to 2567 kg in 8th set. At BAIF Urulikanchan, 187 bulls have so far been used in 9 sets with an overall conception rate of 42 % and an average 305 days milk yield of the progenies being 2930 kg in 1st set has improved to 2991 kg.

Technologies Developed

Development of ration for crossbred bulls

Diet developed with 20 % extra energy of NRC (1989) for growing bull calves resulted in faster growth rate, better libido score, semen donation efficiency and semen quality.The growing crossbred male calves reserved for future semen production are exhibiting better libido and semen quality which has reduced the level of rejection of young bulls.

Development of strategies to overcome sub-fertility of crossbred cows

A common problem of anestrous conditions and delayed puberty observed in crossbred females has been reduced by redesigning the ration and applying some physiological interventions

A cost effective and convenient method for induction of oestrus in anoestrus Frieswal heifers was developed by utilizing oral combination of Estrogen and Progesterone (Levonogestrel 1.2 mg and Ethinyloestradiol 0.24 mg) along with mineral mixture (Agrimin forte) @ 40 g/day for 10 days. The technology is useful in field conditions as farmers need not to depend on injectable estrus inducing protocols.

Development of house designs for crossbred bulls

A modified design for comfortable housing of adult crossbred bulls was developed and erected at the Bull Rearing Unit of the Directorate. The design takes care of hot waves during summer and has been supported by mixed flooring of concrete and sand bedding to avoid injuries to heavy weight crossbred bulls.

Biotechnological interventions for improved production and reproduction:

Inheritance pattern of semen quality parameters of Frieswal cattle has been estimated. The comparative expression profile of PRM1, PRM2, TNP1, TNP2 and CATSPER1 genes were carried out in spermatozoa of freshly collected semen of Frieswal bulls. The spermatogonial stem cells have been isolated, characterised and successfully maintained in culture up to 120 days. In future, these results will certainly help to understand genetic basis of poor semen quality and motility which is being commonly observed in the crossbred bulls across the world. Further, technology of isolation and culture of spermatogonial cells will go a long way in transferring these cells from genetically elite bulls to other crossbred bulls.

Infrastructure and Resources

Animal Genetic Resources

The Directorate has access to a large crossbred population (more than 16000 animals) at 37 Military Farms, Elite germplasm herds of indigenous cattle of Sahiwal, Gir, Kankrej and Ongole at SAUs and NGOs have been created under AICRP. Data recording units both under field as well as farm conditions have been identified in different agro-climatic regions to implement the programmes for productivity enhancement. The Directorate also has a large bull rearing unit with a capacity to rear 225 young and adult bulls.

A group of Gir heifers

Frozen Semen Bank

The Directorate has state of art Semen Freezing Facilities where quality semen produced from Frieswal bulls born out of elite cows is evaluated and processed for freezing. Over the years, the stocking capacity of the laboratory has increased to hold about 25 lakh frozen semen doses. The laboratory has latest equipments for production of quality germplasm as per the international standards. The laboratory, which has also received ISO certificate for quality semen production since 2007, is providing male germplasm for breeding of Frieswal cattle at various Military Farms, besides supplying semen to the State Departments of Animal Husbandry, State Livestock Development Boards, SAUs, NGOs and Para Vets involved in cattle improvement programmes.

Frieswal bull rearing unit

Service to the Farmers

The Directorate is also involved in providing technical knowhow to end users in the areas of cattle breeding, feeding, reproduction and management. Besides holding awareness programmes for farmers at the Directorate, is also participating in Kisan Melas/Gosthis organized by SAUs and State Government Agencies.

PROJECT DIRECTORATE ON FOOT AND MOUTH DISEASE

Mukteswar, Nainital, Uttarakhand

Year of Establishment: 2000

In order to strengthen the research activity on FMD, an integrated "All India Co-ordinated Research Project for FMD virus typing" was initiated in 1968 by ICAR with a Central Laboratory at Mukteswar and three Regional Centres located at Hisar, Hyderabad and Calcutta. Subsequently the scope of this project was expanded in July, 1971 to All India Co-ordinated Research Project for Epidemiological studies on Foot-and-Mouth disease with increased outlay and inputs in terms of laboratory space, experimental animal shed facility, scientific manpower, four additional Regional Centres and Epidemiological Units for extensive FMD surveillance throughout the country. In the successive years the activity of the project was expanded by incorporating several regional centers and network units up to 8th plan. During 9th Five Year plan period (1997-2002) in July 2000, the project has been upgraded to a Project Directorate functioning with the Central Laboratory at Mukteswar, 8 Regional Centers and 15 Network Units distributed in all the states in the country.

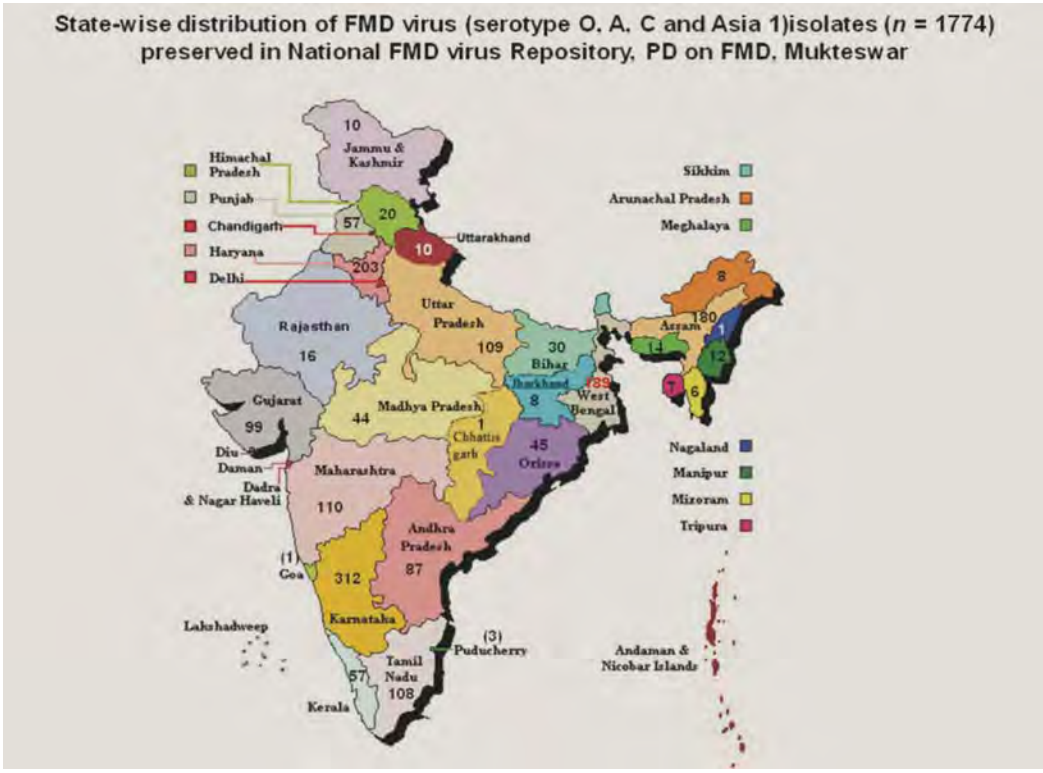
PDFMD is working with a mission of active epidemiological surveillance through regularly monitoring antigenicity and genomic make up of Foot and Mouth Disease virus strains responsible for disease outbreaks, to provide training in diagnosis and epidemiology, and to develop technologies

for making country free from FMD. The vision of the institute is to make India free from Foot and Mouth Disease.

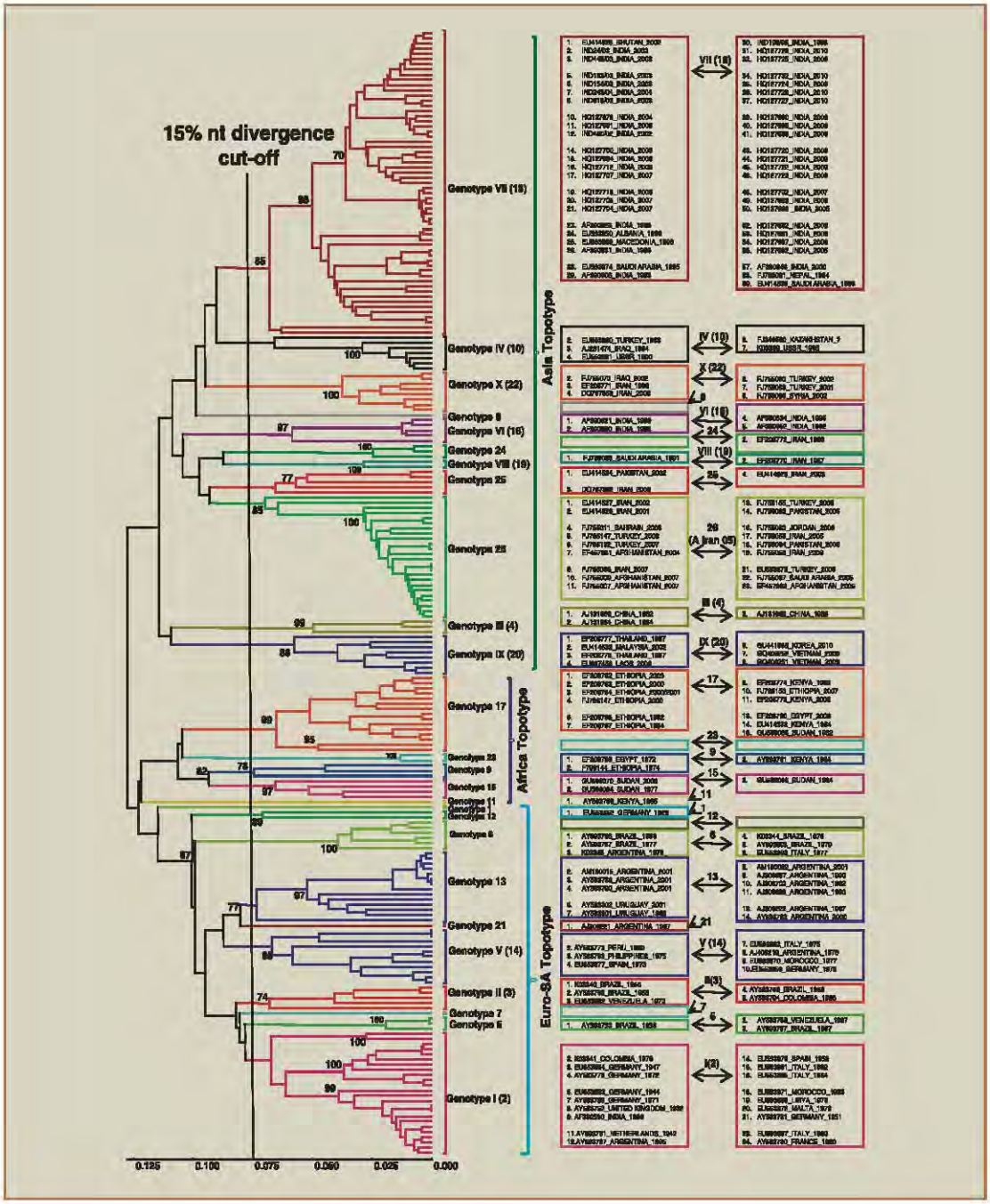
Achievements

- The Regional Centres and the Network Units of the Project have reported/investigated/ recorded a large number of outbreaks of FMD throughout the country over the years. Differential distribution of FMD virus among states of the country has been established for use in effective implementation of control and eradication programme.
- Collected a huge number of clinical specimens for initial virus serotyping and detailed genetic and antigenic characterization that has revealed complex scenario.
- National Repository of FMD virus has been established for retrospect analysis.
- Accumulated epidemiological data in the project has helped to evaluate the economic impact of the disease and planning the strategy for FMD control programme in India.
- Regular vaccine matching exercise between the field isolates and in use vaccine strains from time-to-time has ensured appropriateness of vaccine strains used for protection against FMD.

Clinical lesions in FMD susceptible animals



- A new serotype A vaccine candidate has been selected and provided to the industry for incorporation in current trivalent FMD vaccine formulation to mitigate antigenic diversity.
- Battery of candidate vaccine strains are in ready for future use in case of exigency.
- The absence of the Serotype C virus has been confirmed in the country since 1995, as a result of which the serotype C virus has been excluded from the earlier used tetravalent FMD vaccine to make it trivalent and comparatively a cheaper FMD vaccine.
- Uniformity in antigen components and determinants of trivalent FMD vaccine has resulted in establishing herd immunity and subsequent protection in areas under regular vaccination, which has resulted in reducing incidence of the disease in the country.
- Molecular epidemiology of FMD has helped to a great extent in tracing the movement and spread of FMD in the country, which was not completely possible by conventional serological methods.
- The prevalence of the VP_3^{59} deletion mutant of serotype A virus in the country has been confirmed.
- Initiated National FMD sero-surveillance to understand prevalence of the virus in different parts of the country, the virus reservoirs and the herd immunity.



UPGMA tree showing a complete VP1 sequence-based global phylogeny and topotype/genotype distribution. Inside the boxes, accession numbers or isolate designations followed by the country of origin and year of collection are depicted serially as per their position on the branches in a top-to bottom direction.

- Actively taking part in seromonitoring of FMD control programme being run by Government of India by providing companion diagnostics like LPB-ELISA.
- A pool of trained workforce to undertake active and passive surveillance of FMD is being created in the country.
- Project Directorate on FMD, Mukteswar is adjudged as "FAO SAARC Regional Leading Diagnostic Laboratory for FMD" in South Asia.
- Providing training to the participants from SAARC member countries on diagnosis and surveillance of FMD.
- Member of the Global FMD Research Alliance (GFRA) as a recognition for its proficiency in FMD diagnosis, epidemiology and research at global level.

FAO training programme for SAARC member countries

The institute has made the country self insufficient by developing several diagnostic kits (indigenously) for FMD that are being used though out the country and have saved valuable foreign exchange.

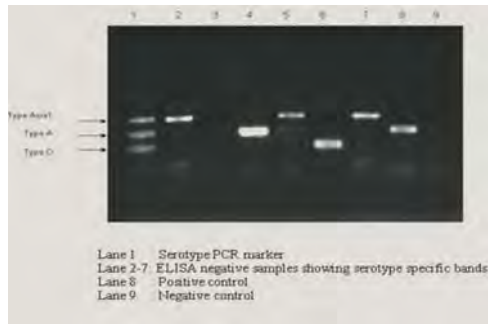
Kits for FMD Diagnosis

Type-FMD kit

For Foot and mouth disease virus (FMDV) serotyping in clinical samples.

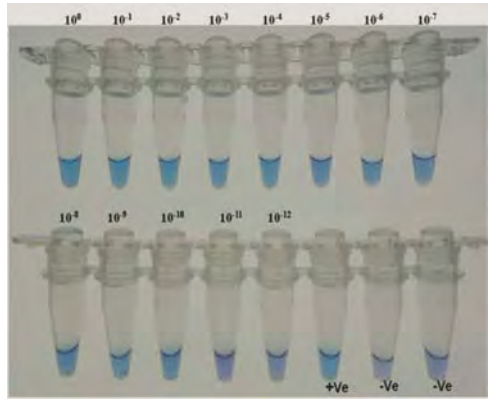
mPCR-FMD kit

For Foot and mouth disease virus (FMDV) serotyping in difficult clinical samples.



LAMP-FMD kit

For Rapid diagnosis of FMD Virus in the field clinical samples. The advantages of the method are simple operation, rapid reaction, and potential for visual interpretation without instrumentation. This could make the technique far more suitable for field deployment as animal side test.

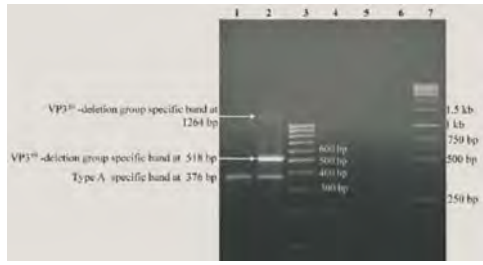


Semen test kit for FMD

For Rapid, sensitive and reliable test for FMDV detection in bull semen. The developed kit (multiplex PCR) is suitable for detection of FMD virus serotype in neat and extended semen samples. Large number of samples can be screened simultaneously. The kit will help in deciding as to when to resume the semen collection and processing for AI purpose following FMD.

Lineage-FMD

PCR based kit for differentiation of genetic lineages of FMD Virus serotypes A and Asia 1. The Kit contains a set of lineage-specific oligonucleotide primers, positive and negative controls, PCR tubes, RNase free water and a manual. The Kit is available in two formats one with PCR reagents and the other without that.



Kits for FMD surveillance/seromonitoring

LPBE-FMD kit

For measuring post vaccinal antibody response against FMD. The test is aimed at the quantification of protective antibody level in the animals following vaccination (seromonitoring).

DIVA FMD indirect kit

Indirect immunoassay for differentiating FMD infected from vaccinated animals. The kit contains recombinant antigen coated microtitre plates, Bovine and ovine anti-IgG HRPO conjugate, positive and negative control serum and test protocol.

r3AB3 DIVA kit for Foot and Mouth Disease

r3AB3 DIVA Kit for FMD released by Hon'ble Union Minister of Agriculture and Food Processing Industries Shri Sharad Pawar on July 16, 2010 (ICAR Foundation Day) at NASC, New Delhi

DIVA FMD Competitive kit

The kit contains monoclonal antibodies against recombinant 3ABC antigen and purified antigen. The test is highly sensitive and specific, and is suitable for testing all the susceptible species on a common platform.

FMD-Multiple NSP Panel DIVA Indirect kit

A Panel of NSP DIVA ELISA for sero-surveillance in controlled zones/disease free zones. The kit contains four NSP recombinant antigens i.e. 2C, 3D, 3AB3 and 3ABC, bovine anti-IgG HRPO conjugate, positive and negative control serum and test protocol.

International and Inter-institutional Collaborations and linkages

- Member participant in OIE/FAO Global network of FMD Reference Laboratories.
- Member of GFRA (Global Foot and Mouth Disease Research Alliance)
- Global FMD Vaccine Matching Exercise
- Collaborative programme with USDA-ARS on "Effective Molecular Vaccines Against Foot-and-Mouth Disease" under Global FMD Research Alliance (GFRA)
- Participation (laboratory support) in FMD CP being run by DAHD&F, GOI.
- Linkage with Indian FMD vaccine industry in the field of diagnostics and vaccine matching.

State of the art facility

International Center for FMD (new Campus of PD on FMD) with BSL 3+ containment laboratory and animal experimental facility is being established in Aragul, near Bhubaneswar,

Odisha. This facility will help to internationally accredit the capability of ICAR/PD on FMD on the field of FMD surveillance, diagnosis and epidemiology which have been developed over last 40 years. In the current international scenario where FMD is the important trans-boundary animal disease, it has become national imperative to handle FMD virus as per international standards of bio-safety and bio-security. Further, the high containment facility will facilitate India's accepted role as SAARC Regional Leading Diagnostic Laboratory for progressive control of FMD in South Asia.

Shri Sharad Pawar, Hon'ble Union Minister of Agriculture and Food Processing Industries in the presence of Shri Naveen Pattnaik, Hon'ble Chief Minister of Odisha laying the Foundation stone for International center for FMD (BSL3+facility) at Aragul, Bhubaneswar

Field investigation of FMD in mithun in Arunachal Pradesh

Field investigation of FMD in cattle in Uttarakhand

PROJECT DIRECTORATE ON ANIMAL DISEASE MONITORING AND SURVEILLANCE

Hebbal, Bengaluru, Karnataka

Year of Establishment: 2000

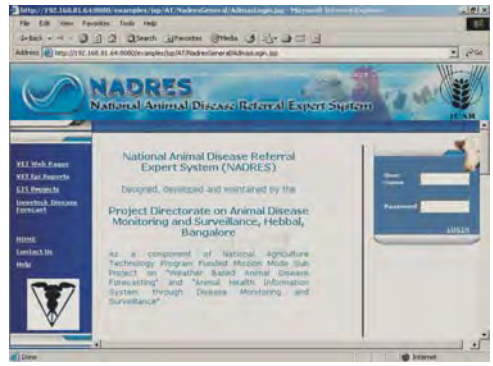
Proposed laboratory cum administrative building

THE Project on Animal Disease Monitoring and Surveillance (ADMAS), which was initiated by the ICAR in the VII five year plan as an All India Coordinated Research Project (AICRP) became fully functional during the last quarter of 1987 with the establishment of four Regional Research Units (RRUs) located at Bengaluru, Hyderabad, Pune, and Ludhiana. The Central Coordinating Unit (CCU) was established at the Institute of Animal Health and Veterinary Biologicals, Bengaluru to coordinate research activities of the regional units. ADMAS was further strengthened in the 8th plan with support of ICAR and European Union by giving the responsibility of the National Project on Rinderpest Eradication (NPRE) involving the participation of 32 state level diagnostic/disease investigation laboratories. Later, realizing the impact of animal disease monitoring and surveillance on our entire livestock sector and to give a boost, ICAR upgraded this project to an independent institute status on 1st April, 2000 (during the IX plan) as – "Project Directorate on Animal Disease Monitoring and Surveillance (PDADMAS)" with ten collaborating

units. The Directorate got further impetus with addition of five more collaborating units in the 10th plan. In XI plan Guwahati Centre in Assam has been included as a collabrating unit of AICRP, ADMAS. In the XII plan it is proposed to upgrade PDADMAS to national institute as National Institute for Veterinary Epidemiology and Disease Informatics (NIVEDI) with 31 AICRP centres.

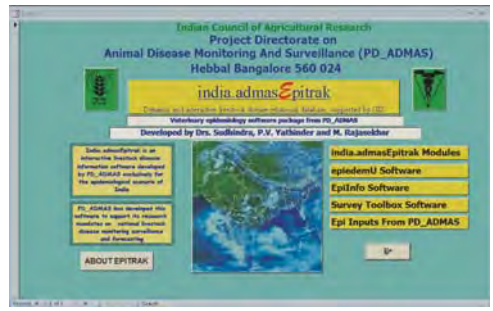
Technologies developed

Module for forecasting of livestock diseases-National Animal Disease Referral Expert System (NADRES)



A Forecasting module developed for predicting possible occurrence of 15 nationally important livestock diseases about two months in advance in the country. It is a web based dynamic and interactive livestock disease relational database supported by Geographic Information System (GIS) which serves as an Epidemiology software. Useful for field veterinarians, administrators, technocrats, research personnel, farmers, veterinary colleges and students. It is available at www.nadres.res.in.

India.admasEpitrak



India.admasEpitrak is livestock disease information software developed by PDADMAS exclusively for the epidemiological scenario of India. Utilizing this software all the major epidemiological analysis can be carried out by running the appropriate quarries. There is a dynamic link with the data and the graphs so that the graphs get updated automatically as and when the data is updated.

Avidin-Biotin ELISA Kit for IBR

Infectious bovine rhinotracheitis (IBR) of cattle and buffalo is highly infectious disease caused by BoHV-1 belonging to the family *Herpesviridae*. Disease causes abortions, repeat breeding, infertility, respiratory problems and transient immunosuppression. Diagnosis of disease is highly complicated and need proper diagnostic assays to eliminate the reactors. Avidin-Biotin (Indirect) ELISA kit for detection of antibodies against BoHV-1

infection in cattle and buffalo has been developed and validated both intra and inter laboratory users with specificity and sensitivity of 95%and 92%, respectively. It has been widely used in population survey of IBR in India. User friendly kit needs no specific training.

Avidin-Biotin ELISA kit for brucellosis

A software based highly sensitive Avidin-Biotin (Indirect) ELISA kit was developed for detection of antibodies in serum and milk against brucellosis infection in cattle and buffalo. The kit is approved by International Atomic Energy Agency (IAEA), Vienna. The kit is being widely used throughout the country for the last 10 years.

Leptospira staining kit

This kit can be applied for identification/ morphology of leptospira including fine coils and diagnosis of the leptospirosis. Leptospirae are stained brownish-black on a brownish-yellow background. The features of technology include the characteristics morphology of the organism is easy discernible against clear background of stained slides, clouding of the smear also avoided, Development of artifacts, over staining and cracks can be avoided by using this kit. No risk involved in adopting the technology, as no isolation of organism involved in preparation of kit. One kit can stain 100 slides.

Indirect ELISA kit for sheep and goats brucellosis

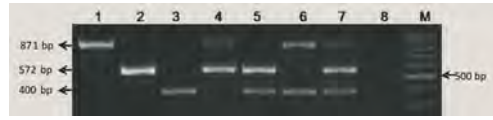
Indirect ELISA for detection of Brucellosis in sheep and goats is standardized using smooth lipopolysaccharaide (sLPS) antigen from *Brucella abortus* S99 and hyperimmune serum (HIS) against sLPS in sheep. The relative diagnostic sensitivity and specificity in comparison to commercial kit (VMRD kit) were found to be 95.66% and 96.33%, respectively. The developed iELISA kit is useful for sero-surveillance of small ruminant brucellosis throughout the country in similar lines to that of AB_ELISA kits for cattle. Patent has been granted to this technology (Date of Grant: 20/01/2012, Patent No. 250709).

Protein-G ELISA kit for diagnosis of brucellosis in livestock and humans

A common ELISA for the detection and screening of antibrucella antibodies in both livestock (cattle, camel and horses) and humans using recombinant protein G (commercially available) which reacts with immuoglobulins of different species like cow, sheep, goat, swine, camel, horse and human, has been standardized using smooth lipopolysaccahride (sLPS) antigen from *Brucella abortus* S99, anti-*Brucella* sLPS hyperimmune sera raised in pigs and recombinant protein G conjugated with Horse Radish Peroxidase. The diagnostic sensitivity of the test varied from 100% in pigs followed by 92% in both human and small ruminants and 88% in cattle. The diagnostic specificity ranged from 100% in humans and cattle and 96% in pigs and small ruminants. The kit is robust and stable and is highly useful in the field conditions.

Multiplex PCR for direct detection of Streptococcus species from mastitic milk

Keeping in view the time taken for phenotypic identification and its insufficient reliability, molecular basis for identification is of paramount importance. Thus, specific primers corresponding to *S. agalactiae, S. dysgalactiae* and *S. uberis* were designed. To make the assay further time saving and cost effective a multiplex PCR was developed which could simultaneously detect all the three organisms in a single reaction. This molecular method satisfies the need of a rapid and specific tool for identification of Streptococci and can be adopted at different levels of laboratories for definite diagnosis of mastitis.



Lane1: *S. agalactiae* (871bp); Lane2: *S. dysgalactiae* (572bp); Lane 3: *S. uberis* (400bp); Lane 4: combination *of S. agalactiae, S. dysgalactiae;* Lane 5: combination of *S. dysgalactiae, S. uberis; Lane* 6: combination *of S. agalactiae, S. uberis;* Lane 7: combination *of S. agalactiae, S. dysgalactiae, S. uberis;* Lane 8: No Template Control; Lane M: 100bp DNA ladder.

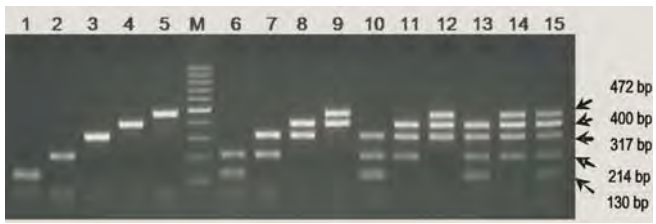
Multiplex PCR for direct detection of Staphylococcus species from mastitic milk

To minimize the time and make the molecular assay cost effective, a mPCR using the specific primer sets, was devised to simultaneously detect S. *aureus* and four other most prevalent *Staphylococci* (*S. chromogenes, S. epidermidis, S. sciuri and S. haemolyticus*) in a single reaction. This molecular method is useful to detect *Staphylococcus* sp. and can be adopted at different level of diagnostic laboratories for routine diagnosis, herd surveillance and evaluation of antibiotic therapy. This mPCR is species specific for the detection of major *Staphylococcus* sp. *viz., S. aureus, S. chromogenes, S. epidermidis, S. sciuri,* and *S. haemolyticus* directly from the clinical milk samples. The assay is labour and cost intensive.

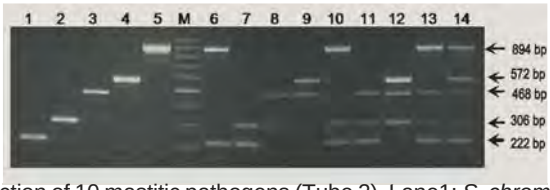
Lane1: *S. epidermidis* (130bp); Lane2: *S. chromogenes* (222bp); Lane 3: *S. sciuri* (306bp); Lane 4: *S. haemolyticus* (531bp); Lane 5: *S. aureus* (864bp); Lane M: 100bp DNA marker; Lane 6: Combination of *S. epidermidis* and *S. chromogenes;* Lane 7: Combination of *S. chromogenes* and *S. sciuri;* Lane8: Combination of *S. chromogenes, S. haemolyticus* and *S. sciuri;* Lane 9: *S. haemolyticus and S. aureus;* lane 10: Combination of *S. epidermidis, S. sciuri* and *S. chromogenes;* Lane 11: Combination of *S. chromogenes, S. haemolyticus* and *S. sciuri;* Lane 12*:* Combination of *S. chromogenes, S. aureus, S. haemolyticus* and *S. sciuri;* Lane 13: Combination of *S. chromogenes, S. epidermidis, S. haemolyticus* and *S. sciuri;* Lane14: Combination of *S. chromogenes, S. aureus, S. haemolyticus* and *S. sciuri;* Lane 15: Combination of *S. chromogenes, S. aureus, S. epidermidis, S. haemolyticus* and *S. sciuri.*

Multiplex PCR (two tube format) assay for the simultaneous detection of ten most common mastitis thogens

A multiplex PCR assay was developed for simultaneous detection of 10 mastitic pathogens (*viz., S. aureus, S. agalactiae, S. dysgalactiae, S. uberis, E. coli, S. chromogenes, S. epidermidis, S. sciuri, S. haemolyticus, S. simulans)*, based on partial amplification of genes to specifically detect target pathogens. With this method, identification of bacterial pathogens can be made in hours. This method requires affordable infrastructure and relatively little hands on training for taking up at organized farm level or at district level diagnostic laboratory. Using the method, the overall time taken from sample receipt to declaration of the result is around 6 hr, thus providing us with rapid and reliable results compared to the conventional cultural method which takes at least 48 hrs. This novel mPCR (two tube format) assay is suitable for the simultaneous detection of ten most common mastitis pathogens directly in milk samples.



mPCR for simultaneous detection of 10 mastitic pathogens (Tube 1). Lane1: *S. epidermidis* (130 bp); Lane 2: *S. haemolyticus* (214 bp); Lane3: *S. agalactiae* (317bp); Lane 4: *S. uberis* (400bp); Lane 5: *S. simulans* (472bp); Lane M: 100 bp DNA marker; Lane 6: combination of *S. epidermidis* and *S. haemolyticus;* Lane 7: combination *of S. haemolyticus* and *S. agalactiae*; Lane 8: combination of *S. agalactiae* and *S. uberis*; Lane 9: combination of *S. uberis* and *S. simulans;* Lane 10: combination of *S. epidermidis*, *S. haemolyticus* and *S. agalactiae*; Lane 11: combination of *S. haemolyticus, S. agalactiae* and *S. uberis*; Lane 12: combination of *S. agalactiae, S. uberis* and *S. simulans*, Lane 13: combination of *S. epidermidis, S. haemolyticus, S. agalactiae* and *S. uberis*; Lane 14: combination of *S. haemolyticus*, *S. agalactiae*, *S. uberis* and *S. simulans*; Lane 15: combination of *S. epidermidis*, *S. haemolyticus*, *S. agalactiae*, *S. uberis* and *S. simulans*



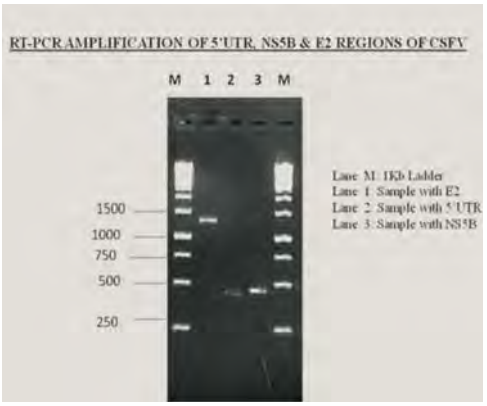
mPCR for simultaneous detection of 10 mastitic pathogens (Tube 2). Lane1: *S. chromogenes* (222 bp); Lane 2: *S. sciuri* (306 bp); Lane3: *E. coli* (468 bp); Lane4: *S. dysgalactiae* (572bp); Lane 5: *S. aureus* (894bp); Lane M: 100 bp DNA marker; Lane 6: combination of *S. chromogenes* and *S. aureus;* Lane 7: combination of *S. chromogenes* and *S. sciuri;* Lane 8: combination of *S. sciuri* and *E. coli*; Lane 9: combination of *S. dysgalactiae* and *S. aureus*; Lane 10: *combination of S. chromogenes*, *S. sciuri* and *S. aureus;* Lane 11: combination of *S. chromogenes*, *S. sciuri* and *E. coli*; Lane 12: combination of *S. sciuri*, *E. coli* and *S. dysgalactiae*; Lane13: combination of *S. chromogenes*, *S. sciuri*, *E. coli* and *S. aureus;* Lane14: combination of *S. chromogenes, S. sciuri*, *E. coli, S. dysgalactiae* and *S. aureus*

PCR based diagnosis for the detection of latent infection of surra

Trypanosoma evansi, an extra cellular haemoprotozoon parasite causes trypanosomiasis or "surra" in animals. Surra is transmitted mechanically by tabanid flies and is characterized by intermittent fever, chronic weakness, dullness, hypoglycaemia etc. The clinical form of the disease can easily be detected by parasitological (blood smear staining) method. But by this method latent infection (carrier status) cannot be detected. The PCR reaction with suitable primer sets helps in the detection of carrier status (as low as 0.15 tryps / ml blood), where conventional parasitological methods are not capable of detecting the parasite. It is also useful in screening the meat supplied in zoo gardens/ national parks for carnivores. This technology helps in the drug study designing/ drug resistance study by detection of localization of parasite in tissues/ circulation.

RT PCR detection of CSFV in clinical samples

Classical swine fever (CSF) is a highly contagious disease of pigs caused by Classical swine fever virus (CSFV) belonging to family *Flaviviridae*. Mortality is 100% in piglets and morbidity is 100% in adult pigs. Diagnosis of CSF at early stage is important and can be done by using CSFV specific primers spanning different genomic regions by Reverse transcription-Polymerase Chain Reaction.



NATIONAL RESEARCH CENTRE ON CAMEL

Bikaner, Rajasthan

Year of Establishment: 1984

CONSIDERING the importance of camel in the socio-economic development of arid and semi-arid zones, Government of India established a Project Directorate on Camel at Bikaner on July 5, 1984 transferring the physical facilities (149 camels of Bikaneri breed and around 824 ha land) of erstwhile Camel Breeding Farm of Sukhadia University, Udaipur. It was upgraded to National Research Centre on Camel (NRCC) on September 20, 1995. Initially, NRCC started with the mandate of developing infrastructure facilities for conservation and preservation of existing breed of camel and generate scientific and technical information. With terms of a shift towards mechanization, the NRCC has taken up issue with an aim of restoration of cultural, economic and aesthetic value of camel in rural life if Indian desert. It is a premier institute for research and development of camel and provide leadership through basic and applied multi-disciplinary research and training and also acts as a national repository of information on camel and to collaborate with national and international agencies for camel research and development.

Establishment of elite herd

Since the distribution of dromedaries (one-humped camel) in India is confined to North-West dry desert, the NRCC is mainly focussing on basic and applied aspect of one-humped

Bikaneri camel

Jaisalmeri camel

Kachchhi camel

Mewari camel

camel. For this an elite herd of 355 animals of Indian camel breeds comprising of Bikaneri, Jaisalmeri, Kachchhi and Mewari has been established at Bikaner following continuous selection for last two decades and true to the type animals are maintained in the camel herd. The Bikaneri, Kachchhi and Mewari have been found to be good milch breeds while the Jaisalmeri breed is excellent for racing.

For genetic improvement of camels in the breeding tract of various breeds elite 102 male camels have so far been distributed in the field to improve the farmers' animals.

Development of Complete Feeds

Complete feeds as feed blocks and pellets have been prepared by proportionate mixing of fodders, agricultural by-products and concentrates for various classes of camels like calves, lactating females and working camels. It was found useful for rearing camels under semi-intensive and intensive feeding system and reducing the browsing and grazing pressure on the resource depleted rangelands of arid region.

Feed processing unit

Feed production unit having feed pulverizer, hammer mill, horizontal mixer, pellet mill and block making compressing machine have been established to prepare concentrate mixture, complete feed pellets/blocks as per need of farm and experimental camels.

Complete feed blocks

Area specific mineral mixture

Area specific mineral mixture has been developed for camels of all groups to meet up requirement of growth, lactation and gestation and has been named as "CAMMIN"

Area specific mineral mixture-"CAMMIN"

Camel housing developed using local materials

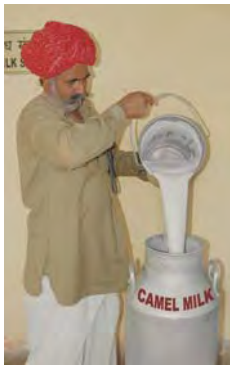
Camel housing kuchcha structure with thatched roof open type and loose housing are better than asbestos roofed close type concrete shelter. Temperature humidity index is the lowest under thatched roofed open type kuchcha shelter followed by loose housing and asbestos roofed close type concrete shelter.

Shed with asbestos roof

Improved shed with thatched roof

Improvement of milk production potential

The milk production potential of Indian dromedary breeds was evaluated which was found to be 7 litres/day with some of the best milkers producing more than 10 litres of milk/day. The peak yield was achieved in 5th month of lactation. Although camels continue giving milk up to 24 months the average length of lactation was found to be 16 months. The facility for camel milk processing has been developed with establishment of units for pasteurization, spray dryer for milk powder making and quality analysis of milk and milk products.



Camel milk pasteurization plant

Camel milk spray dried powder unit

Beneficial properties of camel milk identified

The camel milk is not very popular in our country probably due to its limited production. It is little salty in taste depending upon the nature of plants consumed by camel during grazing. It has about 9% total solids, 2.8% fat, 2.5% protein and 4.25% lactose. It has higher vitamin C in comparison to milk of other farm animals. The raw milk has got a shelf life as high as 8 hours. It has higher concentration of minerals and protected proteins. Beneficial compositional value of camel milk was established to record lower percentages of fat with high quality higher chain fatty acids, higher percentage of free calcium, protective proteins, vitamin C, and micro minerals viz iron, copper and zinc as compared to the cattle and buffalo milk. Using the lipoperoxidase system the shelf life of raw camel milk was extended possible up to 20 hours. Immunoproteins status for IgG, IgA, IgM in camel colostrum and milk is higher than cow/buffalo milk. The development of acidity is comparatively slow in camel milk than cattle milk in all the four lactic strains. The heat coagulation time of camel milk get stable after pH 7.2 to 7.6.

Value added milk products developed

Several value added products like kesar kulfee , soft cheese, flavoured milk, tea and coffee, rasogolla, burfi, camel milk powder, gulabjamun, lassi, raabri, chocolate, mawa, and kheer have been developed.

Shri Ashok Gahlot, Hon'ble Chief Minister, Rajasthan tasting camel milk kulfi

Diverse camel milk products

Camel milk skin cream for people

A human skin cream "Karabh" was prepared from camel milk which was found effective in imparting fairness and smoothness to the skin. The spread per unit area is very high in "Karabh" skin cream.

Camel milk skin cream

Camel as an animal for draught in arid and semiarid region

Income to expenditure ratio of camel cart has been found superior (0.96) than donkey (0.92), bullock (0.71), mule(0.67) and horse (0.49) carts. Camel can pull load 2.5 to 2.8 times of its body weight in a camel cart. After resting cart pulling camel for 4 hours it can be reused for another 4 hours. For sandy tracks and kachha roads the camel carts of two wheels having pneumatic tyres has been found to be more suitable whereas for metallic roads the four wheel carts with jeep tyres are more suitable. Using four wheel cart the camel can pull 2.8 times of its body weights and can cover a distance of 25.5 Kms in a day. With 2.5 times of cart load the camel in four wheel cart can cover distance of 11-12 Km in 3 hours after suitable rest the similar distance can be covered in another 3 hours.

Camel pulling loaded carts

Electricity generation through camel draught

A power generation and agro-processing unit have been set up for studying camel draught ability and its utility in agricultural operations at the Centre. This system offers a viable source of eco-friendly energy in the non-electrified rural areas with camel population.

Camel draught driven fodder chaff cutter

Camel draught driven electricity generation unit

Facilities developed

Camel museum

The center has a state of art museum on camel which offers a visual documentary of cultural, ethical, social, economical and scientific aspects of camel. It possesses the historical background including excerpts from Babarnama, specimens of various utility products made out of camel bones and hide. There is pictorial and iconological depiction of role of camel in history in mythology. The museum apprised the tourist about the development and research aspect of camel husbandry in desert ecosystem.

Camel museum

Camel Milk parlour

The center has established India's first camel dairy as well a milk parlour where different products such as flavoured milk, lassi, ice cream, tea and coffee prepared from the camel milk are available.

Camel milk parlour

Promotion of camel in ecotourism

With the changes of scenario in agriculture and livestock sector, particularly in terms of shift towards mechanization, the NRCC has taken up issues with an aim to restore cultural, economic and aesthetic value in rural life of Indian desert. It has been identified as one of the important tourist place of Bikaner. Every year thousands of tourists visit the center to see the behavioural aspect of camel.

Establishment of first camel dairy of India at NRCC Campus

Other value added camel products

Products from skin

The skin of camel is used to manufacture belts, parts and container for storing oil. The centre has provided technical know-how to utilize camel skin to make show pieces like toys, drum covers, traditional lamp sheds by painting with colours and gold.

Decorative lamp shades and kuppi of camel hide with gold paints

Camel leather purse

Products from bones

The camel bones are used as a cheap substitute of ivory for the production of jewellery and ornamental show pieces. The value added products prepared from the bones offer employment opportunities for rural artisans.

Services provided to the stakeholders

- Quality germplasm.
- Complete feed pellets and blocks.
- Ambulatory clinic in the villages dominated with camel population for treatment and technological advice to camel rearing farmers. Four visits in a month are conducted in different villages and Goshtis are also organized.
- Training in camel management and husbandry practices.
- Preparation of value added camel milk products.
- Training of women farmers for preparation of concentrate mixtures and camel milk products.

NATIONAL RESEARCH CENTRE ON EQUINES

Hisar, Haryana

Year of Establishment: 1985

Sub-Campus : Equine Production Campus of NRCE at Bikaner (1989)

NRCE, Hisar

EPC, Bikaner

Equine Production Campus, Bikaner

Derisory equine health and production technology support available in the past in the country caused considerable catastrophic effect on the equine production programmes that prompted the ICAR for the establishment of a premier species- oriented institute exclusively for development of equines in India. As such, the National Research Centre on Equines (NRCE) came into existence at Hisar for conducting research on equine health and production. Subsequently, realization of the need for improving the technologies for optimization of reproduction and work performance of the equines in order to uplift the socio-economic status of poor equine owners, led to establishment of a sub-campus – known as Equine Production Campus – at Bikaner (Rajasthan).

Research accomplishments

Equine health

Diagnostics for equine diseases

The Centre has been recognized as National Referral Centre for diagnosis of important equine infectious diseases by Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture (Government of India). The Centre has developed and refined diagnostics against various equine diseases including immunodiagnostics and molecular diagnostics.

Equine herpes virus-1 (EHV-1): A highly sensitive and specific neutralizing monoclonal antibody-based diagnostic kit namely **Equiherpes B-ELISA** was developed for diagnosis of EHV-1 antibodies. Testing of serum samples in single dilution makes this test/kit very economical. This kit was formally released by Hon'ble Director General, ICAR on August 20, 2008. Presently, the kit is under the process of commercialization.

Equine herpes virus-4 (EHV-4): A type-specific ELISA using EHV-1/4 recombinant glycoprotein G has been developed for differentiation of EHV-1 and EHV-4 infections. A multiplex PCR targeting glycoprotein G has also been developed for differentiation of EHV-1 and EHV-4 and is routinely used in the laboratory.

Equine rotavirus: A sandwich ELISA (s-ELISA) was developed employing a monoclonal antibody (mAb) raised against VP6 protein antigen of rotavirus, for detection of equine rotavirus (ERV) from faecal samples. The diagnostic sensitivity (DSn) and diagnostic specificity (DSp) of ELISA is 1.0 and 0.96, respectively. This assay has been validated by two external laboratories using bovine, sheep and equine rotavirus samples and detects rotavirus infection among different species of animals. RT-PCR targeting VP6 gene – with equal sensitivity as of s-ELISA – has also been developed for laboratory diagnosis and its results were comparable with the s-ELISA.

Equine influenza virus (EIV): EIV is routinely diagnosed by haemagglutination inhibition assay. A set of RT-PCRs for equine influenza diagnosis and EIV typing as well as a real-time RT-PCR targeting M gene for diagnosis of EIV have been developed which are routinely used for diagnosis.

Theileria equi: For serodiagnosis of *T. equi*, a recombinant truncated EMA-2 protein antigen based-ELISA has been developed with DSp and DSn values – in comparison to OIE-approved CI ELISA kit – is 0.97 and 0.96, respectively. This assay has been compared with western blotting and validated by internal and external laboratories. This ELISA is in routine use in NRCE for equine piroplasmosis surveillance.

Trypanosomosis: An indirect ELISA has been standardized using whole cell lysate antigen of *Trypanosoma evansi* which is in routine use for trypanosomosis sero-diagnosis. RoTat 1.2 gene-specific PCR has also been adopted for sensitive detection of surra.

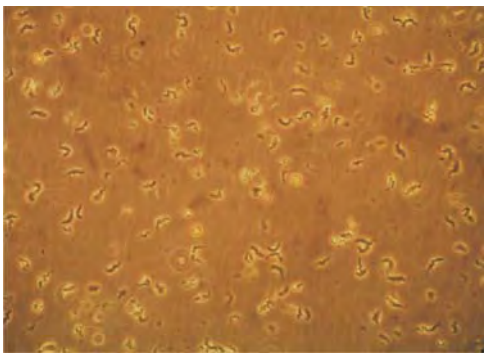
Japanese encephalitis virus (JEV): Serum neutralization test (SNT) and haemagglutination inhibition (HI) have been optimized for diagnosis of JE which are in routine use in the laboratory.

Equine infectious anaemia (EIA): Coggins test and ELISA for EIA sero-diagnosis are routinely being used at the Centre. Recently, EIA virus recombinant p26 protein antigen (synthetic EIAV p26 gene expressed in *E. coli*) based Coggins test and ELISA have been developed whose DSp and DSn are comparable with imported kits.

Equine viral arteritis: Virus neutralization test (VNT) is routinely used for sero-diagnosis of EVA.

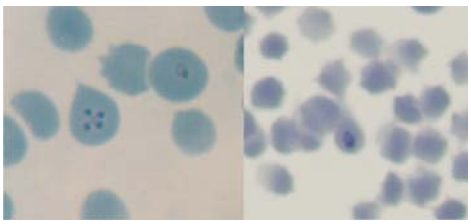
In vitro culture of Trypanosoma evansi

Bloodstream forms of *T. evansi* have been cultivated in IMDM-based HMI-9 medium containing requisite supplements. The continuous cultures were partially replaced every alternate day to maintain parasite density below the optimum density. In HMI-9 medium trypanosomes survived and there was constant increase in number of actively growing parasites up to 55thday. HMI-9 medium yielded best results in terms of adaptation, survivability, multiplication, parasites retaining their morphological characteristics, and *in vivo* infectivity to mice. This *in vitro* culture system will serve as alternative to experimental animals for R&D work including screening of drugs.



In vitro MASP culture of Theileria equi showing Maltese cross

Equine piroplasmosis is an acute, sub-acute or chronic tick-borne disease of equidae which is caused by an intra-erythrocytic protozoa *Theileria equi* or *Babesia caballi*. This disease is posing a serious threat to the international movement of equids. The serological assays developed for diagnosis of *T. equi* are not indicative for confirmed parasite positivity. Hence, we initiated *in vitro*



cultivation of *Theileria equi* by micro-aerophilus stationary phase (MASP) technique in M199 medium containing requisite supplements and appropriate environment. The blood from a horse/donkey/mule was collected in vacutainer (EDTA) and initiated in culture. The equids which were positive for antibodies could become parasite positive in *in vitro* culture on between 4-6th day of initiation of culture and the maximum parasitaemia achieved so far is up to 8-10%. The MASP culture system will serve as alternative to experimental animals for R&D work including screening of drugs

Equine production

Establishment of nucleus herd

- Exotic Donkeys: Twenty jennies and jacks of European breed (Poitu) were imported from France through ODA, UK in 1990, for the improvement of indigenous donkeys and production of superior mules.
- Marwari Horses: In effort to conserve the true-to-breed equids, the Centre has also established a nucleus herd of Marwari horse at Equine Production Campus, Bikaner.
- Zanskari Ponies: NRCE has initiated an on-farm conservation programme in the form of developing an equine sanctuary at EPC, Bikaner, wherein, 12 Zanskari ponies (eight mares & four stallions) were brought from Zanskar valley (Kargil, Ladakh, Jammu & Kashmir) in November, 2009. These animals are doing well in hot-arid climate of Bikaner.
- Indigenous donkey: The Centre established a nucleus heard of small-grey and large-white donkeys found in India in 2010-2011.

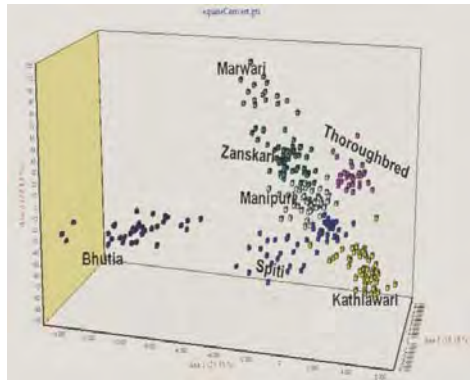
Baseline data on different biochemical, physiological and hematological Indices in equines – Different biochemical, physiological and hematological indices were evaluated to establish baseline data for different donkey populations (Local *vs* Poitu) and horse breeds (Spiti, Kathiawari, Thoroughbred) of either sex and different age groups in healthy and diseased animals (URTI, EIA, Chronic and acute hepatopathy, Trypanosomosis, Equine Ataxia Cystitis Syndrome, Fatty liver in exotic donkey, Colic and Canker etc) in order to develop reference standards for use in disease diagnosis and prognosis.

Biochemical studies related to different Stress conditions – Different biochemical studies have been conducted to evaluate stress due to routine use of drug (Ivermectin, Fenbendazole), vaccine (tetanus toxoid, influenza etc) and other natural stress conditions (short-term and long-term feed deprivation stress, heat stress, water deprivation stress) in order to devise mitigation strategies.

Equine work efficiency – Equine work efficiency in terms of load carrying capacity of donkeys as pack animals with different loads have been evaluated for the benefit of poor equine owners. This study - based on physiological, physical and biochemical indices with fatigue scores under different working hours with varied loads – has led to framing standard work-rest-work cycle for various works.

Indigenous breed characterization

- Phenotypic characterization of indigenous horse and pony breeds : All the six indigenous breeds of horses/ponies (Marwari, Kathiawari, Spiti, Zanskari, Bhutia and Manipuri) have been characterized phenotypically on the basis of their biometric indices and coat colour. True-to-breed equids of each breed were selected from their home tracts in India and fifteen different biometric indices were recorded for each equids. Significant differences among different biometric indices were observed due to breed as well as sex. Marwari and Kathiawari had wither height equivalent to 150 cm or more and as such both these breeds come under the category of horse breeds while Manipuri, Spiti, Zanskari and Bhutia breeds come under the category of Pony Breeds. Equids of Marwari and Spiti breed were observed to be significantly ($P>0.05$) tallest and smallest, respectively, among all the horse breeds. Almost similar pattern was observed in body length of all these breeds.
- Genotypic characterization of Indian equine breeds : Genetic characterization - an important part of any breeding program - to study genetic diversity among different equine breeds available in India was done using 55 microsats. Heterozygosity analysis with different polymorphic microsats indicated the presence of high genetic diversity within and between different breeds. The Neighbor-Joining algorithm was used for the construction of both the topology as well as phylogenetic tree. The Thoroughbred expectedly clustered separately in topology as well as phylogenetic tree. Other Indian breeds clustered into two distinctive classes. One cluster grouped Kathiawari and Marwari horses while the other cluster had Manipuri, Spiti, Zanskari and Bhutia ponies. It can be inferred from the study that the geographically distant breeds are also genetically distant.



Correspondence analysis of different indigenous horse breeds including thoroughbred horses based on microsatellite markers analysis

- Improvement in production potential of equines : Poitu jack semen for breeding purpose: Physical and biochemical characterization of Jack semen was done to study the effect of different seasons as well as influence of exercise on sexual and seminal characteristics in jacks. The procedure and technique for cryopreservation of jack semen have now been perfected which is helping in cryopreservation and storage of jack semen.
- Semen cryopreservation and artificial insemination (AI) : In order to conserve the germplasm of indigenous equine breeds and to provide AI services to farmers, the technique for cryopreservation of semen of Marwari, Kathiawari, and Zanskari stallions as well as Poitu and indigenous jacks have been optimized for routine use. The technique of AI

using cryopreserved semen for production of superior quality Marwari horses, superior mules and donkeys has been perfected and is used in routine at NRCE farms and also in the field as and when we receive request from farmers. The pure germplasm of indigenous breeds of horses and donkeys is being maintained, multiplied, and conserved using this technology.

- Early pregnancy diagnosis: Pregnancy diagnosis between days 14 and 18 post-insemination has been achieved using ultrasonography in jennies and mares. NRCE has also developed Pregmare Kit which is routinely used to diagnose pregnancy between 30-35 days. The added advantage of the kit is that this also tells about the foetus viability.
- Semen for breed improvement: Good quality cryopreserved semen of Marwari stallions and Poitu jacks are made available to equine owners for production of good quality horses and mules, respectively.
- Facilities for collection of semen of elite horses at farmer's door: NRCE has perfected the technique for collection and freezing of semen at farmer's door as the farmers/equine owners do not want to move their prized stallions. This technique is being used routinely and NRCE has been collecting semen from good quality stallions from Rajasthan regularly and this year onwards in Gujarat**.**
- Utilization of animal energy for agricultural operation has also been demonstrated successfully in ploughing, sowing, leveling, and chaff cutting; with establishment of appropriate work-rest-work cycle.
- Donkey fibre has been used to produce carpets by mixing with sheep fibres in the ratio of 40:60 at CSWRI.

Recognition of the NRCE labs

National referral lab on human glanders

The Glanders Lab of NRCE was given recognition of Ministry of Health & Family Welfare, Government of India for diagnosis of glanders in human, Endorsed by Standing Committee on Zoonoses in its meeting dated 31.05.2011 and communicated by National Centre for Disease Control (NCDC), New Delhi vide letter F. No. 4-2/2009-PRC dated 18th October 2011.

OIE Laboratories-Twinning labs

The OIE-Laboratory Twinning programs are meant especially for capacity building of laboratories (Candidate Laboratory) which wish to work as "OIE Referral Laboratory" in time to come. Under this program, the Candidate Laboratories are linked up with OIE Referral Labs or OIE Collaborating Centre on a particular disease (the Parent Laboratory) for a period of three years. After expiration of the twining program, the candidate laboratory has to demonstrate that it can work on that particular disease for another 2 years, after which the Parent Laboratory recommends to OIE for upgradation of the Candidate Laboratory as "OIE Referral Lab" for that particular disease.

- OIE approval 3 OIE-Laboratory Twinning programmes one each with Japan, Germany, and United Kingdom on ***Equine Piroplasmosis, Glanders,*** and ***Equine influenza***, respectively. The scientists will have linkages with these laboratories for at least 5-6 years as after the twinning program support (3 years) is over, these laboratories will have to sustain themselves on their own for two years and then only they will be eligible for recommendation – by the respective Parent Laboratory – to be upgraded to "OIE Referral Lab" status. **It is to mention here that only three OIE-Twinning Laboratories have been approved by OIE for India and all these three Laboratories are at NRCE, Hisar.**

Technologies

Equiherpes B-ELISA diagnostic kit

Equine herpesvirus-1 (EHV-1) is a major cause of abortion, early foal mortality, respiratory and neurological disease in equines, which results in heavy economic losses to the equine industry worldwide including India. In order to develop a diagnostic test for disease control, the NRCE developed Equiherpes B-ELISA Kit - an alternative to virus neutralization test - which has successfully been extensively validated by various laboratories (in-house labs of NRCE/SAUs/Government department) in the country. The kit is able to (i) detect sero-conversion and thus is able to diagnose EHV-1 recent infection, (ii) and is useful for assessment of herd immunity in equine breeding farms where vaccination is undertaken against EHV-1. The diagnostic assay is versatile and user-friendly as the kit can test the serum samples on different days as per the availability of test serum samples.

B-ELISA kit for EHV-I diagnosis

Equiherpabort (inactivated EHV-1) vaccine

In view of the adverse economic consequence of EHV-1 infection, the NRCE developed an oil-emulsified killed virus vaccine - known as Equiherpabort vaccine - using Indian strain of EHV-1. Efficacy of this vaccine in different phases of trials has successfully been demonstrated in pregnant pony/horse mares without any vaccine adverse reactions while the performance of this new vaccine compares well – in terms of post-vaccination antibody titre – with the "Pneumabort 'K' (an imported established vaccine) paving the way for use of this vaccine in India.

Updated equine influenza vaccine

Equine influenza - commonly known as 'Horse Flu' - is a viral disease of horses caused by equine influenza virus (EIV) subtype H3N8 which emerged in India in 1987 and re-emerged in 2008 - after a gap of 20 years - wherein equines from 14 states across the country from north to south and extending up to West Bengal in east were affected. An inactivated aluminum hydroxide

adjuvanted vaccine was developed consequent to 1987 outbreak using Ludhiana/87 isolate which belonged to pre-divergent lineage of the EIV isolates. Keeping in mind the human and animal Influenza vaccine updation, NRCE developed an updated equine influenza vaccine employing the new strain [A/eq/Katra (Jammu)/06/08 (H3N8)] of EIV as vaccine virus but employing the same established international EI vaccine technology which was also used for developing earlier EI vaccine by NRCE. This vaccine has passed all the mandatory testing requirements and is also totally safe in equines tested so far and generated immunity equivalent to international vaccine in the market. Vaccination Schedule includes (i) **f**irst vaccination in animals above 6 months of age, (ii) followed by booster vaccine 4-5 weeks of first vaccine, and then (iii) repeated annually or after monitoring of titres (when HI titres are below 64 the animals need to be vaccinated again).

Indirect ELISA kit for Theileria equi

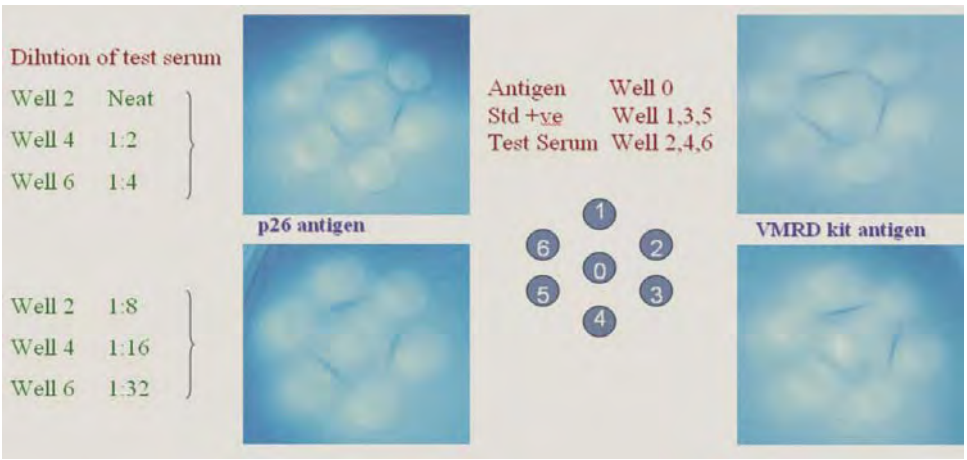
Equine piroplasmosis - also called equine babesiosis - is an acute, sub-acute or chronic tick-borne disease of equids, caused by an intra-erythrocytic protozoa *Theileria equi* (*T. equi*) or *Babesia caballi* which adversely affects the performance of the working equids (sero-prevalence up to 35% of the indigenous equid population) as well as race/breeding horses. The disease of equine piroplasmosis caused by *T. equi* - more widespread and pathogenic than that by *B. caballi*- – is done by sero-diagnosis employing an imported kit (OIE recommended CI ELISA Kit). Recently, NRCE developed recombinant EMA-2 protein antigen-based ELISA for detection of antibodies against *T. equi* parasite in equine serum. The kit provides ready-to-use ELISA plate which makes it simpler to use in two steps, viz., serum sample application and conjugate addition – and the results can be obtained in just 90 min after application of serum samples with Diagnostic Sensitivity (DSn) of 94.0% and diagnostic specificity (DSp) of 96.0% in comparison to OIE recommended CI ELISA Kit. Serum samples shipped to the laboratory at ambient temperature can be utilized for testing by kit and with same practice now the new kit is being used in the NRCE in routine. The kit is ready for commercialization and patent filing is under process.

Equip rotavirus test

Rotavirus associated diarrhoea results in high morbidity and mortality in neonatal animals (including foals) and human infants. A monoclonal antibody-based sELISA – named as EQUIP ROTAVIRUS TEST – for diagnosis of rotavirus in different animals and human stool samples has been developed at NRCE. The assay has 100% sensitivity and a specificity of 96% in comparison to virus isolation, exhibiting good agreement between the results obtained by both virus isolation and ELISA (k = 0.9346). This mAb-based ELISA is simple to perform, highly sensitive and specific assay for detection of rotavirus from equine stool samples. The assay is of great utility for timely diagnosis of rotavirus associated diarrhoea in animal and human population, which, in turn, can help in developing control strategies.

Recombinant antigen-based ELISA for detection of EIAV

The control of equine infectious anaemia (EIA) - a chronic and debilitating retroviral disease of equids - is based on identification of inapparent carriers by detection of EIAV antibodies by imported kits of the agar gel immunodiffusion (AGID) test (or Coggin's test) and ELISA albeit with high cost and import hassles. As such, NRCE developed a recombinant EIAV p26 protein antigen-based indirect ELISA (iELISA), ensuring a cheaper and continuous availability of the kit at national level. This new iELISA - faster (takes 3-4 h to complete the assay and result interpretation) than Coggin's test and not requiring any special expertise or sophisticated instrumentation enabling even normal laboratories to perform this test with high relative DSn (100%) and DSp (98.7%), in comparison with AGID assay - has successfully been validated extensively with 4545 equine serum samples (horse=3648, mule=295, donkey =602) so far and compares well with imported ELISA kit. Efforts are now on to get this ELISA converted into kit form, validated internationally by any OIE-Referral Laboratory, and put to use in routine sero-surveillance which will enable the country to know the status of the disease in India and thereby help in eradicating/declaring EIA-free nation which will be invaluable in terms of exporting our equines in EIA-free country.



Pregmare kit for pregnancy diagnosis in mares

Pregmare Kit - an early pregnancy diagnosis ELISA kit based on detection of PMSG or eCG in serum which is released after conception (after about 30 days of gestation) from the endometrial cups in pregnant mares - can be used for early PD (between 35 to 120 days of gestation) in mares covered by horse stallions. Pregmare Kit - being a serum-based test – spares the pregnant mares from transport stress which otherwise is imminent due to loading/ unloading from the vehicle and during actual transportation to Vet Clinics for rectal examination or Ultrasonography. The Pregmare Kit - with Ready-to-Use ELISA plate for confirming the pregnancy and foetus viability at an early date (*i.e.,* after 35 days of gestation) - helps the equine owners in re-covering their mares for getting one foal every year from any good quality broodmare which will have a direct impact on economic gain to equine owners which may vary from Rs 15,000 to a few lakh per mare. The Pregmare Kit [more sensitive than commercial kit (EVL) for early pregnancy diagnosis (35 days of gestation)] is a versatile kit with (i) capability of testing 72 single serum samples (36 in duplicate) shipped to laboratory even at ambient temperature or even up to 45^{0}C with 100% sensitivity and 97.84% specificity, with a shelf-life of 6 months, (ii) quite low cost per test as compared to ultrasound scanning fee, (iii) ensuring animal welfare during transport besides saving transporting fee and stress-related loss.

Artificial insemination using frozen jack and stallion semen

The EPC of NRCE has perfected the technologies of (i) the artificial insemination (AI) which is safe, cheap and viable as by this technique more number of foals can be produced in a year by judicious use of the valuable semen of good quality stallions, and (ii) freezing of semen at farmer's door and in the laboratory as well as the technology for cryopreservation of semen has made the countrywide transport of semen easy. The cryopreserved semen can also be used after the death of precious jacks/stallions for production of superior quality mules and true-to-breed indigenous equines. All these technologies are now in routine use at both the farms of NRCE at Hisar and Bikaner and also in the field (Haryana, Rajasthan, Gujarat) as and when request is received. Frozen semen technique is also being used for *ex situ* conservation of equids as well as to get more foals from a stallion in its lifetime. The NRCE has extended the AI services to field in Haryana (for mule production), Rajasthan (for Marwari foal and mule production), and western UP (for mule production). Now the AI is in demand for breeding of Marwari horses in Rajasthan and Kathiawari horses in Gujarat. NRCE has been actively promoting AI in horses and training field veterinarians of Rajasthan and Gujarat for performing AI, freezing of semen, and pregnancy diagnosis in horses.

Semen collection at farmer's door

AI in field

Marwari foals-at-foot – borne after AI – at farmers stables

Marwari foals-at-foot – borne after AI – at NRCE

Biological resources

Microbial and serum Bank

NRCE has a strong biological resource base having numerous pathogens, recombinant clones, reference sera, equine sera, monoclonal antibody secreting hybridomas, etc.

- Pathogenic isolates (viruses, bacteria and parasites) of equine origin available with NRCE include EHV-1 (6 isolates), EHV-4 (14), equine rotavirus (29), equine influenza (11), Japanese encephalitis virus (2), West Nile virus (1), *Rhodococcus equi*, *Streptococcus equi*, *S. zooepidemicus*, *Burkholderia mallei*, *Salmonella* Abortusequi, *S. equisimilis*, *Enterobacter aerogenes*, *E. coli*, *Staphylococcus aureus*, *Trypanosoma evansi* (3).
- NRCE has a number of hybridomas secreting monoclonal antibodies against equine herpes virus-1, equine rotavirus, Japanese encephalitis virus, West Nile virus.
- NRCE has a repository of more than 15000 equine serum samples collected from different geographical locations in its Equine Serum Bank.
- NRCE has a collection of more than 100 recombinant plasmid clones with recombinant genes of pathogens including equine influenza virus, equine rotavirus, EHV-1, EHV-4, EI, JEV, EIAV, *R. equi*, *Burkholderia mallei*, *Trypanosoma evansi*, *Theileria equi*.

Animal genetic resource

A total of 140 animals (Marwari horses, Kathiawari horses, Zanskari ponies, non-descript ponies, poitu and indigenous donkeys, mules) at EPC Bikaner and 38 animals (Marwari horses, other ponies, poitu and indigenous donkeys, mules) at Hisar are being maintained.

State of the art BSL-3 Laboratory

A state-of-the-art BSL-3 facility has become operational. This laboratory will cater to the needs of the centre for working on classified pathogens that can spread rapidly from animal to animal or even to human beings. The laboratory has special engineering and design features.

Marwari

Kathiawari

Zanskari

Poitu

Small grey donkey

Mule

The ventilation to the laboratory is balanced to provide unidirectional airflow. The exhaust air from the laboratories is discharged after filtration to prevent escape of microbes in the environment. Solid and liquid wastes from the laboratories are sterilized before final disposal. Access to the laboratory is restricted, and the Standard Operating Procedures (SOPs), based on Standard Microbiological Practices for Biosafety Level- 3, have been developed and are rigorously followed.

Services offered

NRCE provides various services to the farmers, equine breeders, and other stakeholders which include: (i) disease diagnostic services for various infectious and non-infectious equine diseases to equine owners, breeders, state animal husbandry departments, police and army horses, (ii) artificial insemination to augment the production of superior quality Marwari horses, mules and donkeys, (iii) quality jacks and jennies are supplied to various states, breeding societies and farmers, for production of superior quality mules and donkeys, (iv) NRCE is providing health certification for movement of equines within and outside the country. This facility has helped in promotion of export of horses, (v) Assessment and transfer of technology to the end users using the latest know-how of information technology is done. The scientific and technical staff provides clinical and diagnostic (including pregnancy diagnosis) services and consultancy to the farmers on demand in the areas of equine health and production. Farmers are imparted trainings and supplied education materials for equine management, production and health, (vi) extension activities to receive feedback from the equine owners, various activities like health camp, awareness and farmers meets are organized on regular basis in different areas of the country. Brief about these services is mentioned as below:

Surveillance and monitoring and disease investigation of equine diseases in India

NRCE is involved in nation-wide sero-surveillance and monitoring as well as disease

investigation of important equine infectious diseases, with a view to manage, control and eradicate diseases. Important achievements of the Centre in disease surveillance include (i) getting AHS-free status for India in 2006 by Office International des Epizooties (OIE) – the World Organization for Animal Health, (ii) diagnosis and containment of spread of glanders whenever country experienced including in the recent past in 2009-2010 and 2012, (iii) diagnosis and control of equine influenza during 1987-1988 and 2008-2009 epizootics, (iv) diagnosis and control of equine infectious anaemia (EIA) outbreaks in 1988, *etc*.

Contractual services for disease testing for certification

NRCE has been recognized as National Referral Lab for equine disease certification for the purpose of import or export. Besides testing of the samples from imported equines received from Animal Quarantine Stations located at Airports in India, the Centre also tests samples received in routine from Race clubs, Turf Authorities, Polo Clubs, Equestrian Federation, Thoroughbred Breeders, etc. on prescribed fee charge basis.

Artificial insemination

NRCE provides the artificial insemination services to farmers in the field. The farmers of Rajasthan and Haryana have been provided AI services for mule production and now there is a growing demand for AI services from Rajasthan and Gujarat farmers for foal production.

Pregnancy diagnosis

NRCE provides the services of pregnancy diagnosis by Ultrasonography and rectal examination in all the states where the NRCE team goes for animal health camps, animal fairs, and kisan melas. NRCE also provides pregnancy diagnosis services employing the Pregmare Kit as and when samples are received from field.

Training of farmers and field vets

NRCE provides timely help and support to under-privileged equine owners by organizing health camps, kisan gosthis and farmers interactive meets, etc. by disseminating the knowledge and technologies on equine health, production and management for optimal rearing of the animals to meet their livelihood. To popularize the technologies developed by NRCE, we regularly participate in different animal fairs, exhibitions, and Kisan Melas. A total of 31 course/workshops/conferences/ training; 70 health camps and kisan gosthis; 39 animal fairs, kisan melas, and exhibitions have been organized/attended so far besides small-scale activities at individual or small group level interactions being a routine activity.

Information dissemination through visits of stakeholders, farmers, field vets, and students

The groups of stakeholders, farmers, field veterinarians, paravets, and students visit farms at Hisar and Bikaner farms and these visiting groups are briefed about the R&D activities and the services provided to the stakeholders so that the information is widely disseminated to the stakeholders and the general public.

24-hour InfoEquine helpline (Kisan call centre)

NRCE has started 24-Hour Helpline at Hisar (1800-180-1233) and EPC Bikaner (1800-180-6225) Centres with call transfer facility beyond working hours to the cell phones of the scientists to provide information to the stakeholders including the farmers and equine owners on 24-hour basis. This service has become popular and helpful in advising the farmers about treatment of the animals and AI services.

Zanskari ponies in Zanskar valley – The native tract

VETERINARY TYPE CULTURE COLLECTION

NRCE Campus, Hisar, Haryana

Year of Establishment : 2004

VTCC, Hisar

The Veterinary Type Culture Collection (VTCC) was established at NRCE campus in 2004 as a national repository of animal microbes including dairy and rumen microbes aimed at (i) exploration and collection of microorganisms of animal origin/significance/relevance, (ii) central storage of animal microbes from existing culture collection centers, institutions and universities, (iii) characterization, documentation and digitization of microbial database of cultures of animal microbes, (iv) development of a National Microbial Gene Bank for conserving the biodiversity of animal microbes, and (v) conservation (both short-term and long-term) and utilization of microorganisms. This microbial resource centre focuses on the acquisition, authentication, production, preservation, development and distribution of standard reference microorganisms, cell lines, and other microbial resources for research in veterinary and life sciences.

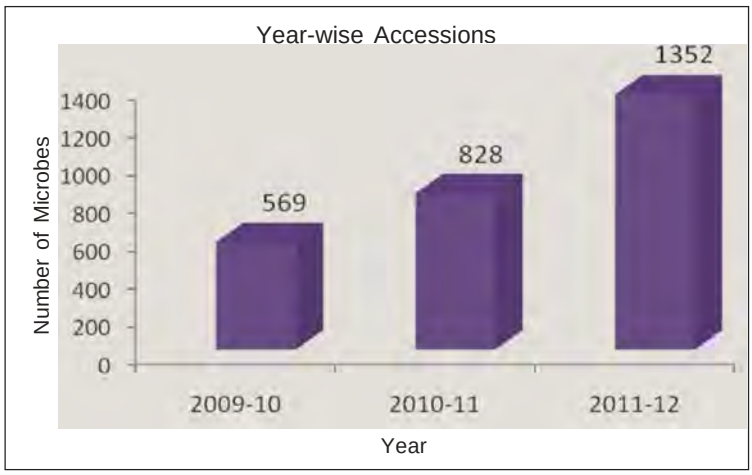
Achievements

As per the main mandate of the institute; isolation, identification, characterization, accessioning and reposition, and utilization of microbes of animal origin is the main activity. As

such, the main achievements of this institute – as listed below in the table – would be mainly on microbial isolation, repatriation, identification, characterization, and reposition.

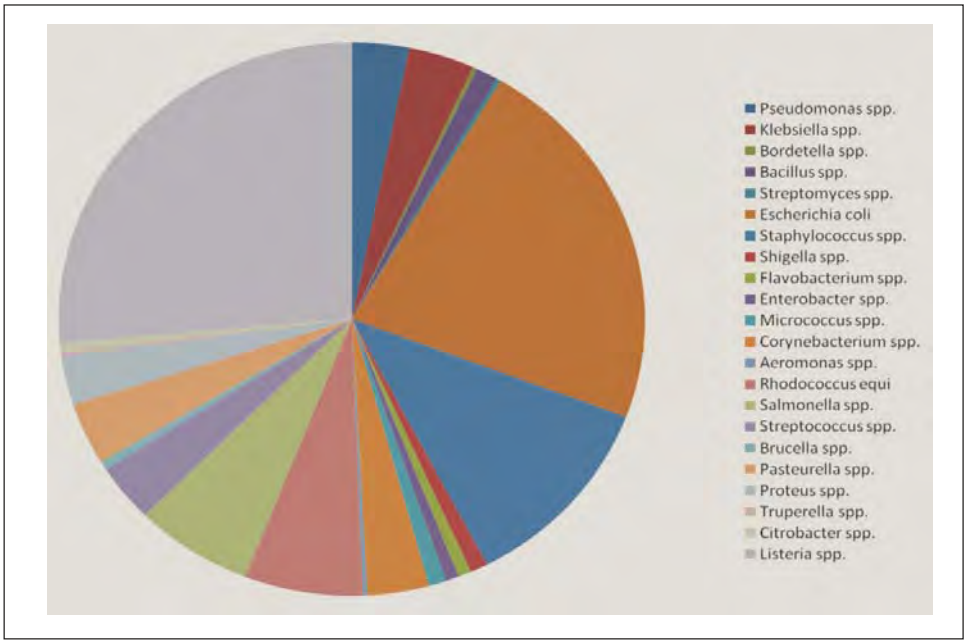
Present strength of the repository of microbes of animal origin at VTCC

Microbial Resource	Accessioned	Under accessioning	To be deposited	Total
Veterinary Microbes				
Bacteria	440	339	96	875
Virus	106	4	-	110
Fungus	-	13	80	93
Recombinant clones	180	12	-	192
Phage library	27	-	-	27
Total	**753**	**368**	**176**	**1297**
Rumen microbes				
Anaerobic bacteria	19	51	-	70
Fungi/Yeast	76	18	-	94
Methanogenic archae	-	8	-	8
Total	**95**	**77**	**-**	**172**
Dairy Microbes				
Bacteria	504	66	51	621
Grand total	**1352**	**511**	**227**	**2090**

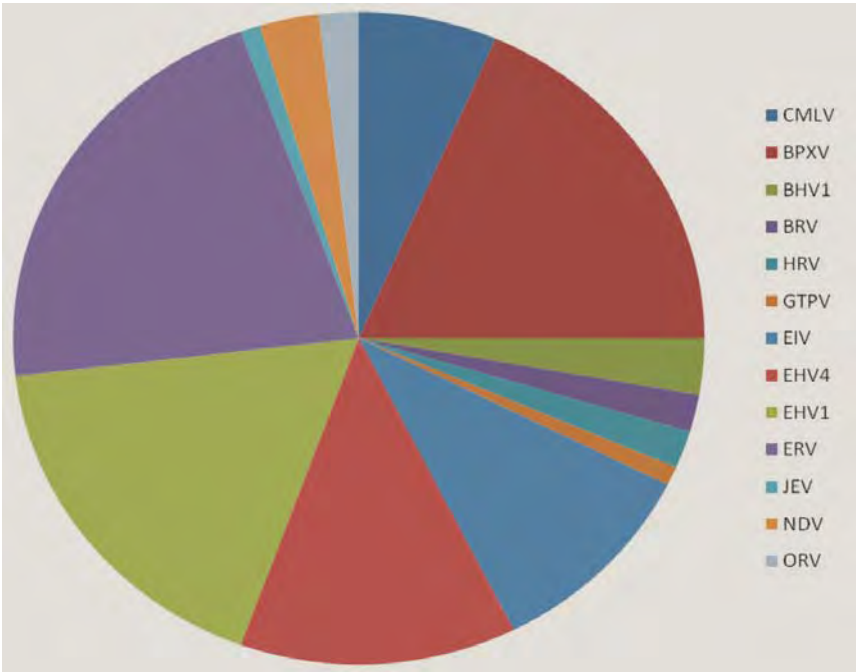


A total of 1352 microbes have already been accessioned and approx. 527 microbes will be accessioned in very near future. The accessioned microbes have originated from a number of animal species viz., cattle, buffalo, pig, sheep, goat, horse, donkey, camel including double-humped camel, rabbit, deer, leopard, poultry, emu, fish, tick, monkey, human *etc*.

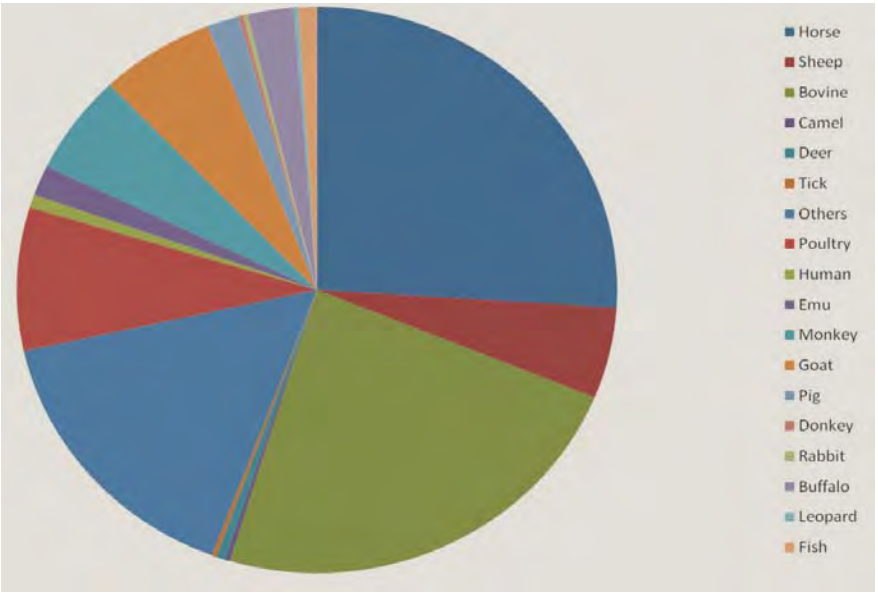
- The centre had many opportunities to record the many new isolations of the bacteria from several species of animals *viz.*, buffaloe (*Trupenella pyogenes*), horses (*B. bronchiseptica*, *Corynebacterium pseudotuberculosis*, *C. bovis*, *Enterococcus asini*), foals (*Actionobacillus equilli*), pig (*Staph. hyicus*, methicillin-resistant coagulase-negative *Staphylococcus sciuri* from pigs, *Exiguobacterium* spp.), double-humped camel from Leh region (*Rhodococcus equi*), fish (*Aeromonas hydrophila), etc*.
- The Centre also identified two bacteria belonging to two new Genus *viz.*, *Brevibacterium* spp. and *Brevibacillus spp.* from equine faeces, and 22 atypical R. equi isolates.
- Microbial species-wise, host-wise and geography-wise distribution of microbes is depicted below:



Genus-wise distribution of bacterial isolates



Distribution of viral isolates



Animal host-wise distribution of bacteria

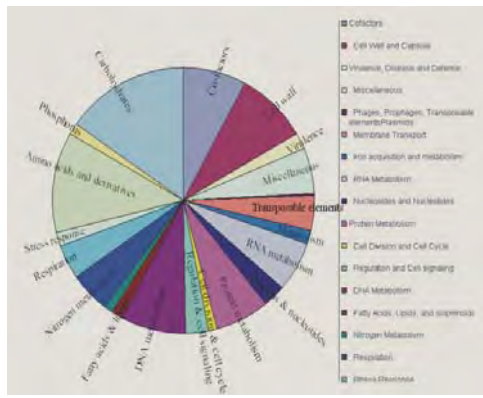
Geographical location of microbial cultures/isolates
(isolations from colour-coded states)

Isolation, identification and whole genome sequencing of *Pasteurella multocida* Bu2 strain

Whole genome sequencing of *Pasteurella multocida* Bu2 strain isolated from a buffalo calf died of per acute haemorrhagic septicaemia was done by 454 sequencing platform. The whole genome sequence contigs were bioinformatically analysed by online RAST platform which revealed 207386 bp genome, 953 contigs, 330 sub-systems, 1960 ciding sequences. It has 52 RNA Coding Sequencs,

Important pathogens in the repository: Some of the important microbes are mentioned below:

Zoonotic viruses: Notable among them include camelpox viruses (4 isolates from camel from Delhi, Bikaner, Barmer), buffalopoxvirus isolates from



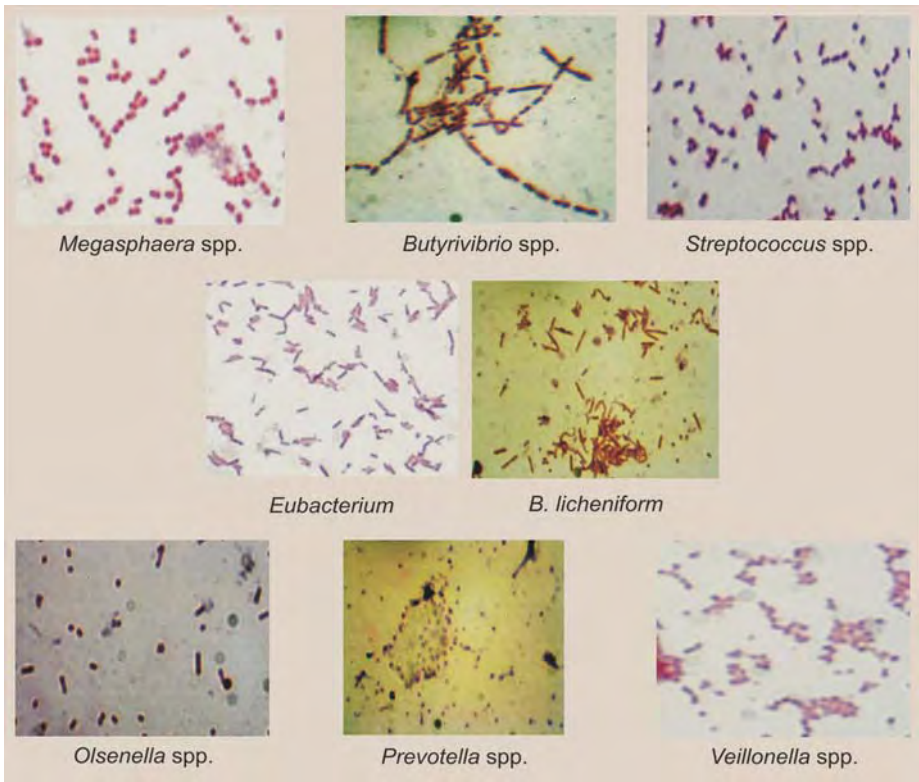
Genome sequencing of *Pasteurella multocida*,
Bu1 strain VTCC

various geographies like Maharashtra and UP include human (07 isolates), buffalo (12 isolates), and cow (6 isolates) including three isolates of buffalopox virus recovered from human from Meerut which are very virulent as they produced severe lesion in humans, Japanese encephalitis virus from horse (Haryana), *etc.*

Zoonotic bacteria: Rhodococcus equi from foals (including – typical, 22 atypical isolates), and double-humped camel from Leh Region (01 isolate), *Burkholderia mallei* from equids, *Aeromonas hydrophila* from fish, *etc. Escherichia coli* and *Klebsiella pneumoniae* from equine abortion cases.

Important rumen microbes in the collection

Important rumen fungi and bacteria isolated and accessioned include bacteria and fungi isolates. Important rumen fungi isolates in the repository include O*myces* joyonii, *Orpinomyces intercalaris, Anaeromyces* sp., *Piromyces* sp. (3), *Neocallimastix* sp. (Figure 8), while bacterial isolates include *Bacillus licheniformis*, *Butyrivibrio* sp., *Eubacterium limosum*, *Megasphaera elsdenii* (2 different host animals), *Olsenella* sp., *Prevotella* sp., *Streptococcus bovis*, *Streptococcus equines*, *Streptococcus gallolyticus*, *Streptococcus lutetiensis*, *Streptococcus sanguinis*, and *Veillonella parvula*, *etc.*



Important dairy microbes in the collection

Identification and accessioning of significant and promising dairy isolates viz. *L. lactis* and *Leuconostoc* sps. Various utility selections - based on technological properties - include (i) combination of *L. lactis* ssp *lactis* & leuconostoc selected for dahi preparation, (ii) Galactose fermenting strains -*Streptococcus thermophilus* used for preparation of low-galactose fermented milks including yoghurt and low browning Mozzarella cheese, (iii) EPS positive - *Leuconostoc* spp. – for preparation of low fat lassi and sweetened Dahi, (iv) mannitol producing- *Leuconostoc* spp. - preparation of reduced caloric lassi, (v) phytase degrading- *Lactobacillus* spp. - defined strain starter culture for cereal-milk fermented products.

Dairy microbes in commercial use

Manufacturing units of various cooperative dairy federations (Mother Dairy, Delhi; Mother Dairy, Kolkata; Dudh Sagar Dairy, Mahesena, Gujarat; Creamline Dairy Products Ltd., West Godavari, Andhra Pradesh; Verka Milk Plant, Hoshiarpur, Punjab; Verka Milk Plant, Sangrur, Punjab; Jind Milk Plant, HAFED, Haryana; D'souza Biotech, Goa; Dehradun Milk Plant, Uttrakhand) are using Dairy cultures (Dahi (thermophilic and mesophilic) and yoghurt cultures as freeze dried ampoules) from NDRI culture collection (VTCC) to produce curd and other products from milk for commercial purpose.

NATIONAL RESEARCH CENTRE ON PIG

Rani, Guwahati, Assam

Year of Establishment: 2002

PIG rearing is one of the most important occupation of rural society especially the tribal masses of India. It has largely remained under nomadic system of rearing (scavenging) with the weaker sections of the society both as a source of income and a choice of meat for consumption. The bulk of the pig population in India is indigenous type with low growth rate and productivity. In order to improve the performance of indigenous pigs, ICAR has initiated AICRP on Pig in the year 1971. The review committee of AICRP on Pig in the year 1990 felt the necessity for establishing a full-fledged institute and recommended the establishment of National Research Centre on Pig preferably in the North Eastern part of the country where 40% of country's pig population is distributed. The National Research Centre on Pig was established in 2002 and started functioning from 2005 from private premises in Guwahati before permanently shifting to the main campus in the year 2009 after completion of the laboratory cum administrative building. The institute has the responsibility for overall development of the piggery sector in the country for excellence in pig production, health and product processing through innovative research and to provide technology backstopping for enhanced pork production, employment generation and poverty reduction among socially and economically weaker sections through the medium of pig husbandry.

Improved Germplasm

Two phenotypically different strains of indigenous pigs viz. Ghungroo and Niang Megha were collected from their breeding tracts and characterized genetically to establish their morphological, morphometrical, cytogenetic and DNA profile as per FAO recommended microsatellite loci. The productive and reproductive traits of these breeds were to facilitate and register them as first indigenous pig breeds of India.

Ghungroo

The Ghungroo pig is from Dooar's Valley of eastern sub-Himalayan region mainly in the Siliguri and Darjeeling districts of West Bengal. These are medium sized animals with compact body conformation. The typical body colour is black but white spots on forehead and other parts of body are not uncommon. The face is broad and flattened with slightly upwardly curved snout. Ears are large and heart shaped resembling those of an elephant. The head is prominent with bright eyes in males and little dull in females. Fore-quarters are light and hind-quarters heavy. Legs are small and stout. Body is covered with thick, coarse and long hairy coat. Tail is long, reaching below hock with long bristles. Average body weight at birth is around 1.0 Kg and 106.00 Kg at 1 year of age in both sexes. High prolificacy, fast growth, consumers' preference and adaptability to low management inputs are some of the outstanding characteristics of the breed. Pork of this breed under normal free range management is lean with less intramuscular fat. The average litter size at birth is about 12.

Ghungroo

Ghungroo sow with piglets

Improved variety of crossbred pig

An improved variety of crossbred pig was developed by crossing Ghungroo (indigenous) with Hampshire (exotic) breed. The crossbred pig is found to have superior growth rate, litter size at birth and weaning and feed conversion efficiency. This variety has been propagated in farmers' field through Institute Village Linking Programme (IVLP) programme.

Crossbred sow with piglets

Preservation of boar semen and artificial insemination (AI) in pigs

Technology for extended preservation of liquid boar semen at 15°C in Glucose EDTA Potassium Sodium Tartarate Sodium Citrate (GEPS) extender up to 7 days has been standardized. Methods for AI in pig for the first time in Assam under farm and field conditions have also been standardized. More than 1500 piglets have been produced till date using AI. The institute has extended the technology to more than 82 villages till date.

Semen collection and artificial insemination

Unconventional feed resources for economic pig production

Studies indicated that 10 % replacement of whole concentrate with colocasia (stem and leaves) and 2 % of maize with Azola (*Azola carolini*) can meet the nutritional replacement requirement of grower crossbred (HS X GH) pigs without affecting the growth rate, feed conversion efficiency and cost of production. Colocasia and Azola contain 11.57 % and 21 % crude protein respectively.

Azola (*Azola carolini*)

Colocasia (*Colocasia esculenta*)

R&D Pork processing plant

The state-of the-art slaughter house is equipped with all essential equipments required to ensure hygienic slaughter operations. It also has the basic facilities for hygienic processing of

pork and production of value added products viz. pork sausages, nuggets, patties, slices etc. The unit has a state of the art effluent treatment plant and incinerator which allows the treatment of the liquid and solid wastes respectively.

Value added pork products

Institute has standardized the technologies for refinement and standardization of different value added pork products viz. frankfurter, salami, cocktails, ham slices, patties, nuggets, kebab, momos etc.

Value added pork products

Services being provided to stakeholder

Improved germplasm

The upgraded variety of pigs developed by crossing Ghungroo with Hampshire have been transferred through IVLP for validation of its performance at farmer's field. This variety of pig is gaining popularity among the farmers due to its high litter size at birth and adaptability.

Artificial insemination

Artificial insemination technology is being extended to several villages even upto 250 km from the institute. Till date more than 2500 AI have been performed. Using AI, a record litter size of 19 piglets was obtained under field condition. The crossbred born out of AI fetches around Rs.1700 to the farmer at 2 months of age.

Public private partnership initiative

The Institute has established close linkage with small scale entrepreneurs who are willing to take up the improvised technologies/products from the Institute market the fresh pork and processed pork products. In this regards, a Memorandum of Understanding has been signed for joint venture with M/s Arohan Foods, Guwahati for processing and marketing of value added products and four different products i.e. frankfurters, cocktails, salami and nuggets have been released for marketing under the brand name of 'Choice Pork'.

NATIONAL RESEARCH CENTRE ON MITHUN

Jharnapani, Nagaland

Year of Establishment: 1988

MITHUN, a rare bovine species of the North-eastern Hill Region (NEHR) is mainly found in four different States of India viz., Arunachal Pradesh, Nagaland, Manipur and Mizoram. With an aim to identify, evaluate and characterize the mithun germplasm available in the country, the National Research Centre on Mithun was established to conserve, improve and propagate mithun for meat, milk as well as hide through organized research and extension activities and also to act as repository of germplasm and information on Mithun.

Development of improved germplasm

NRC mithun has collected the typical animals of all the four strains (Arunchali, Nagaland, Manipuri and Mizoram) based on each of the states where mithun is found.

Arunachali mithun

These mithuns are distributed in different districts of Arunachal Pradesh. The animals have massive, deep body conformation showing great variation in colour and phenotypes. The adult body weight vary from 450 to 600 kg in male and 350-400 kg in females.

Arunachali mithun

Nagaland mithun

These are free ranging woodland animals distributed in several districts of Nagaland state. The animal has a massive, well built and sturdy body, with predominantly black or brown colour and white stockings. The body weight varies from 400-500 kg in males and 350-400 kg in females.

Nagaland mithun

Manipuri mithun

These are phenotypically similar to Nagaland type mithuns. However, they possess larger colour variations. The animals are distributed in jungles in the hilly terrain of the state. The relative body size is smaller weighing around 400-500 kg in males and 300-400 kg in females.

Manipuri mithun

Mizoram mithun

There is a small population of mithun in Mizoram distributed in upper hilly terrain of the state bordering Manipur. The animals are having heavy built and are mostly black or brown colour. The horns are more flatter than those of other strains.

Mizorum mithun

Nutrition Technologies

Preparation of low-cost nutritious feed blocks for Mithun

Complete feed blocks developed for better growth and production reduced dustiness, improved palatability as well as digestibility of nutrients, thereby increased the productivity in Mithuns for higher income. The feed blocks were made from locally available feed ingredients. Tree leaves, straw and concentrate feeds were mixed together and pressed by using feed block making machine.

Feed block machine

Feed blocks were also made from paddy straw and spent grains (a breweries industry by-product) with high moisture content (75-80%). Simultaneously, methods have also been developed for drying high moisture content byproducts (spent grain)/fodders more efficiently during rainy season.

Performance of mithun was found to be good with average daily growth (ADG) of 500 g in tree leaves based feed blocks and 553.6 g from spent grain based feed blocks as against ADG of 396.2 g in control feeding. The cost of tree leaves and spent grain based feed blocks was observed to be Rs 6.70/ kg and Rs. 8.20/kg, respectively replacing the concentrate feeds costing Rs.14.00/kg.

Silage making

Silage has been prepared using agro-industrial by-product (orange pulp after extraction of juice), grasses and paddy straw. The ratio of different combinations as used was as follows: Napier grass: orange pulp = 1:1; Napier grass: orange pulp = 1:2; Paddy straw: para grass:orange pulp = 1:1:4.

Mixing of grasses and orange pulp during preparation of silages and silage storage tanks

The silage making by using waste products from the food processing industries (fruit processing waste) will be able to solve not only the requirement of animal feed shortage during winters, but also the problem of disposal of these waste products.

Area-specific mineral mixture

In an analytical study of micro-nutrient content of fodder tree leaves showed that the levels of calcium, magnesium and iron contents were higher whereas, concentration of phosphorous, copper and zinc was found to be lower than the standard levels. Based on this study, an area specific mineral mixture has been formulated to balance the mineral requirement for better production and reproduction in mithuns.

Area specific mineral mixture

Reproduction Technologies

Development and validation of estrus synchronization protocol using $PGF_{2á}$, GnRH - $PGF_{2á}$ - GnRH (Ovsynch) and controlled intravaginal drug (progesterone) releasing device (CIDR).

Estrus synchronization using PGF_2

Two injections of PGF_{2a} were given at 11 days apart in cyclic mithun cows. Animals were observed for signs of estrus after second injection of PGF_{2a} and found that all mithun cows responded to this treatment. The intensity of estrus in mithun cows synchronized was found to be high to that of spontaneous estrus and the conception rate was 75%.

Estrus synchronization using Ovsynch protocol

Cyclic mithun cows irrespective of any day of estrous cycle were subjected to Ovsynch protocol of estrus synchronization. Ovsynch (GnRH + PGF_2? + GnRH) protocol for synchronization of estrus and ovulation produced a response of 100% in mithun.

Estrus synchronization using CIDR

Experiments were conducted to synchronize estrus using CIDR in cyclic and post-partum mithun cows. CIDR was inserted into the Mithun cows and on 8th day, CIDR was withdrawn. One day before withdrawal of CIDR (On day 7) $PGF_{2á}$ was injected. All the animals exhibited estrus within 48 to 72 hrs of $PGF_{2á}$ injection. In both categories of animal, synchronized estrus using CIDR showed more prominent behavioural signs of estrus than spontaneous heat. Use of CIDR is therefore advantageous in terms of a) prominent behavioural signs of estrus thus ease detection of estrus and b) increased productive life span of around 50 days. The advantages of CIDR were in terms of higher intensity of estrus expression than spontaneous estrus and the technique was very useful for early induction of postpartum oestrus.

Standardization of innovative method of semen collection

Mithun bulls do not mount cows that are not in estrus (heat) which causes problem in obtaining semen regularly using artificial vagina (AV) method. To solve this problem, an innovative method was developed. Urine was collected from estrus cows

Innovative ways of using urine of estrus cows for collection of semen using non estrus cows as dummies

and stored at refrigerated temperature. The urine was sprinkled over the perineal region of a mithun cow not in estrus and bull reacted by mounting and semen was collected successfully. Urine collected from estrus cows and stored at refrigerated temperature was effective till day 7 post-collection.

Standardisation of semen preservation and Artificial insemination

For improving the production performance of mithun, it is required to breed females with the semen of the bulls of superior genetic merits. This can be achieved easily through artificial insemination (AI) with preserved semen. Mithun semen could be preserved successfully at 4°C

Mithun calf born by AI at Khunoma village

for about 2 days. Semen could also be successfully cryopreserved in liquid nitrogen using tris–egg yolk–glycerol or citrate–egg yolk–glycerol diluent. It was observed that 5% glycerol concentration in the diluent was suitable for preserving semen in liquid semen. AI using liquid and cryopreserved semen has been sucessfully used inproduction of mithun calves both at the farm and field levels (Khunoma village).

Superovulation and embryo transfer

After synchronization of estrus, mithun cows were superovulated by using FSH (Folltropin-v-Bovine) 400mg for 4 consecutive days on days 10-13 post estrus. PGF_2 á (5ml) was administered on day 3 of FSH treatment. After insemination at superestrus flushing was carried out on day 6 of the following oestrous cycle (considering day 0 = day of estrus) by non surgical method and embryos recovered from the donor animals were transferred into recipients. Pregnancy was monitored through ultrasonography. The first calf named as BHARAT was born in March 27, 2012. The second calf (PRITHVI), was born on May 11, 2012 but survived only for two days due to premature delivery.

BHARAT, first mithun calf born through ETT

Cryopreservation of mithun embryos

The technique of cryopreservation of mithun embryos in liquid nitrogen has been standardized. After 100 days of cryopreservation an embryo was transferred into a recipient animal and MOHAN, the first mithun calf was born on May 12, 2012 through embryo transfer technology (ETT).

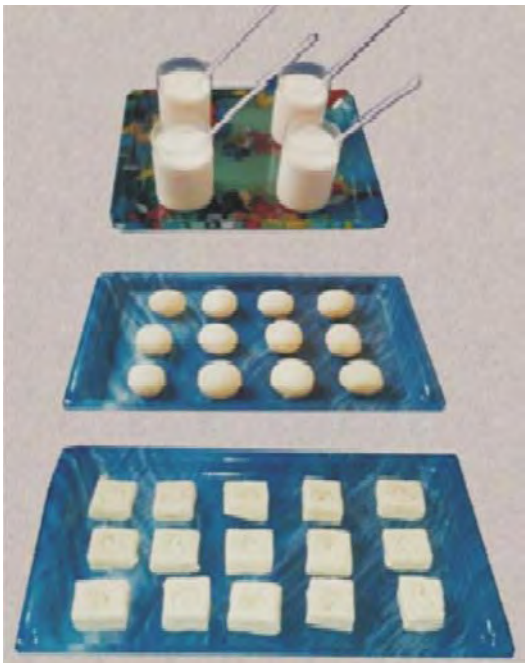
MOHAN, the ETT born calf from 100 days cryopreserved embryo

Value added products from mithun milk and meat

Mithun milk is very rich in fat and protein. Milk fat ranges from 7.04 to 14.56%. Mithun meat is also of high quality. Based on these quality parameters value added products from meat and milk have been prepared and organoleptic test showed overall palatability of meat (6.92 ± 0.20) in comparison to beef (6.33 ± 0.17). Milk product palatability has been recorded as 7.10 ± 0.15 in a scale of 1-10.

Mithun meat product

Leather bag from mithun hide



Pruducts prepared form mithun milk

Value added products have also been prepared from Mithun hides and finished leather products like leather bag, shoe upper as well as garment.

NATIONAL RESEARCH CENTRE ON YAK

Dirang, Arunachal Pradesh

Year of Establishment: 1989

ICAR established the National Research Centre on Yak (NRCY) at Dirang in West Kameng district of Arunachal Pradesh to make an in-depth study on traditional yak rearing and to formulate future plans, strategies and programmes for overall improvement and sustainable development of yak husbandry in India. In April, 2009 a state-of-the-art laboratory-cum-office building was inaugurated and presently full-fledged activities of this centre has been initiated. Since the last couple of decades, this centre has been conducting comprehensive research in the areas related to yak in genetics & breeding, nutrition, physiology, reproduction, health, management, product technologies and extension.

Germplasm identified

Indian yaks have been categorized into five distinct types namely, Common type, Bisonian type, Bare back yak, Hairy forehead and White yak.

Common Type

Common type yaks are comparatively smaller in size. These animals are apparently mild and docile in nature and are predominantly milch type animal. They constitute about 60% of yak population in Arunachal Pradesh.

Indian yak

Bisonian type

These animals have bison like horns and dorsal ridge. Head is thick and blunt, shoulders are well developed. Muzzle and nostrils are comparatively thick. These yaks are larger than common type and hair on the forehead are curled. Most of the animals are white, black or of mixed colours. These animals are predominantly of draught type.

Bisonian yak

Bare back type

These are heavy animals, comparatively larger in length. They have little hair on the back but drooping hair on all the sides almost touching the ground. Bare back are dual type, have good milking temperament and also possess character of draught. Around 14% of yaks are of this type in Arunachal Pradesh. Polled or horned characters show no particular trend. Some of the animals are humped which unlike cattle gradually descends from peak at third and fourth thoracic vertebrae.

Bare back type yak

Hairy forehead type

These animals have long bushy hair on forehead that even cover the eyes. The remaining features of yaks are of common type. These animals are similar to long hair forehead type found in other parts of Himalayas.

Hairy forehead type

White Yaks

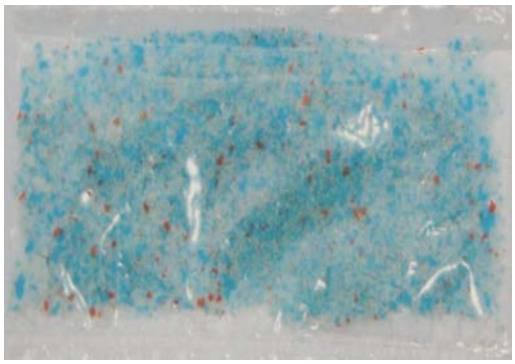
Pure white yaks with black or brown eyes are also found in limited numbers. These animals are very popular amongst tourists. Yaks are used for rides at places of tourist attraction by local farmers for attracting tourists. The white coat of long hairy fibers is used for making various items including chawars.

White yak

Technologies developed

Area specific mineral formulation

Analysis of soil, feed and fodder of yak rearing regions revealed the deficiency of zinc (Zn), copper (Cu), cobalt (Co) and manganese (Mn). Area specific mineral formulation for yak feeding has been prepared with Zn, Cu, Co and Mn to improve yak health and production. Area specific minerals can further be supplemented in complete feed blocks made through locally available feed resources. This has an additional advantage of ease in transport and storage in difficult hilly terrain due to compact size of voluminous feed for animal feeding during winter scarcity period.



Amelioration of degraded high altitude pastures for yak

Yak husbandry of Arunachal Pradesh is totally dependent on high altitude pastures. The quality of these pastures have been deteriorating due to degradation of natural grasslands and unprecedented growth of unwanted grasses. Therefore, NRC on Yak has taken initiative to

Temperate grasses *Dactylis glomerata, Lolium perenne* and legume *Trifolium repens* growing in temperate pastures of Arunachal Pradesh.

rejuvenate the degraded high altitude pastures by introducing suitable species of temperate grasses and legume like *Dactylis glomerata, Lolium perenne, Setaria spp, Tall fescue* and *Trifolium repens*. Yak farmers of *brokpa* community were also educated and trained regarding the scientific management of degraded high altitude pastures.

Toxicant and Eco-toxicology

Senecio crysanthomoides an alkaloid containing poisonous plant was found to have fatal effect on yaks and thereby posing a major problem in this region.

Farmers and yak herders are educated for safe grazing of their animals.

Reproductive Management

Semen collection, cryopreservation of semen and AI has been standardized indigenously. First AI calf was born in 2006 in the institute farm at Nyukmadung.

First AI calf

Embryo Transfer Technology (ETT) was standardized and the first female yak calf, named MISMO, was born through ETT in 2005.

First ETT calf

Ovsynch protocol, and progesterone impregnated vaginal sponge method was standardized for synchronization of oestrus in yak with 100 and 60% conception rate, respectively.

Yak health related technologies

Healing touch- a polyherbal wound healer and fly repellant

Yak's wild and aggressive nature has made it susceptible to attacks by wild animals in dense forest, causing complicated wounds and infections. These wounds were further complicated by maggot infestation. Pestering wounds have become a common cause of failing yak farming in Arunachal Pradesh. To counteract such problems, a poly-herbal preparation was prepared by the institute using extracts of different herbs and medicinal

plants. The clinical efficacy of the preparation was first tested on experimental mice model which was followed by successful tests on farm animals of Nyukmadung yak farms and yaks, hill cattle and mithun of local and adjacent areas. Its effectiveness in treating surgical wounds and external application has provided much needed relief from hot painful swelling of the udder in mastitis.

Polyherbal wound healer and fly repellent

Infection and Immunity

A herbal eye drop of ophthalmic preparation was developed which has proved to be effective in treating *keratoconjunctivitis* (pink eye) in yak.

First global report of cutaneous papillomatosis in yak has been confirmed through sequence information of proviral partial gene for capsid protein. *Mammomonogamus laryngeus* ovum has been identified for the first time in Indian yak during coproscopy.

Value added yak milk and meat product technologies

Dietary fibre enhanced low fat paneer from yak milk

Based on the demand of health conscious consumers, low fat paneer was developed having 1% fat content. The product quality of low fat paneer was improved with the enhancement of fibre content by incorporation of dietary fibres @ 2% inulin. Increased fibre content in the product has health benefits like prevention of cardiovascular diseases and colon cancer etc.

Low fat paneer

Sausages from yak meat and pork

Sausage, from yak meat was developed by incorporating pork meat and fat (yak meat 60%, pork 20% and pork fat 20%). The product is widely accepted by consumers due to its flavour, texture, juiciness and tenderness and has good market potential.

Sausages

Yak milk whey beverages incorporated with kiwi fruit pulp

Whey being a rich source of nutritional and functional components is utilized in beverage and food supplements to meet the increasing demand of protein and energy in human nutrition. Beverages from yak milk whey have been formulated with 15% sugar, 0.1% coco powder, 0.2% salt, 0.015% caramel flavour, 0.05% alpha-tocopherol and enriched with natural vitamin C by addition of kiwi fruit pulp.

Yak milk whey beverages

Yak fibre technologies

Technologies for making chawar, cap and carpets/wall hangings from coarse and fine hair fibres of yak have been developed.

Chawar (Holy Duster)

Yak has a bushy tail and white hair colour types are specially selected by farmers. The tail hairs are used for making chawars which are used as holy duster in Buddhist shrines, Gurdwaras and some ceremonies in Hindu mythology.

Caps and other novelties, including wall hangings have been produced from down hair of yak which is very fine. Yak herders also use these fibres for making quality garments from hand spun yarn.

Chawar

Cap

Carpet

NATIONAL RESEARCH CENTRE ON MEAT

Hyderabad, Andhra Pradesh

Year of Establishment : 1999

THE National Research Center on Meat was conceptualized in the year 1986 at IVRI Campus, Izatnagar with a view to conduct research in the frontier areas of meat science and technology and to develop human resource for the fast growing meat sector. The Centre has begun functioning since 1999 at Hyderabad in its sister institutes of ICAR – initially Project Directorate on Poultry and subsequently from Central Research Institute for Dryland Agriculture. The Centre has developed its new campus with well equipped laboratories and is now functioning from April, 2007 at the new premise located at Chengicherla, Hyderabad.

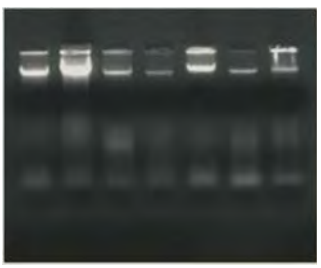
Technologies for small scale meat processing

Small scale technologies with low cost machinery and locally available ingredients and culinary practices have great relevance in Indian situation for large scale adoption. Meat emulsion technology is a relevant technology for quality meat products production utilizing tough meat and by-products from old (spent) animals.

Meat byproducts

Technologies for Sex identification of meat by Amelogenin XY gene

Identification of sex of meat animals is important issue as cow slaughter is banned in India but not bullock slaughter. A technology for identification of sex of the animal from which the meat is produced has been developed.



Amelogenin XY gene PCR gel

Specialty meat products with health and nutritional benefits

Product with different natural ingredients have been developed that could beneficially be incorporated in the production of value added meat products.

Value added meat products

Retort pouch technology for shelf stable meat products

Lack of cold chains and frequent power failures are major constraints in the preservation, distribution and marketing of highly perishable meat products in the country. Shelf stable, ready to eat (RTE) Indian traditional meat varieties such as curries, kheemas and soups were thermally processed in transparent pouches having shelf life up to one year at room temperature.

Retort pouch machine

Packaging technology for improving the shelf-life of meat

Super-chilling and vacuum packaging technology for enhancing the quality and shelf-life of buffalo meat steaks has been developed. This process improves the shelf-life of fresh buffalo meat upto 3 months without freezing, thereby significantly reducing the drip loss, labour charges, storage and transportation cost, electricity and space requirement to meat processors and buffalo meat exporters.

Vacuum packed meat products

Experimental Abattoir

Technology for slaughtering of sheep and goat with chilling, deboning and cold storage facility has been developed. About 20-25 animals can be slaughtered for carcass quality. Hands on training and demonstrations on clean meat production are being conducted for various stakeholders.

Experimental abattoir

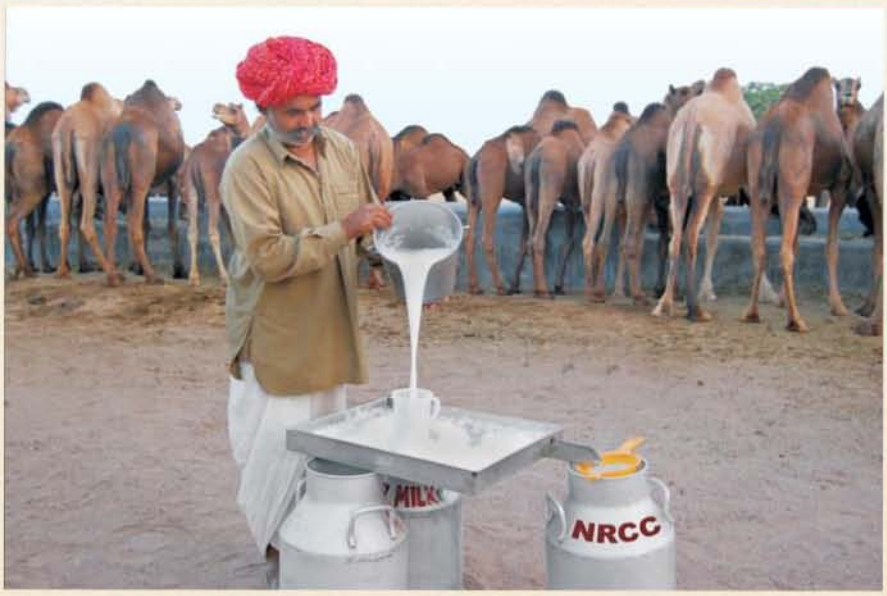
Success stories

The entrepreneurs have successfully started poultry products processing business in Hyderabad and Warangal districts of Andhra Pradesh. In addition to these entrepreneurs who were already in the meat processing business, and have undergone training at NRC Meat, they have also introduced new range of products. Entrepreneurs from Punjab, Gujarat and Kashmir have been trained and technology for packaging and production of value added products have been transferred.

Processed meat products of entrepreneurs

Shri Sharad Pawar, Hon'ble Union Minister of Agriculture and Food Processing Industries releasing area specific mineral mixture at CIRG, Makhdoom, U.P.

Dr. S. Ayyappan, Secretary, DARE and DG, ICAR distributing quality goat germplasm to a farmer



Diversified uses of Camel

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