



# Vision 2050



हर कदम, हर डगर  
किसानों का हमसफर  
भारतीय कृषि अनुसंधान परिषद

*Agri*search with a human touch



National Research Centre on Camel  
Indian Council of Agricultural Research





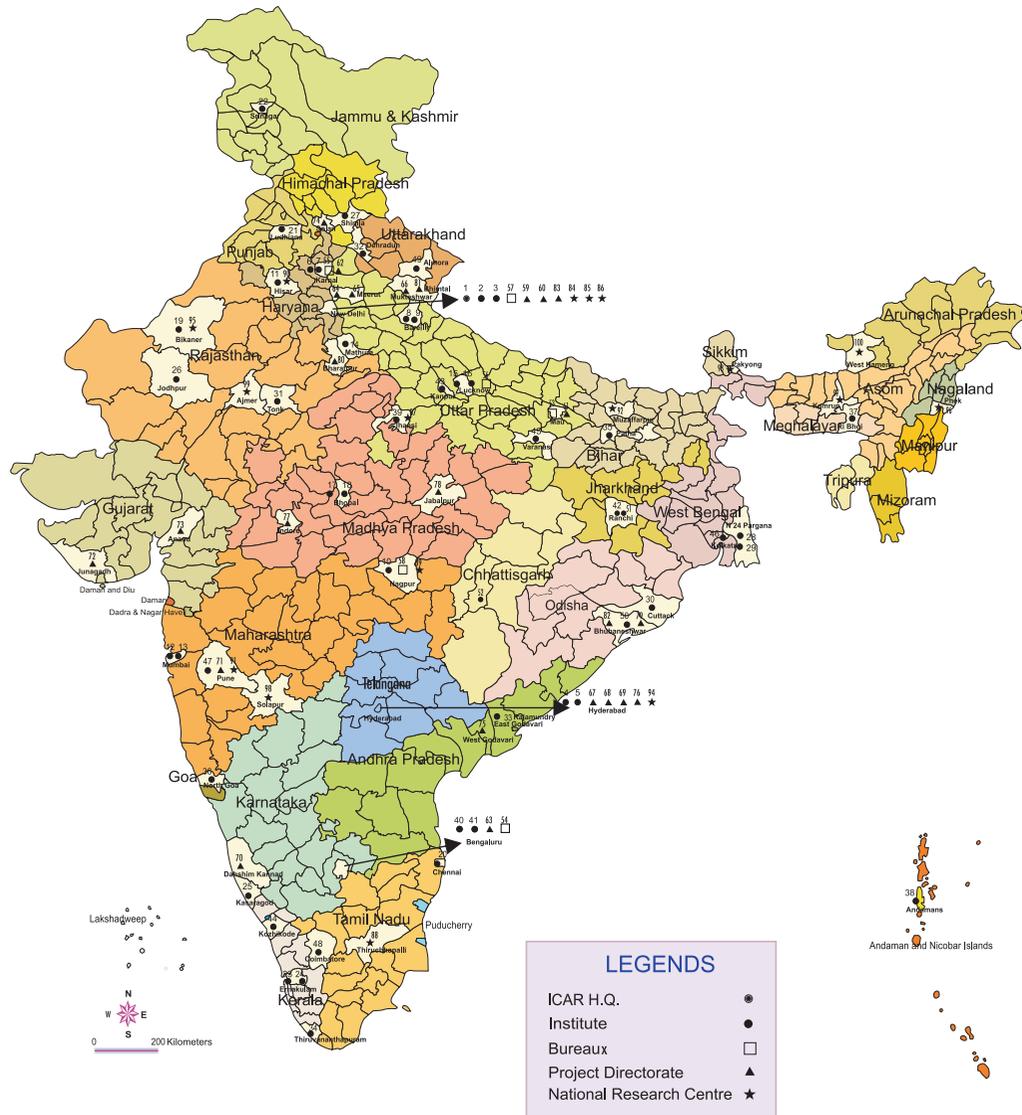
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Vision  
2050



National Research Centre on Camel  
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## संदेश



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

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

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

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

*राम मोहन सिंह*

( राधा मोहन सिंह )

केन्द्रीय कृषि मंत्री, भारत सरकार



# Foreword

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

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

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

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

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



**(S. AYYAPPAN)**

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# Preface

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In India the human-camel relationship and camel culture have a long history and is unique in many ways. In addition to its use for warfare by the Maharajahs, camel has played an important role in desert communication, transportation and trade. Today, the camel seen as an important component of the fragile desert ecosystem is because of its adaptation, its unique bio-physiological characteristics, and formidable ways of living in arid- and semi-arid regions. The proverbial 'Ship of the Desert' although earned its epithet on account of its indispensability as a mode of transportation and draught ability in desert, but in the present context there is an imminent threat to its sustainable use due to growing mechanization. Its utilities are today subject to progressive social and economic changes. The future of the camel in India lies in conservation, providing better health care and utilization of their other untapped potential uses for improving the significance of Camels, as basis of the livelihoods of the resource.

The National Research Centre on Camel at Bikaner remains the premier research centre of prominence in the world dedicated to the cause of camel and camel keepers. Two species of the family camelidae viz. *Camelus dromedarius* and *Camelus bactrianus* are present in our country and are focussed by NRCC for basic and applied research. The Camel production system which is in flux these days due to other reasons also need specific research attention in bringing forward the issues of camel health, nutrition, breeding and management. The Vision 2050 document proposes the research areas needed urgent attention to reverse the trend of negative population growth by adopting new improved methods of breeding by accepting the fact that camel has low reproduction efficiency, has slow herd growth and is a seasonal breeder. The issues of a need to establish camel as an alternate dairy animal and rate of decline in traditional rangelands in arid areas have also been pointed to emphasize much needed research efforts to devise methods of economic and scientific feeding in semi intensive or intensive management system and devise new approaches to integrate the available feed resources into complete feeds and also to take up issues of rangeland rejuvenation strategies. The basic studies to know adaptive nature of camel digestive, thermoregulatory, excretory and disease resistance system

have also been focused. These issues and targeted priorities have been envisioned and given due research attention in this document of Vision 2050.

The world scientists are already using Cameline Single domain antibodies and we need intensified research attention on the role and possible use of camel immunoglobulins for some human disease conditions and future research thus need be planned to produce products of potential use for human health diagnosis and therapy. These areas have been included to be part of Vision document to bring forward and establish this new role of camels. Similarly the future sustainability of camel will depend not only on draught but other utilities like of milk, hair etc. and its biological functions. The research efforts done in past points to the fact that the camel milk can take up an important role of functional food in human and need a quantum jump to popularize its new role by validating the research findings on a large scale. Further scientific research is needed to identify the biologically active principles in camel milk and establish its functional utility. These scientific validation studies are proposed in the present Vision 2050 document. Another challenge remain in the form of bringing social change in accepting the improved role of camels in human health and making traditional people ready for diverting their attention from the age old role of camels and to look for and adapt to modern scientific utilities of camel.

There has not been much organized research activities for camel health about which there is a strong need for the disease surveillance, monitoring, development of diagnostic kits for the diseases as trypanosomiasis and alike along with robust programmes for its control and treatment. The research programmes are being proposed to overcome these challenges by health research and validate the traditional health management measures followed by camel farmers.

Vision 2050 document of NRCC identifies new challenges and opportunities for future camel development sector for developing appropriate technologies and adopting strategies to reshape the camel husbandry targeting livelihood security of camel owners to suggest newer areas of production and adoption. The major focus will be on establishing new role of camel as milk animal and possibility of its use as an animal of biomedical research. The greater emphasis will be on demand driven research to meet the anticipated challenges of germplasm and resource conservation, feeding under changing geo-climatic situations, establishing camel as milk animal, processing of camel milk and validate its functional quality, overcoming problems

of reproduction and health threats and providing livelihood security to poor farmers in difficult areas of the country. It is hoped that the future research directions can be sought from this document not only in India but also by the scientific fraternity interested in camel research and development in other parts of world.

N. V. Patil  
Director



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## Context

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Camel production system is prevalent in Indian States like Rajasthan, Gujarat, Haryana and parts of Madhya Pradesh, Uttar Pradesh and Punjab. The traditional use of camels for draught purpose for transport of goods including agricultural material and its use in agriculture work is reduced in last few years due to advent and cheaper availability of mechanical means in desert terrains and has been a main reason restricting or declining camel number by its owners. Additionally the shrinkage of range lands and its deterioration in terms of number of trees, herbs and shrubs and also quality has created considerable economic pressure on traditional camel herders for management of camels who ultimately had to shift camel rearing system from extensive to semi-intensive and to intensive system of rearing which is not economical.

The continuous decline in camel population has been at an alarming rate since last two decades as evident from nearly four livestock census figures. Another reason for such a decline could be development activities in this Thar-desert, the world's most thickly populated desert, providing alternative economic means and also intensive agricultural practices for cash crops due to availability of canal water leading to less dependence on camel draught agriculture. Change in the climatic conditions like rise in humidity and high night temperatures has also been affecting the flora and fauna of desert. The camel production system is also affected seriously due to emergence and re-emergence of new diseases resulting in higher incidences of camel affections of bacterial, viral, fungal and protozoal nature – may be due to higher multiplication of vectors and increase susceptibility of camels to these new agents due to climate change stress factors.

The National Research Centre on Camel, Bikaner since its 30 years of existence has maintained elite germ plasm of camel genetic resource in the form of Indian camel breeds like, Bikaneri, Jaisalmeri, Kachchhi and Mewari and also distributed selected studs to camel herders through Department of Animal Husbandry, Government of Rajasthan for conservation of purity of field germplasm at farmer door. The research done in various aspects of camel production also included studies on draught-ability, management of reproduction and health to improve camel productivity. In last decade the Centre has been effectively portraying camel milk as useful commodity of human health benefit which hopefully

can promote camel husbandry to provide economic sustenance to the camel herders. Various functional food value attributes of camel milk to manage human ailments like diabetes, autism, milk allergy in children, Tuberculosis, asthma, autism, hyper-cholesterolemia are also of recent interest. The unique camel immunology in the form of specialised structure and functionality of immunoglobulins has attracted attention of human biomedicine scientists and collaborative studies in this direction have been initiated. Some of the basic studies in understanding camel gut metagenome and pre- & pro-biotic qualities of fermented camel milk products can make camel an useful animal for the basic as well as applied research to benefit both human and animals. In view of the future potential the camel holds and some encouraging results obtained due to initiation of some research work on biotechnology and applied science, it was felt to envision a productive role for National Research Centre on Camel, Bikaner so that the expectations of general public and scientific community are met by the year 2050 by preparing a document like 'VISION 2050'.



# Challenges

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India could be the World's largest economy by 2050 and by this time the country would have 1.6 billion people. Almost 800 million or 50% of the estimated population would live in urbanized territories.

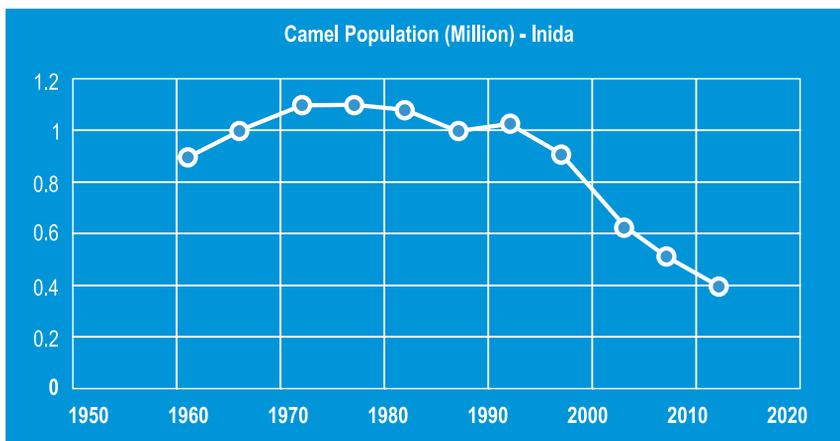
The dromedary camel, an important animal of arid region livestock production system provides a livelihood support to pastoral communities through provision of milk and draft power for transportation of goods after withstanding harsh conditions of climate and scarcity of water, feed and fodder. But the major challenge in camel production system has been loss of camel strength in numbers. The country have already suffered a lot in last 4 to 5 decades and the most significant being loss during post-independence period in last 50 years from 1.0 to 0.40 million (Livestock census, 2012, Table 1 and Fig 1)

**Table 1** Percent change in Camel population (1961-2007)

| Year | Population (Million) | Percent Change |
|------|----------------------|----------------|
| 1961 | 0.90                 | -              |
| 1966 | 1.00                 | 11.11          |
| 1972 | 1.10                 | 10.0           |
| 1977 | 1.10                 | -              |
| 1982 | 1.08                 | 1.-82          |
| 1987 | 1.00                 | 7.-41          |
| 1992 | 1.03                 | +3.00          |
| 1997 | 0.91                 | 11.-65         |
| 2003 | 0.63                 | 30.-77         |
| 2007 | 0.52                 | 17.-50         |
| 2012 | 0.40                 | -22.63         |

The situation is more or less similar for the double humped camels living in the cold arid conditions prevalent in northern parts of India in Leh and Ladakh of Jammu & Kashmir where about 150 double humped camels are surviving facing the adversaries of nature and lack of adequate and quality nutrition and even water .

The future sustainability of camel will depend not only on draught power but exploring its milk and biological utility. The camel having low reproduction efficiency being a seasonal breeder is resulting in slow herd



growth. In early years emphasis was given to overcome these challenges by conducting of basic researches and improving management practices. It has been observed that the efforts to optimize reproduction should be aimed at knowledge of folliculogenesis and its endocrine control to manage breeding of females at designated time and season. Similarly standardization of AI protocol also require basic understanding of factors responsible for effective release of viable sperms from cryo-preserved semen.

Overall camel health programme need attention of researchers and development agencies to minimise the loss of camel germplasm due to known and unknown diseases and affections. Lack of policy support for camel health in the past years has put us in a situation that organised health programmes specifically designed for camels in different states are not found. In tropical climate camels are highly sensitive and susceptible for trypanosomiasis which continues to be a major disease to affect camels worldwide. There is a strong need for the disease surveillance, monitoring, development of diagnostic kits, treatment and control for the diseases like trypanosomiasis. The diseases like Camel Pox, Contagious ecthyma, skin affections although do not cause mortality but affects most animals in different stages of life and need control programmes to ascertain that the growth and production of camel is not affected and human health is safeguarded. The focus on future researches need be towards development of preventive measures to arrest spread of all these diseases.

The work carried out in the area of camel immunology for understanding role of adaptive and innate camel immunity relationship has given hopes to develop vaccines for disease control. The collaborative work done with the agencies like BARC and SP Medical College, Bikaner, have generated possibility of development of single domain

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antibodies from camel for treatment and diagnosis of human ailments. But the said areas need be explored with greater details and positive vigour to develop immune-products of human and animal health benefit for which commercially viable technologies can be used with suitable collaborators. It will be an area of major research activity by NRCC along with other collaborating agencies to develop products of human biomedicine like diagnostics and treatment in next few decades.

The basic work done in exploration of camel gut microbiome by functional metagenomics approach yielded unique information regarding variety of functional adaptabilities of camel based on camel specific microorganisms in situations of feed stress and its ability to utilize the rare and camel specific feed resources efficiently. The information need be further used for rumen manipulation approaches to reduce methane production and increase efficiency of nutrient utilization in other grazing animals for various production functions. More research programmes need be planned to identify the microorganisms from camel gut metagenome pool and know its functional utility in adaptation of camels for feed stress situations which help camel to thrive and efficiently utilize the nutrients for various production functions. The work has been initiated and will be the focus of the nutrition research in next few years' time.

The development programmes for camel are not in place, therefore, efforts for increased awareness of improved management practices and basic data with respect to camel marketing and effective utilization of camel products are lacking. It need be a continued activity for many years for the farmers, entrepreneurs and the personnel from AH departments of camel inhabiting states of India.

Use of work efficiency of camels has been tradition in the camel populated areas but not much research has been conducted to improve upon design of existing camel-drawn implements including camel carts and also to improve efficiency of these implements by which manufacturing agencies can be sensitized to ensure availability of such equipments. In the next few years to follow the research efforts need be directed towards utilising camels for other utility functions out of draught like electricity generation and use of mechanical means for variety of agricultural functions.

Traditionally the camels had been used for the safeguard of international borders by Border Security Force and other Defence departments. In spite of the development of road network and availability of mechanized and rapid means of transport/vigilance, there are areas with accessibility problems due to difficult terrains where use

of camels is inevitable. The profitability of camels compared to new means of transport need to be established in terms of economics, all area vigilance and special training imparted to border camels to notice and arrest incursion efforts. In double humped camels also the endurance and adaptability to hilly terrain, cold desert conditions need to be further explored for its utility as baggage animal for both civilian and defence personnel needs and programmes need be planned in collaboration with the BSF and Indian Army units to work out utility value in difficult parts of deserts, hills and valleys both in hot and cold arid areas.

There is likelihood that well-adapted livestock system will be lost unless proper attention is given to conservation and development of pasture/rangelands and related developmental programmes need immediate attention of various state departments (Animal husbandry, forest and village panchayats). Camel husbandry systems are in a state of flux as pastoralists are forced to shift from their traditional extensive management mode to more restricted system like semi-intensive and sometimes almost sedentary conditions due to shrinkage and degradation of rangelands resources and overall increased population pressure both of human and animals as the camel keeping is becoming uneconomical and difficult. These changes in socio-economic conditions of the societies in the dry land and continuous shrinking of rangeland area need be addressed by way of sound rangeland improvement programmes involving participation of village communities and also involvement of other departments of the states to evolve grazing policy. It need be planned with long term action plan of 30-40 years involving the community groups, Government-local and state institutes and NGOs. There is need to undertake studies on effect of climate change in areas of camel inhabitations on the quantity and quality of feed, fodder and water resources to devise support policy for the traditional pastoral territory.

Similarly in the existing situation, lack of interest of rural youth towards camel rearing need be addressed by devising the training programmes for entrepreneurship for commercial camel husbandry so that it becomes more remunerative and attractive which may also include short term training programmes for women to learn about modern uses of camel and exploit commercial value of various products and by-products of camel. Various areas of entrepreneurship will be identified and training on milk product, tourism, camel hair processing, bone craftsmanship need be provided by local or outside artisans to earn the livelihood and profits. The activity should be continuously taken up for the interested youths and camel owners.



## Operating Environment

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The land on which camel rearing is done was earlier productive and was rich with vegetation useful for camel needs but now in the context of changing climate it need to be re-looked in the changing scenario of vegetative resources available, both in hills and plains, their fluctuations and carrying capacity of the land. Similarly there is need to consider the degradation status and based on which practices followed for land and water management and the measures undertaken for rejuvenation of grazing resources for expanding feed fodder base. Further the shift in camel management practice from extensive to semi-intensive and stall feeding condition need be looked into.

The specialized people involved with camel rearing like Raikas, Rabaris, Jats, Rajputs and Muslims also need to be studied in changing scenario from social and cultural dimensions. Their traditional knowledge, economic and ecological security, and the reasons for non-inclination of youths towards traditional camel production system need be explored. Camel development programmes in participatory approach mode involving village social groups and the development agencies could be formulated so that the herders and farmers are properly skilled at making the best of their resources, investment of time and efforts in their vocation. A flexible approach would be to formulate need based programmes, develop interventions on the skills using locally available resources, awareness raising, joint analysis and reflections which will prove successful for implementation of camel entrepreneurship development programme.

For shifting the role of camel beside draught there is need to undertake programme on improvement of production potential of the camels based on information available on camel herds management systems, breed characteristics with special references to draught, growth performance, milk, meat and hair production potential, genetic estimation of production potential, reproductive efficiency and their use in scientific breed improvement schemes. It is needless to emphasize that proper nutrition plan for providing balanced and economic feeding to meet different nutritional requirements depending upon locally available feed and fodder resources are imperative. Fixing standards for feeding camels for draught, agricultural operations and milk production when camels are reared under intensive and semi-intensive system of management is

required and is essential for augmenting their production potential and maintaining adequate health status. The role of NRCC will be pivotal in this case which has infrastructure and trained manpower to impart training and to formulate research programmes based on field and practical need of camel pastoralists.

The future camel development policy should utilize camel bio-energy (which is renewable utilizing natural and traditional resources) by creating package of innovations for development of camel drawn implements (plough, seed drill, bund former, leveller and bio-energy power generation etc.). Further the electrified camel carts can be important source of electricity for small poor farmers in interior villages.

In recent years worldwide scientific studies have proven a beneficial role of camel milk and also indicated possibility of camel immunoglobulin use in human health. There is immediate need of validation of the nutraceutical and therapeutic potential of camel milk and manufacturing of value added milk products and its popularization through milk parlours. Utility of single domain antibodies for diagnosis and therapy of human and animal diseases is another area for exploitation.

The major priority of future camel improvement planning would be the identification of socio-economic constraints to resource-poor camel production systems, collection, collation and analysis of socio-economic information dealing with trends in domestic market demands for camel products, prospects for export, producer prices, income analysis within the pastoral sub-sector (including that of other livestock species) and outside the pastoral sector (wage labour or self-employment etc.) need significant attention. Also the study of implications of herd fragmentation, infra structural advances (roads, vehicles etc.), economics of supplemental feeding versus traditional consumption behaviour and migration of traditional herders require ample attention. Further, the role of gender in camel-oriented production systems need investigation and correlation with other socio-economic variables.

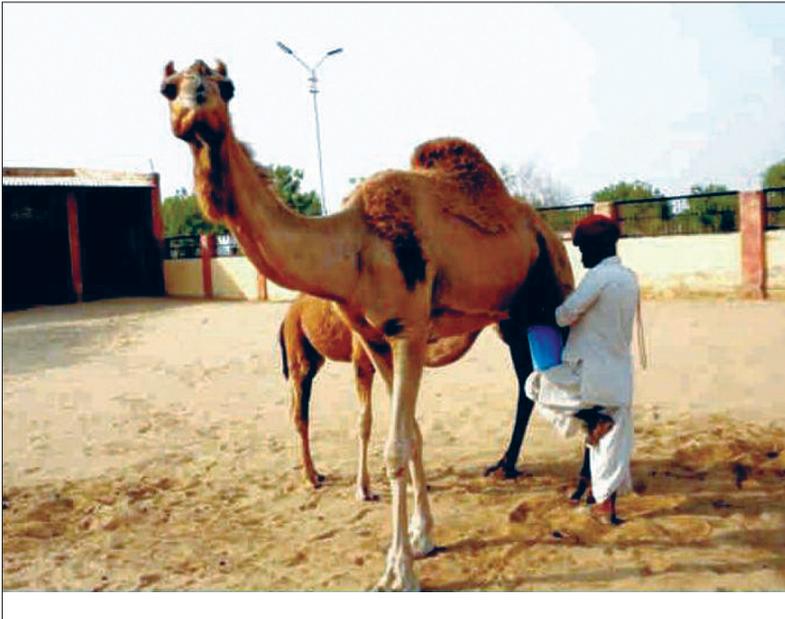


## New Opportunities

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In view of shifting utility of camel from draught, enhancing camel productivity in term of milk and energy in rapidly changing environmental conditions for providing economic security to the farmers remain the priority. The onus therefore lies in establishing camel as a milch animal. The social and cultural issues must be dealt properly to persuade camel owners to look and utilize camel for milk production function. The scientific efforts therefore should look to take advantage of opportunities available in camel milk in terms of its therapeutic and functional food value.

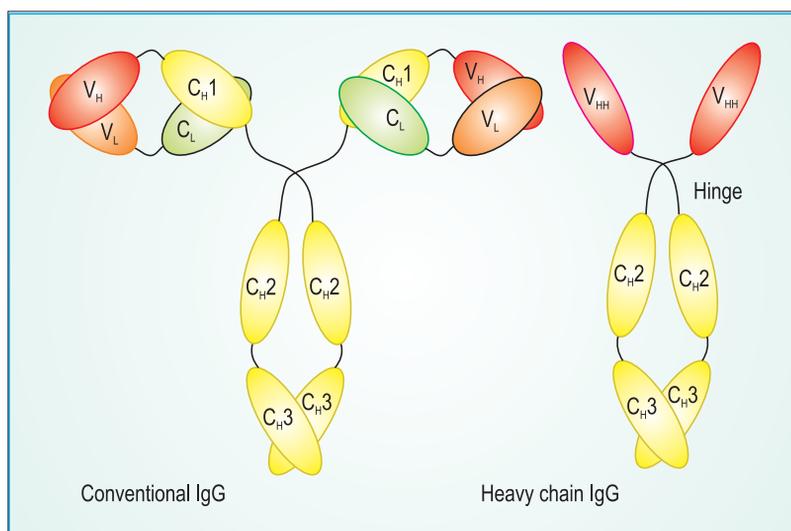
The camel draught which had been used traditionally in pulling carts and also in agriculture functions need be exploited for other work functions of generation of electricity to meet needs of people living in deep deserts and far off places isolated from the power supply. The prior efforts done in this direction need be taken up on mega scale seeking help of engineering institutes and similar collaborations are desired in developing efficient agricultural implements proving its worth over the new mechanized tools. This will immediately convince people of utility



of this species and help gain active support from farmers to use camels for these functions and thereby increase number of camel population.

Another issue requiring urgent scientific attention remains to develop proper practicable protocol for AI with cryo-preserved semen so that it is utilized through the chain of state Animal Husbandry departments of camel inhabiting states. The use of assisted reproduction technologies have indicated possibility of reduction in calving interval (CI) in camels and if the camel is promoted as an animal for milk purpose the reduction of CI and standardization of lactation length will remain to be priority area of research. Similarly the protocols for ETT, super ovulation and pregnancy diagnosis need to be developed.

Some of issues requiring long term studies on new science include, biotechnological aspects regarding camel genome, unique immunoglobulins and its application in human medicine. Study on milk proteins and establishing therapeutic values of camel milk and milk products also require in depth collaborative research attempts.



### Unique Immunoglobulins (Heavy Chain Abs)—Single Domain Antibodies of Camel

One of the other major reasons for drop in camel population is inadequate measures of control, diagnosis and treatment of camel diseases. Research efforts are needed to develop disease diagnostics which are OIE compliant for various diseases and also undertake surveillance and epidemiological programs to know about various disease conditions.

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The poor rangelands in arid environment remain cause of sustenance of low camel population hence the models of rangeland improvement need extensive application efforts in the field and proper authorities of State Governments like Departments of Forests and Environment, Animal Husbandry, Agriculture and Revenue along with local village bodies and NGOs need to be activated for undertaking suitable measures of reseeding, development of agro-silvi-horti-pasture system and ensuring potential feed production measures. In situations of very less grazing land left for the camels there is need to develop feeding plans for camels reared in semi-intensive & intensive system and also during drought situations and similar technologies need to be strengthened.

To undertake these research in all aspects of camel there is need to develop quality human resource base to meet the emerging needs of camel production system so that it becomes a remunerative livestock industry.



## Goals and Targets

In order to achieve the vision statement outlined above, the strategy would be to explore various opportunities to find solutions to the core issues identified in a technology-driven way. Nutritional security, environmental safety, employment generation, livelihood security, skill development and market trends are the core issues to be addressed. Developing inter-institutional linkages between different animal science institutes and strengthening their core competence, building partnership with different stakeholders and industries are essential to implement the plan. Networking of programmes in different agro-climatic zones and developing strategic partners for technology showcasing and up-scaling is the critical path to achieve the target. The challenge is to produce more from less for more (MLM). In the following table, the expected outcomes for the targets and goals set for the NRCC have been outlined against the indicated timelines.

| GOALS/<br>TARGETS                     | EXPECTED OUTCOME   |   |  |  |
|---------------------------------------|--|---|--|--|
|                                       | 2014-2020  | 2021-2030   | 2031-2040  | 2041-2050  |
| To arrest decline in camel population | Understanding folliculo- genesis, reproductive endocrinology, standardisation of AI Protocol, selection of breeding males and females, <i>in-situ</i> conservation | Marker assisted selection, field progeny testing and implementation of breeding programmes  | Superovulation protocol standardisation, multiplication through MOET   | Standardised AI, ET, superovulation protocols for multiplication, ex-situ conservation                                       |
| Optimizing camel productivity         | Understanding foregut functional kinetics and role of microbes through metagenomics, working out the nutrient requirement for major and minor nutrients            | Development of feeding strategy for optimum production and reproduction, standardising housing conditions for semi-intensive and intensive rearing system | Molecular characterisation of genes associated with camel production, strategy for amelioration of climatic stresses | Development of dairy characteristics in camel breeds, use of biotechnological tools for production of Proteins of interests. |

|  |  |   |  |   |
|--|--|---|--|---|
| Improvement of health status                             | Development of standard diagnostics, preventive and therapeutic measures for trypanosomiasis, mange, camel pox, mastitis   | Therapy for ailments like impaction, Kumri – nervous disorder of hind legs, reduction of calf mortality                       | Development of diagnostics, preventive and therapeutic measures for respiratory diseases like <i>Khudak</i>  | Development of pen diagnostics and use of therapeutics based on micro array.                  |
| Establishing camel as milch animal                       | Early post-parturient reproduction and standardisation of lactation parameters like lactation length, persistency and peak yield   | Improving productivity through genome wide selection and palatability characteristics of camel milk.                          | Value addition to milk for development of various milk products for human health care  | Development of designer milk and milk products for human health.                              |
| Improving camel utility                                  | Exploration of insulation properties of camel hair and its blends and its industrial use. Improvement of carts and harnessing systems  | Use of dung in paper making and as packing material, use as organic fertiliser  | Use of camel bones and hides for handicraft industry.  | Development of racing strain of camel   |
| Exploration and validation of e-compatible bio-molecules | Identification and characterisation of variable fractions of heavy chain antibodies (VHHs) of camel immune system, milk, urine etc. for microbial infections and allergy disorder. | Validation of biomolecules of diagnostic, therapeutics and functional utility for various neo-plasms, allergens and microbes. | Patenting and commercialisation of biomolecules of diagnostic, therapeutics and functional utility for various neo-plasms, allergens and microbes. | Development of multi valent constructs and use of VHH in protein purification and enzymology. |

## Way Forward

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Considering the future road map of strategy for research on camels which would provide information on the major areas to achieve targets, address challenges, and smoothly adjust to environment using the cutting edge research themes, the way forward for the NRCC would be to establish it as the centre of excellence for assuring the future of camels in terms of its utility functions redefined in terms of milk production and use of its draught power for other beneficial functions to serve more basic need of human beings and also to support the cause of living in the desert environment.

The institute also will remain focused on basic researches for initiation of applied researches like studies on hormonal profile during different physiological phases/periods including reproduction to serve the function of forming a valid basis for improving reproductive efficiency through A.I. and other tools of interest to increase the camel population with modern techniques like ETT and super-ovulation.

The basic research to understand the rumen and gut kinetics through the tools like metagenomics will decide the feed/fodders combination which will help to arrive at the practical management aspects of feeding the camels in semi-intensive or captive conditions for various purposes.

During next 3-4 decades the new basic and strategic research areas will be part of study to establish new role of camels in human health either by establishing the role of camel milk as a promoter or maintenance of health and also designing the human health food products having specific beneficial functional attributes by knowing the functional specialities of proteins and other components of camel milk. Similarly the knowledge and use of camel immunoglobulins have raised hopes in designing medicinal products of therapeutic and diagnostic utility. The attempt therefore would be to harness these functional excellences of camel by initiating collaborative programmes with the institutes working already in such disciplines of basic sciences and medical science research in India and abroad along with enriching the skills of human resource component of NRCC.

The area of camel health will be focus of research in next 2-3 decades in terms of devising economic and effective measures of prophylaxis and treatment including validating the efficacy of traditional methods in practice. The diagnosis and prophylaxis of camel diseases causing loss of

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number and production deficit would be attempted by employing new biotechnological advances by developing kits and vaccines.

In addition to above high end research, the Centre would aim continuously to create the database to serve the purpose of knowledge sharing to various institutes working on camel in the country and outside and it will comprise of:

- Biological data generation will be for various production traits of camels. In addition it will create data base in terms of camel drawn agricultural implements, selection for draught ability and race, evaluation of feed & fodder and nutrient requirement and feeding practices in different agro-climatic zones, supplementary and complete feed system. Biological and physiological adaptation, immunology etc.
- Management data creation will be aimed at specifically in the management of new born calves, advance pregnancy and lactating females, level of supplement and economic feeding during scarcity and droughts and improvement in milk production. It will also include inventory of management practices such as maintenance of camels on pasture; length of grazing periods; watering regimes; seasonality of breeding; selection and culling practices for breeding stock; type, amount and timing of off take of products; and traditional application of preventive and curative medicine.
- Data on rangeland management research would include surveys conducted of traditional land-use patterns as seasonal migration, establishment of reserve grazing areas, harvesting and storage of feeds, and distribution and use of watering points. Information would also be obtained on the use of rangeland improvement techniques like burning, deferred grazing, sequential grazing of different livestock species, control of stocking density and grazing pressure and over sowing or re-seeding. Factors conducive to or limiting improvements in range management, i.e. land tenure, grazing rights, water rights and actual population densities, are essential by active involvement of state forest department.
- The major over-riding of research would also be to identify socio-economic constraints to resource-poor camel production systems, collection and analysis of socio-economic information dealing with trends in domestic market demands for camel products, prospects for export, producer prices, income analysis within the pastoral sub-sector (including that of other livestock species) and outside the pastoral sector (wage labour or self employment etc.) which will be given due attention. Also reasons for herd fragmentation,

implications of infrastructural advances (roads, vehicles etc.), and economics of supplemental feeding in semi-intensive and intensive feeding system in relation to traditional rearing of camels, migration of traditional herders hired under absentee-ownership regimes are important research topics which will be areas of social science research attention. Further, the gender implications in camel-oriented production systems and correlation with other socio-economic variables will be investigated.



# First Time in the World: Animal Science Research Achievements 2014

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## **Animal Production**

- “Deepasha”, the clone of the only wild-buffalo in Chhattisgarh in semi-captivity has been produced through hand guided cloning technique.
- Female cloned calf named ‘Lalima’, produced through ‘Hand-guided Cloning technique’. It is a clone of an elite Murrah buffalo (MU-5345) of NDRI Livestock Farm. Further, a male cloned calf named ‘RAJAT’ was also produced which is a clone of a highly ranked progeny-tested Murrah buffalo bull (MU-4393), died many years ago.
- An ‘Indian Livestock Feed Portal’ with recent information pertaining to various feed resources, feeding standards for livestock and other related issues was made available online.
- A novel protocol – estradoublesynch – has been developed and test tried in limited trials for the first time in buffaloes for synchronisation of ovulation and timed insemination for achieving high pregnancy rates in cycling and anestrus buffaloes.
- An indigenous earthworm viz. *Perionyx ceylensis* species that has the ability to thrive on cow dung and crop residues, adapt under variable temperature (0-44oC), and is highly prolific has been used for vermiculture technology. This earthworm species has been given name as “Jai Gopal” and technology known as “Jai Gopal Vermiculture Technology” has been developed.
- Attenuated vaccine of sheep pox virus was developed.
- Lateral Flow Assay (LFA) for rapid diagnosis of brucellosis – an economically important zoonotic disease – has been developed.

## **Technology Assessment, Refinement and Transfer**

The following technologies were commercialised:

- Non-structural protein 3ABC-based diagnostics assay (ELISA)

for FMD to differentiate infected from vaccinated animals (DIVA technology).

- Live attenuated PPR vaccine.
- Goat pox vaccine.
- Blue Tongue pentavalent vaccine for sheep and goat.





