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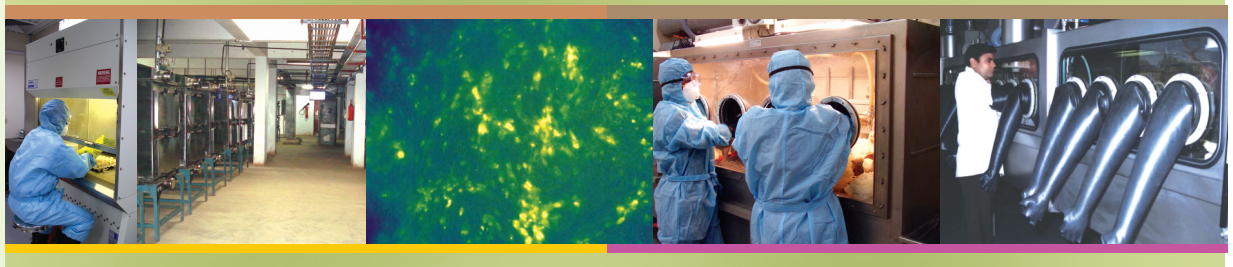
Vision 2050

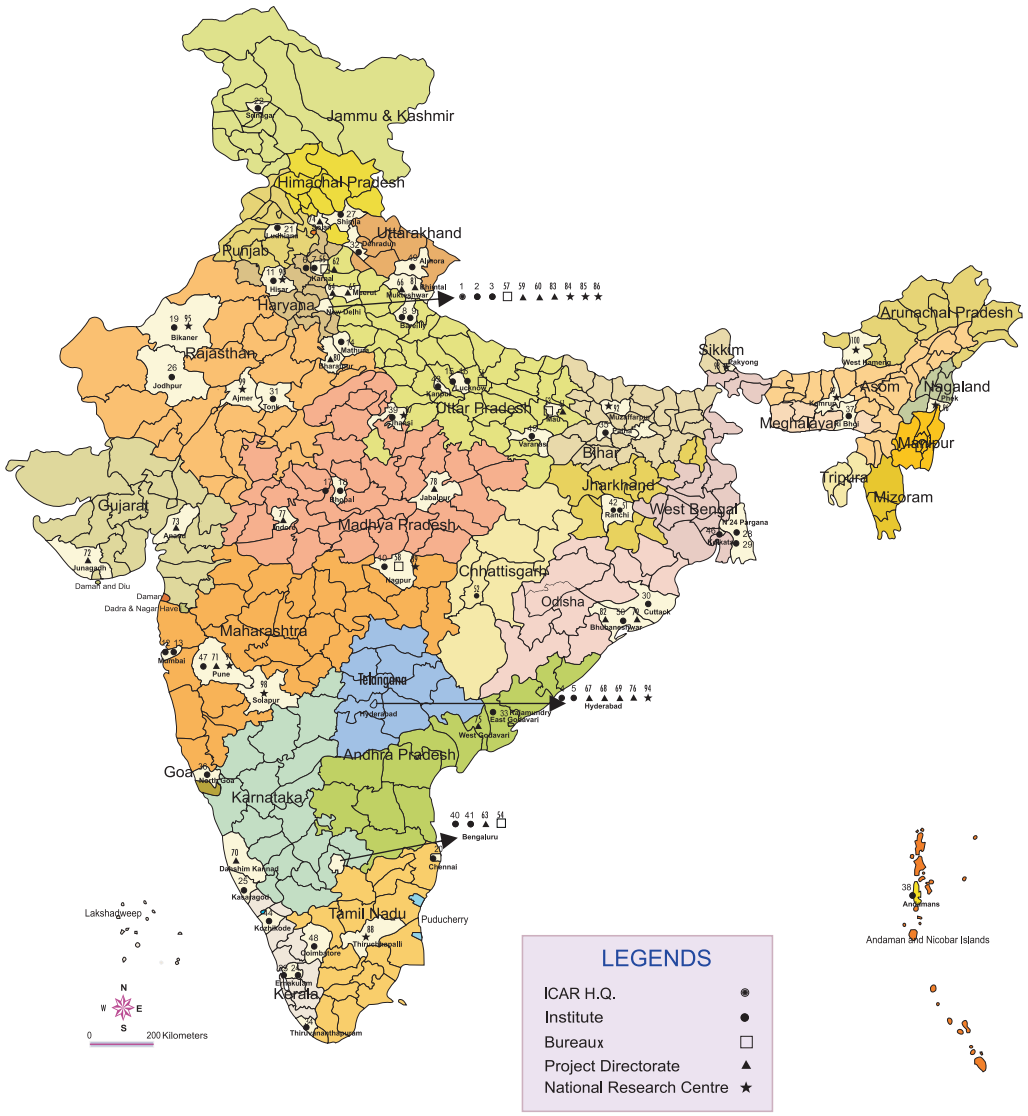


National Institute of High Security Animal Diseases
OIE Reference Laboratory for Avian Influenza

Indian Council of Agricultural Research

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

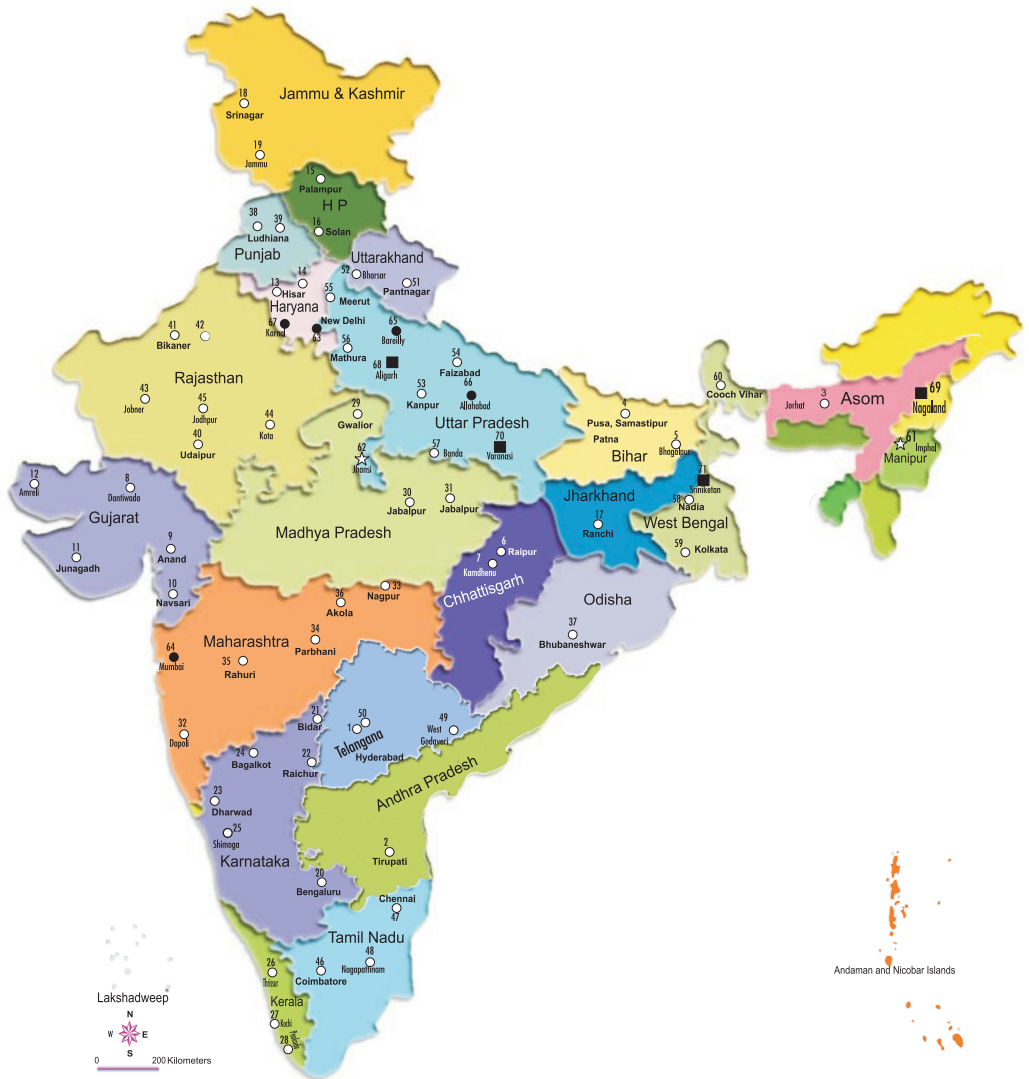
Institutes, Bureaux, Directorates and National Research Centres



● 64 Research Institutes ● 6 Bureaux ● 15 National Research Centres ● 15 Project Directorates

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Agricultural Universities



Vision 2050

National Institute of High Security Animal Diseases
OIE Reference Laboratory for Avian Influenza
(Indian Council of Agricultural Research)
Bhopal

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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 कई बदलाव होने की उम्मीद नहीं की जाती है। अतः खाद्य, पोषण, पर्यावरण आजीविका सुरक्षा के लिए तथा समावेशी विकास हासिल करने के लिए कृषि क्षेत्र में स्थायी विकास बहुत जरूरी है।

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

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

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

(राधा मोहन सिंह)

केन्द्रीय कृषि मंत्री, भारत सरकार

Foreword

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

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

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

Vision-2050 document of ICAR-National Institute of High Security Animal Diseases (NIHSAD), Bhopal 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)
Secretary, Department of Agricultural Research & Education (DARE)
and Director-General, Indian Council of Agricultural Research (ICAR)
Krishi Bhavan, Dr Rajendra Prasad Road,
New Delhi 110 001

Preface

It gives me immense pleasure to bring out this VISION 2050 document of ICAR – National Institute of High Security Animal Diseases. India's National Agriculture Policy focuses on the economic well-being of farmers. Since majority Indian agriculturist community is dependent on uncertain rain-fed farming, supporting income from livestock and poultry may help to keep it at possible sustainable level. Although there are constraints of feed and fodder, healthcare and remunerative prices for the produce, they all still can be managed to a certain extent. There are infectious diseases that pose threat but preventive and control measures can reduce the losses. The diseases that are entering in the county for the first time or re-entering after a long gap spread in the population easily and speedily as the hosts are fully susceptible. Many of these diseases may be of trans-boundary nature and may have disastrous consequences for a country when they compromise food security by production losses or result in loss of livestock/poultry of high genetic potential. To counter such situation, it is essential to go for planned preparedness for high risk infections that includes readiness for quick identification of etiologic agent and contingency plan for rapid action to control the disease. Such preparedness for exotic and emerging diseases is more difficult since it requires special attention towards issues that are not commonly considered important under normal circumstances, provision of specific infrastructural facilities and trained manpower to deal with such exigencies. Therefore the vision document is of high significance since it elaborates challenges that are likely to be faced in future and methods of mitigating them.

The Vision 2050 document of the NIHSAD is our best effort to reflect the achievements made by the institute, the gaps in research that need to be filled through research programmes to be undertaken in the coming years, keeping in mind the challenges being faced, the newer developments taking place, particularly the technological and informatics developments, both at national and international level, till the year 2050. The efforts are to become responsive, vibrant and sensitive to the needs of the country in the rapidly changing scenario of animal husbandry and to help researchers, research managers and planners to be more prudent and relevant in their approach to the current technological developments while planning research programmes for next 35 years.

It is hoped that the institute would be able to fulfil its mandate, partly generate resources for its research programmes and remain a leader in research with an aim to protect the country's livestock from threats of unknown and known emerging diseases and exhibit its indispensability in National Agricultural Research System.

The establishment of High Security Animal Disease Laboratory under IVRI is the best example of foresightedness of great visionaries like Dr Chintamani Singh. It is worthy to place on record the gratitude for the support given for the establishment of this institute by Dr S. Ayyappan, Secretary, DARE and DG, ICAR and Shri Aravind Kaushal, the then Secretary, ICAR along with Dr K.M.L. Pathak, DDG (Animal Science) and Dr Gaya Prasad, ADG (Animal Health) who had identified the importance and future need of the country to upgrade this lab into an independent national level institute. The contributions by the first Joint Director of this laboratory Dr G. C. Mohanty and subsequently Dr H. K. Pradhan as well as Dr S. C. Dubey to prepare a roadmap for the institute are noteworthy. The constant efforts made by Dr Dubey to persuade ICAR, Govt. of India and OIE to get this institute recognized as OIE Reference Laboratory for Avian Influenza bore fruits in 2009 and this "Bhopal lab" became the first OIE reference lab in India under animal sciences. We would also like to acknowledge the Ministry of Agriculture, the Planning Commission of Government of India, FAO of UN and OIE for wholeheartedly supporting this institute since beginning. The NIHSAD has a very limited but dedicated staff that needs patting for their untiring efforts and there is an unending list of persons, authorities and organizations that needs to be acknowledged, we are grateful to all of them.

Diwakar D Kulkarni
Acting Director
NIHSAD, Bhopal

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Context

National Institute of High Security Animal Diseases (NIHSAD) is a premier institute of Indian Council of Agricultural Research (ICAR) in India for research on exotic and emerging animal pathogens. Owing to its Biocontainment facility, the institute is known for its biosafety level 3+ laboratory dedicated to animal health. With its huge and cost-intensive infrastructure which is an unique combination of engineering specialities and bio-security protocols, this institutes is continuously contributing towards animal health, public health, disease control measure and trade policy formulations. Apart from research on exotic and emerging animal diseases, the institute caters to the diagnostic service requirements of national quarantine centres, animal/ animal goods importing firms and outbreak investigation of new/unknown animal diseases.

The laboratory was developed as a need-based facility and was conceptualized in 1973-74 as special facility of Indian Veterinary Research Institute, Bareilly (IVRI). With the promotion of trade and traffic of animals and animal product between nations and continents, the risk of entry of animal disease agents in the country was enhanced. During 1960s and 1970s, there were severe outbreaks of life-threatening animal diseases like Rinderpest, newly entering African horse sickness, infectious bursal disease etc. These diseases being exotic to our country that time, were affecting the economics of animal husbandry adversely. A need was felt for having the preparedness to detect theses exotic/ emerging animal diseases. However, research on such agents in open laboratories would have further enhanced the chances of their transmission in the environment. Hence the scientific community at the premier institute - IVRI, decided to go for a biocontainment laboratory for the country in order to have diagnostic preparedness, develop tools for region-specific pathogen variants and develop indigenous disease control measures.

With the support of ICAR and other international agencies like FAO, UNDP and World Bank, the laboratory was established at Bhopal in an area of 132.85 acre of land allotted by the Govt of Madhya Pradesh. The fully functional facility, named High Security Animal Disease Laboratory (HSADL), was constructed under the supervision of National Dairy Development Board (NDDB) in 1998 and was dedicated to the nation on June 23rd, 2000. Since then, this laboratory has played a pivotal

role in country's animal health system by providing accurate diagnosis for many animal diseases considered exotic to India, particularly the Highly Pathogenic Avian Influenza (HPAI) in poultry, Crimean Congo Hemorrhagic Fever, Porcine Respiratory & Reproductive Syndrome in pigs etc.

After the first "bird flu" outbreak in 2006 and subsequently getting a status of 'OIE Reference Laboratory for Avian Influenza' in 2009, the need for an independent status of HSADL was intensified owing to its expanding activities and international platform of operations. HSADL required the autonomy and authority of an independent institute to serve as a leading biocontainment facility tackling major challenges of handling and controlling high risk pathogens among animals not only for objectives of animal health but also for public health. Also animal disease profiles of nations were gradually becoming an important component in the trade decisions and HSADL was rightly handling this responsibility for the country in providing technical and subject matter advice to policy makers. The importance of HSADL as an independent institute was repeatedly felt at various platforms like the Planning Commission; ICAR and Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Govt. of India (DADF), Ministry of Health, Govt. of India as well as on international platforms like OIE, FAO etc. Considering the imminent need for this change, the XII Plan EFC of ICAR accepted the proposal in March, 2014 and subsequently, HSADL was upgraded into an independent national institute, renamed as ICAR-National Institute of High Security Animal Diseases (NIHSAD) and brought under the direct control of ICAR on 8th Aug. 2014 by delinking it from IVRI.

With its exemplary preparedness to diagnose exotic diseases, the institute is involved in reporting the disease status to the DADF to assist in decision making on policies pertaining to trade and other related issues. It has the onus of providing laboratory diagnostic services for exotic and emerging diseases in the country as well as animal quarantine sample testing. The laboratory of the institute also serves as repository of the most dreaded animal viruses for further research so as to provide strategic guidelines for their monitoring and control.

The institute has national and international linkages which are expected to grow further with its increasing role as a referral facility at national and international level for diagnosis of various emerging infections, an infrastructural model for bio-containment facility, a leading learning centre for bio-risk management and as an animal disease institution partnering with medical institutions for reduction of public

health risks from zoonotic infections under one-health concept. The diverse dimensions in which the institute is set to emerge in next 20-30 years necessitates that the existing linkages grow further to harness opportunities from other agencies as well as deliver benefits to the stakeholders in animal health. The institute currently has linkages with World Organization for Animal Health (OIE), Food and Agricultural Organization (FAO), World Health Organization (WHO), DADF, National Dairy Development Board (NDDB) and various research funding agencies e.g. Department of Science & Technology (DST), Department of Biotechnology (DBT), Indian Council of Medical Research (ICMR) and other governmental agencies. The institute has been working on several platforms with many of these institutes, organizations/industry at national/international level for research collaborations, in the past and present.

Present Scenario of Exotic and Emerging Disease in India

Consequent upon multiple factors ranging from climate change, rapid movement of men and material due to trade and tourism, deforestation due to urbanization, pressures of unmanageable population explosions, predispositions of polluted environment etc a plethora of infectious diseases have emerged and re-emerged around the globe. India being surrounded by nations like Bangladesh, Nepal, Bhutan etc that are stressed down with poor infrastructure for animal health, is greatly exposed to the risk of exotic and trans-boundary diseases. India faces numerous outbreaks of avian influenza with recurring introduction of newer clades of H5N1 virus since the first outbreak in 2006. There have been outbreaks of CCHFV in parts of Gujarat and Rajasthan since 2011 with fatal consequences in humans due to transmission from infected animals by tick bites. The southern states of India are constantly reporting incidences of KFD in humans and primates. Newer stains of BVDV are being identified in Indian cattle, buffaloes. PRRS outbreaks in pigs in North-eastern India has been recorded in past few years. Outbreaks of fatal bat borne diseases like Nipah have been reported from India as well as neighbouring Bangladesh. Whatever be the cause of all these outbreaks a constant preparedness to identify the pathogens and develop sound indigenous diagnosis and control measures is the need of the hour.

The preparedness for providing the lab diagnostic services for exotic and emerging diseases of animals was initiated at this institute in 2001. On the basis of prioritization and as per the need and request from Quarantine Department of the country, a few diseases were taken up.

These included bovine viral diarrhoea (BVD), bovine immunodeficiency virus (BIV), transmissible gastroenteritis (TGE), avian influenza, caprine arthritis and encephalitis (CAE), rabbit haemorrhagic disease (RHD) and malignant catarrhal fever (MCF). During first few years, diagnostic preparedness for the above diseases was completed. After the first outbreak of highly pathogenic avian influenza in 2006 in Maharashtra, the diagnosis of avian influenza was at the forefront. During the course of time, other diseases were added to the list. e. g. BVD related other pestiviruses, West Nile fever virus (WNV), Nipah virus, swine influenza (SIV-H1N1), Bunyaviral infections including CCHF etc.

Being the first bio-containment lab of the country working for last 15 years, the administration and staff has gained experience in running and maintenance of such lab and therefore, it is in a position to be the torch-bearer for other organizations that are now trying to create and run bio-containment labs in India.

The expansion of the work areas of NIHSAD and the projected research thrust areas have been carefully carved based on the expected patterns of animal and animal product movement across international borders due to increase demand for animal foods and improving productivity and processing potential of Indian farmers. Apart from the demand driven changes there is growing need for diagnostic kits developed indigenously as import substitutes. With and efficient scientific group and networking with numerous international laboratories it is envisioned that NIHSAD would contribute increasingly towards development of indigenous diagnostics to make diagnosis of emerging animal diseases economical with time.

Animal rearing and organized animal production are gradually being taken up by the private sector as sole investor or as public-private partnership (PPP) mode enterprise. In this scenario, the private sector is willing to fund and cooperate in R&D activities. Since the goals set by the private sectors are usually for short term commercial application, it is assumed to give impetus to the applied research. Hence research under the PPP mode and other contractual mode can be utilized for systematic commercialization of research findings. The challenging need of stringent biological safety measures in the era of globalized animal trade and the growing threat of novel pathogens are now clearly evident. In the current scenario, NIHSAD needs to work continuously to develop its R&D and HRD programs for extending better services to the nation in terms of providing diagnostic services, vigilance for unknown pathogens and training in biosafety and biosecurity for contributing towards the ultimate goal of food security through better animal health,

improvement in public health and economic prosperity of the country. In this perspective, to tackle the present day challenges of increasing population, depleting natural resources and global competition, the institute shall envisage its research programs with the broad aim of biorisk management related to exotic and emerging pathogens.

Mandate of NIHSAD

To conduct research on basic & applied areas related to exotic, emerging & re-emerging animal diseases of national importance including-

- Basic mechanisms for disease occurrence, pathogens characterization, their transmissibility under various ecological factors, host-pathogen interactions, development of diagnostics and vaccines and fundamental aspects arising out of work on exotic/emerging animal pathogens.
- Updating on biorisk management and to train the manpower in the areas of biosafety, biosecurity and biocontainment for handling high risk pathogens.

Vision Statement

"Mitigating risks of known and unknown emerging infectious diseases in animals including zoonotic infections at human-animal interface through forecast, early detection of pathogens, emergency preparedness with diagnostics and vaccines while keeping vigil on changing host-pathogen and environment interactions and creating understanding of potential bio-risks and disease threats among stakeholders."

Mission

Reducing threats of emerging and new pathogens for sustainable animal husbandry sector and safeguarding public health.

❑

Challenges

Effective measures to guarantee animal health through exclusion and/or containment of emerging as well as trans-boundary or exotic animal diseases is a prerequisite for sustained livestock production and public health. The increasing globalization and trade volume of livestock sector has created new mechanisms by which pathogens and diseases may be introduced or spread to new areas. Known and unknown disease problems may rise quickly in any country's livestock, often with serious socio-economic, ecological, food security problems and public health consequences and may be difficult or impossible to eliminate once established. The institute with its mandate to work on exotic and emerging diseases of animals has to address many challenges that are emerging in the current scenario and are expected to be more visible in next few decades.

1. Emergence of new and unknown pathogens in the country threatening the prosperity of animal husbandry sector and creating trade barriers for export of livestock /livestock products. (Emerging diseases)—Multiple factors contribute to emergence of infectious diseases which include evolution of the existing pathogens to more virulent ones, increased resistance of the pathogens to the available drugs, and adaptation in new host range and geographical areas. Changing environmental conditions along with increased human-animal interaction due to urbanization, deforestation, expansion of road links, mixed farming practices, intensification of livestock production and trade are resulting in emergence of unknown pathogens.

Climate changes and changes in seasonal temperature and rainfall patterns lead to noticeable change in landscapes and ecosystems. These in turn are precipitating the changes in the microbial flora and fauna and creating favourable ecological niches for emerging animal diseases. Such changes may lead to emergence of novel pathogens or convert the commensals to pathogens. Abiotic changes lead to biotic ones and the dynamic changes in the populations of vectors, reservoirs and pathogen affect their bionomics and their ability to establish in new ecosystems. Overall vulnerability of a given ecosystem is a key variable in this regard.

In view of the expanding host range of several pathogens, program for prevention and control of infectious diseases can't have restricted focus on defined host populations only. The diagnostic tools developed

will have to be frequently evaluated for their efficacy to detect the newer variants. The trade policies will need to be revised based on scientific data in order to minimize the loss to the farmers while guarding the disease profile of the Indian livestock population. Some of these decisions and actions will be extremely critical in political, social and economic context.

2. Changing profile of livestock diseases due to paradigm shift in animal husbandry practices leading to altered host pathogen interaction (Host-Pathogen Interaction)—The livestock population is one of the major drivers of changing disease dynamics. It is propelled by demand-driven increase in consumption of livestock production, especially poultry meat, eggs, and pork in a fast developing country like India. There has been a trend to scale up to huge commercial livestock production enterprises and greater intensification, with a parallel exit from small-scale farming to more lucrative income-generating activities. This would lead to a gradual decline in those endemic and epidemic diseases that are both easier to control in intensive systems and an increase in diseases associated with animal crowding and environmental degradation. In the changing scenario of animal population in the country driven by several socio-economic and ecological factors, there is need to keep vigil over culminating changes in disease patterns, understand the dynamic impact of the changed host pathogen interaction and develop control measures for the new emerging o pathogens with practical compatibility with the farming practices.

3. Rise in risk of zoonotic infections with increasing number of animal pathogens adopting human beings by crossing species barriers with greater ease due to ecological changes and greater contact between humans and animals. (Zoonotic infections)—In the past two decades a large number of new viral infections with severe life-threatening and economic consequences have emerged. At present, of all the microbial pathogens, 60% are zoonotic with 13% species regarded as emerging or re-emerging. Among emerging infectious diseases, 75% are zoonotic with wildlife being one of the major sources of infection. In India, agriculture and animal husbandry workers such as farmers, livestock owners, animal handlers, veterinary extension workers and veterinarians contract many zoonotic diseases due to increase in contacts between human and wildlife either through human encroachment into wild or vice versa. Many viral zoonotic diseases from wildlife including avian influenza and rabies are well known. However, many have recently emerged or linked to wildlife reservoir species, for example Ebola virus, severe acute respiratory syndrome (SARS) coronavirus, Middle East

respiratory syndrome (MERS) virus and Hendra virus from bats. Several of these like MERS and CCHF are asymptomatic in domestic animals but cause fatal infectious disease in humans. At present, the institute cannot handle risk group-4 agents like CCHF, Ebola and Nipah due to non-availability of BSL-4 lab. However, with upcoming BSL-4, the institute will have to work on these viruses much more extensively and contribute significantly towards the cause of public health under 'one health concept'

4. Rise in antimicrobial drug resistance due to indiscriminate use of antibiotics in animals leading to emergence of superbugs unresponsive to treatments of modern medicine (Drug resistance)—Superbugs are the product of an astounding bacterial evolutionary process that started with the use of antibiotics 70 years ago. As early as the late 1950s, 'difficult to treat infections' were reported that involved bacteria resistant to the antibiotics available at the time. Nowadays, multi-resistant strains have become a major concern for public and animal health. Indiscriminate use of antibiotics in food animals as well as in humans over number of decades has resulted in emergence of multi-drug resistant strains. Since antibiotics are selectors of bacterial strains, in the evolutionary process, bacteria with resistance to all known classes of antibiotics are now emerging and are sometimes called as 'superbugs' that are too dangerous to be handled in open laboratories. The evolution and adaptation of bacteria to the use of antibiotics as therapeutic agents are unfolding in front of us, and are challenging our understanding. Preparedness is needed at the animal-human interface to mitigate the risks of emerging drug-resistant strains.

5. Increasing possibilities of use of animal pathogens as biological warfare agents to disturb the economy of the country (Bio-terrorism)—By and large, the most disease outbreaks and food contaminations occur naturally. However, there is also a real risk that disease may be introduced into susceptible human or animal populations following a deliberate or accidental release of an infectious agent or toxin. These 'unnatural' biological threats carry special risks because pathogens may be engineered or released in such a way as to make them more harmful. Although the probability of a deliberate or accidental release may be relatively low the impact may be catastrophic from a national to a global level. Animal pathogens may be used as bio-weapons or in bio-terror because they have a high impact, are cheap, easy to acquire and propagate, and can be readily smuggled through border checks undetected. The biotechnology revolution means that options for engineering animal pathogens are increasing all of the time whilst the cost of doing so is decreasing. All

of the animal pathogens that have been developed as bio-weapons or have potential for use as such are listed by the World Organization for Animal Health (OIE). Animals themselves play an important role as biosensors for accidental or deliberate releases of infectious agents and toxins, and for emerging diseases. The same disease surveillance and intelligence systems that are in place to detect day-to-day occurrences of natural outbreaks, within countries and at national borders, will also detect deliberate and accidental releases.

❑

New opportunities

The transmission of exotic and emerging disease pathogens from animal to humans provides NIHSAD with a great opportunity to collaborate with national and international institutions involved in human infectious disease research to ensure development of early diagnosis and disease forecasting measures aimed at early warning system to prevent spread of animal pathogens into the vulnerable human population. There is also an opportunity to develop collaborative surveillance programs involving veterinary and medical professionals targeting both the animal and human population in a particular region vulnerable to such infections. Most of the new opportunities which can be harnessed to realize vision-2050 arise from the novel technological platforms available for developing new generation diagnostics and vaccines and pathogen characterization at molecular level-

A. **Utilize the high throughput tool and techniques like NGS and microarrays for rapid diagnosis of known and unknown pathogens.**
   The rapidly developing high throughput tools like NGS and microarray have tremendous potential for detection of known as well as unknown pathogens. This being an all inclusive approach for pathogen detection, will emerge as a tool of preference for the diagnosis and detection of emerging and reemerging pathogens as well as recording of their evolution with respect to pathogenicity and host range.

B. **Use a multiplexing approach for identification of multiple pathogens by a single window test.**
   The ability to detect multiple pathogen by a single window test can be visualized as an ideal target of any diagnostic laboratory. Such a test will save tremendous time and resource being spent at present, on the processing of sample separately for each diagnostic test. The panel of test may be grouped as per species or as per syndromes so that health consequences due to multiple co infections can also be easily detected and action plans developed for each of them. Such single window test/protocol would be easily adaptable to different laboratories with minimum infrastructural prerequisites.

C. Utilization of computational biology for addressing the lacunae in biological approach in disease prediction and management.

Bioinformatics can play a special role in studying emerging infectious diseases, where a fast characterization of the diseases is often urgently needed before they are widespread. The rapid characterization of an emerging disease will provide invaluable information in the prevention and control of the disease. Compared to the biological approach, computational methods can provide a relatively fast and efficient approach to derive theoretical models based on experimental data, to simulate/predict biological processes and to provide working hypotheses for rational disease prediction and management.

D. Utilize the cutting edge techniques like nanotechnology, nano-medicine and biosensors for developing new generation diagnostics and vaccines

The recent and continuing advancements in nanotechnology and development of biosensors have opened new technological platforms for next generation diagnostics. These technologies hold huge potential for developing extremely cost effective and point-of-care diagnostics and can be utilized by the institute for its major program on development of diagnostics and vaccines. Applications of nano-technology include the identification of specific strains or serotypes of disease agents, such as the identification of specific influenza strains, or the differentiation of diseases caused by different viruses but with similar clinical signs, such as vesicular viral diseases.

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Thrust Areas

a) Exotic & emerging infectious diseases of livestock and poultry
b) Adaptation of modern technology in development of diagnostics and vaccines
c) Bio-risk management related to exotic and emerging pathogens
d) Patho-genomics
e) Bioinformatics

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Goals and Targets

a) Development of next generation diagnostics for multiple detections of known and unknown pathogens for meeting national needs in time bound manner.
b) Development of cost effective and user friendly instant diagnostics that is easily accessible to the farmers
c) Participate in the process of risk assessments and gap analysis exercises for major threats of exotic and emerging diseases of animals.
d) Improvement of disease vigilance and monitoring by partnering with various ICAR institutes, medical institutes and private/public organizations to address the risks of emerging pathogens of animals and zoonotic agents.
e) Establishment of pathogen repository and retrieval system
f) Participation in regional and global collaborative structure of animal health relevance by information sharing, exchange of skills and knowledge in the form of trainings and workshops
g) Periodic dissemination of knowledge and awareness amongst stakeholders and policy makers regarding the diseases status and control.
h) Imparting professional education in bio-risk management with post-graduate diploma and certificate courses.

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Way Forward

Adoption of State of Art Technology for the Development of Cost Effective, Accurate and User Friendly Diagnostics

The rate of development of technology in the past two decades has been very rapid. With the enhanced speed of communication and wide spread publicity available for such innovations as nanotechnology, biosensors etc., what is needed is an open ended approach to explore the interdisciplinary areas to utilize the state of art technologies for the development and improvisation of diagnostics and make them more accurate, cost effective and user friendly. The biological applications of technological advances in the areas of physics, chemistry, engineering and information technology can facilitate in achieving the much needed goal of user friendly, point of care diagnostics for animal diseases.

High Throughput Approaches for Pathogen Detection and Analysis

In recent years, high-throughput technologies (HTT), bioinformatics and computational biology approaches (BCB), have resulted in a major transformation in the area of emerging infectious disease research. Furthermore, these new technologies have set the stage for powerful new approaches to the diagnosis, surveillance, control and reporting of infectious diseases.Scope of high-throughput technologies includes various next-generation sequencing platforms, microarrays, proteomics, the newest single DNA molecule sequencers (third-generation sequencing) and nanotechnologies currently in the developmental phase.

These high-throughput technologies enable the detection, identification and detailed analyses of pathogen genomes, host genomes and environmental factors at an unprecedented scale, speed and depth. In recent years, these new methodologies and platforms developed, and will make HTS more and more affordable in small diagnostic laboratories and even in the field.

The new developments in HTT-BCB offer a variety of opportunities in the context of animal health, and specifically in the diagnosis, surveillance and control of animal infectious diseases. For example, with HTT-BCB there is also the potential of Panmicrobial surveillance and diagnosis It can also lead to identification of novel pathogens, designers microorganisms and extraterrestrial life, if any. There are

ever-increasing opportunities to study the evolutionary dynamics of pathogens at the farm, local, national and global levels, in addition to a growing understanding of the epidemiology of infectious diseases and the phylogeography of infectious agents. In general, HTT-BCB offers the capability to characterise the full genomes of pathogens at scales unimaginable until a few years ago. As with any new scientific development, HTT-BCB also creates some interesting challenges. For example, the approaches to sample preparation from the specimens biologically appropriate for veterinary investigations need to be improved and optimised. Also, the systems and infrastructures for HTT data capturing, handling, archiving and access need to be optimised and standardised. Indeed, the interpretation of HTT data in the context of animal health requires careful evaluation and harmonisation.

Communication and Extension Strategies for Dissemination of Knowledge to Stakeholders and Public Awareness

The institute shall develop its communication and extension wing to take up various activities for better dissemination of knowledge generated at the institute as well as creating public awareness that would be useful for emergency disease situations. Through community based approach, public awareness about zoonotic diseases and farmer awareness about lesser known animal diseases can be spread among stakeholders. More specifically, the institute can provide technical assistance to media partners in component design, implementation and monitoring for disease awareness programs. Selection and training of spokespersons to provide timely and accurate information in emergency situations and mobilization and media support to raise awareness in rural and peri-urban areas can be effected from the institution level. Communication channels can be developed with priority stakeholders in order to promote a coordinated and coherent multi-sectoral response if and when a disease outbreak situation appears. With involvement of communities at rural, urban and even at industrial level, the institute shall aim at achieving direct linkages with grass root level so that the useful information in terms of either disease awareness, technology, diagnosis, public health related measures can be effectively passed on for broad aim of better sanitation and disease control in animal health sector.

Partnering and Networking with Other National and International Institutes

Research is increasingly becoming a global effort, based on international cooperation and resource sharing. In time to come, more and more components of the science infrastructure will be geographically

dispersed, and used in different configurations over time. The institute shall adopt this trend in research and shall aim to develop theme-specific research partnerships with other institutes. Apart from collaborative research, the institute shall participate in information sharing with nationally and internationally recognized networks in addition to its current linkages with OFFLU and OIE. The institute has already initiated collaborative research with National Institute for Veterinary Epidemiology and Disease Informatics (NIVEDI) and National Institute of Virology in selected areas and shall further work with these institutes in a number of areas towards the goal of improving disease surveillance and public health. Computational biology is another area where networking and resource sharing is critical to the success of research endeavours. Computing facilities are becoming generic resources that can be combined to provide services through the network infrastructure. In last few years, a number of computational biology networks have been developed e.g. National Agricultural Bioinformatics Grid (NABG) developed by ICAR and National Network for Mathematical and Computational Biology (NNMCB) developed by IISER group of institutions. The institute is set to harness these huge computational biology resources for achieving its goals of disease diagnosis and technology development for better diagnostics and vaccines.

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