NAVS POLICY PAPER 09

Transboundary Viral Diseases of Livestock- FMD, LSD & ASF

Jointly Published by

National Academy of Veterinary Sciences (India)

&

Guru Angad Dev Veterinary & Animal Sciences University

(GADVASU), Ludhiana 141004, Punjab

POLICY PAPER 9

National Academy of Veterinary Sciences (India)

Transboundary Viral Diseases of Livestock- FMD, LSD & ASF

Based on Proceedings and Recommendations from National Workshop and Brainstorming

on

"Strategy on Control and Eradication of Formidable Transboundary Viral Diseases of Livestock – Foot and Mouth Disease (FMD), Lumpy Skin Disease (LSD) and African Swine Fever (ASF)"

14th–15th November, 2022

ISBN 978-81-19072-31-6

Jointly organized by
National Academy of Veterinary Sciences (India)
&
Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana 141004, Punjab

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PREFACE

Livestock is important for food security and balanced nutrition in India. Trans-boundary animal diseases (TADs) are a threat to food security and animal health and have a negative socioeconomic impact. The 'Freedom from disease without vaccination' is the ultimate aim of all disease control programs. Many factors such as high livestock density, inappropriate or insufficient animal identification systems, broad host range, pathogen virulence and infectiousness, ban on cow slaughter and limited resources substantially constrain the efforts to eradicate TADs in India. Sincere efforts involving all the stakeholders along with scientific management are recommended to cushion the devastating health and economic impacts of TADs in India.

Cultural practices do not allow slaughter and stamping-out to be the mainstay of any disease control program in India particularly the control programs aiming for bovine trans-boundary animal diseases (TADs). Lack of slaughter campaigns means high reliance on vaccination, quarantine, biosecurity and border security for the control of bovine TADs in India. This also eliminates the option of fast eradication of TADs in India.

Policy development is extremely important to achieve the goal of disease eradication to uplift the livestock production and industry. The current document is intended to supplement the ongoing FMD, LSD and ASF control programs in India. Priority control options to achieve realistic goals in disease prevention and control have been documented to aid the ongoing TAD control programs in India.

Editors

FOREWORD

I am happy to note that the National Academy of Veterinary Sciences (India) in collaboration with the Guru Angad Dev Veterinary & Animal Sciences University has developed an important policy paper on "**Transboundary Viral Diseases of Livestock – FMD, LSD and ASF**". The accurate development and execution of policies and a long-term commitment is must to control TADs in India. Most of the policies have to be embedded around the ongoing vaccination programs. Accurate vaccination protocols, vaccine quality and cold chain maintenance are important to generate sufficient antibodies to develop protective herd immunity. The current policy document is a sincere effort to supplement the ongoing TAD control programs in India.

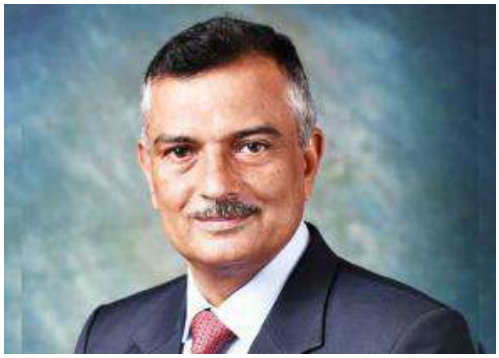
I express my sincere gratitude towards all the subject matter specialists who have generously contributed in this policy publication on the control and eradication of transboundary viral diseases (TADs) in India. The collaborative efforts of the Guru Angad Dev Veterinary & Animal Sciences University in this regard are highly appreciated.

I am confident that this policy document will be highly valuable for the ongoing TAD control programs in India.

DVR Prakash Rao
President
NAVS (India)

Dt. 15.11.2022

FOREWORD



The Indian livestock industry is confronted with a serious challenge to control transboundary animal diseases such as foot and mouth disease (FMD), lumpy skin disease (LSD) and African swine fever (ASF). In addition, preventing the introduction or incursion of foreign animal diseases such as rift valley fever (RVF), West Nile fever (WNF), Crimean Congo hemorrhagic fever (CCHF) and bovine spongiform encephalopathy (BSE) is always a government priority. The introduction of Lumpy Skin Disease (LSD) in 2019 has caused a huge health and economic impact on the livestock industry in India. The LSD has covered most of the country and protecting vulnerable livestock populations and industry is a serious challenge. Predicting LSD outbreak and pre-empting a vaccine campaign before the occurrence of disease outbreak or epidemic in the identified areas is the key to control LSD in India. It is my pleasure to introduce this policy paper on "**Transboundary Viral Diseases of Livestock–FMD, LSD and ASF**" as an official document published by the National Academy of Veterinary Sciences (India) in collaboration with the Guru Angad Dev Veterinary & Animal Sciences University, Ludhiana. I sincerely compliment both the National Academy of Veterinary Sciences (India) in collaboration with the Guru Angad Dev Veterinary & Animal Sciences University for bringing out this policy paper.

I am sure that this document will be very useful to aid the ongoing foot and mouth disease, lumpy skin disease, African swine fever and other TADs control programs in India.

Inderjeet Singh
Vice Chancellor
GADVASU

Dt. 15.11.2022

FOREWORD

Emergency preparedness, import risk analysis, contingency and risk communication plans must be developed well in advance to prevent the introduction of foreign TADs and to avoid future disease emergencies. Many transboundary animal diseases such as foot and mouth disease, lumpy skin disease, African swine fever seriously undermine the much-needed food security in India. Continuous availability of good quality vaccines, HACCP system based cold-chain management and high vaccine coverage are key to eradicate many TADs in India. I am happy to note that the National Academy of Veterinary Sciences (India) in collaboration with the Guru Angad Dev Veterinary & Animal Sciences University has developed an important policy paper on "**Transboundary Viral Diseases of Livestock–FMD, LSD and ASF**". My sincere thanks to all the scientists and other stakeholders for contributing in this policy document.

I am sure that all the stakeholders engaged in the livestock production such as veterinarians, dairy farmers, vaccine manufacturers, and policy makers will be immensely benefitted and this document will aid in the ongoing TADs prevention and control programs in India.

Praveen Malik
Commissioner Animal Husbandry
Government of India

Dt. 15.11.2022

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NATIONAL ACADEMY OF VETERINARY SCIENCES (INDIA), G-4, A Block, NASC Complex, DPS Marg, Opp. Todapur Village, New Delhi – 110012
Tel: +91-989-6068-399; Email: navsdelhi@gmail.com; Web site: http://www.navsindia.org

CONVENERS:

Dr DVR Prakash Rao, President NAVS (I) &

Dr Inderjeet Singh, Vice-Chancellor, GADVASU

EDITORS:

Dr Yashpal Singh Malik, Dr BB Singh & Dr JPS Gill

REVIEWER:

Dr RP Singh, Dr Ravindra Sharma, Dr NN Barman,

Dr Naveen Kumar, Dr Manoj Kumar

CITATION:

NAVS 2022, Transboundary Viral Diseases of Livestock –FMD, LSD and ASF. Policy Paper No. 9, National Academy of Veterinary Sciences (I), New Delhi, pages 1-21.

ISBIN No.:

ISBN 978-8119072-31-6

9 788119 072316

1. Transboundary Animal Diseases

India has a human population of 1.39 billion people (WB, 2021) and most of the population residing in rural areas is dependent on crop and/or livestock production. In 2019-20, the total gross value added (GVA) of the country was 184613.43 billion (Indian Rupees). The agriculture and allied sector (16.3%) and the livestock sector (4.9%) substantially contributed in the total GVA of the country (http://164.100.161.63/publication/national-accounts-statistics-2022).

The country is home to 193.46 million cattle consisting of 51.36 million exotic, and 142.11 million indigenous cattle (BAHS, 2020). There are 109.85 million buffalo and 9.06 million pigs in India (BAHS, 2020). In 2019-20, the country produced 198.4 million tons of milk with a per capita availability of 406 gram/day (BAHS, 2020). The country produced 414140 tonnes of pork contributing 4.82% to the total meat production in the country (BAHS, 2020). Livestock production is important to food security in India.

Emerging infectious diseases (EIDs) are a serious threat to livestock production in India. The ongoing Corona virus disease 2019 (COVID–19) pandemic has demonstrated that EIDs have substantial potential to undermine the global economy. Resource poor countries or those living under poverty are most vulnerable and victims of these EID outbreak events. Multiple factors such as climate change, human and livestock movements and deforestation have substantially enhanced the threat and epidemic potential of novel pathogens. The country is predicted to be a hotspot for disease emergence. Recently, it has been reported that climate change is likely to increase the risk of introduction of novel species-jumping pathogens in India (Carlson et al., 2022).

In the past decade, many novel transboundary and emerging animal diseases have been reported in India. The disease status on important bovine and ovine transboundary viral diseases (2008-2022) as per the World Animal Health Information System, World Organization for Animal Health has been presented at https://wahis.woah.org/#/analytics. In the recent past, many EID events or disease outbreaks have been reported in the livestock populations across the country (https://wahis.woah.org/#/analytics). During 2011-2020, a total of 2226 foot and mouth disease (FMD) outbreaks have been recorded in both domestic livestock and wildlife in India (Subramaniam et al., 2022). In 2019, the lumpy skin disease (LSD) was introduced and the first disease outbreak was reported from Odisha state of the country (Sudhakar et al., 2019). Within three years of its entry, the LSDV has

spread across most of the country (Pandey et al., 2022; Kumar et al., 2021). African swine fever has emerged as a serious threat to pork production in India (Patil et al., 2020). In addition, many exotic diseases such as rift valley fever (RVF), West Nile virus (WNV), African horse sickness (AHS), bovine spongiform encephalopathy (BSE), and Crimean Congo hemorrhagic fever (CCHF) could be considered absent (although freedom from disease has not been demonstrated), but the risk of introduction or incursion of such diseases into the country could not be completely ignored.

a. Recommendations

1. On-time availability of vaccines is very important to contain TADs. Therefore, national and regional vaccine banks should be developed and buffer stocks of available vaccines against all TADs should be maintained to tackle disease emergencies.
2. Maintenance of cold-chain is extremely important for the success of vaccine-dependent infectious disease control program in India and therefore poor cold-chain management throughout the country, except a few states, is a serious issue that requires immediate redressal. GoI should support and ensure the same at least in states bordering neighboring countries.
3. Efforts should be directed to attain 100% vaccination coverage for economically important TADs. Harmonization among stakeholders such as those involved in vaccine production and vaccinating the animals is important. Vaccination periods should be synchronized as per the crop/husbandry practices and hence availability of time of the farmer (as per the schedule of farming operations in different states).
4. The efficacy of all the vaccine batches should be fully ensured with standard protocols both during the manufacturing process as well post-vaccination (assessing quality and quantity of the immune response). The payments to vaccine manufacturers should be linked with quality assurance of the supplied vaccines. The loss incurred to farmers consequent to outbreaks in vaccinated animals should be thoroughly examined for appropriate compensation.
5. Vaccination, together with ear tagging and updating in a national animal health software e.g., INAPH, should be outsourced to private players while the government departments' field staff should be mandatorily mandated and made responsible to monitor and ensure complete vaccination of all eligible animal heads.
6. It is highly essential to strengthen the disease reporting systems. Similar to the World Animal Health Information System (WAHIS) of the World Organization for Animal

Health, an Indian disease reporting system (may be called as National Animal Health Information System or NAHIS) for all animal diseases or specific diseases like FMD should be developed to facilitate country-specific disease control programs. State wise / regional offices of the system should be scanning information emerging locally in the region in mass and social media, followed by immediate response in terms of disease identification, control, reporting and prevention of its spread.

7. Inter-state and intra-state movement of animals particularly during the outbreaks must be strictly regulated. Uncontrolled inter-state and intra-state movement of stray and wild animals (in particular wild pigs for slaughter) should be appropriately regulated.
8. Develop risk assessment and risk communication plans.
9. Active and passive surveillance systems must be in place to have robust disease control programs. Passive surveillance at abattoirs, slaughter shops (for buffalo, sheep, goat and pigs) must be conducted. Ongoing active surveillance for the disease and post-vaccination titers must be practiced. A syndromic surveillance system should be put in place in the country. The farmers should be educated to adopt this surveillance system and symptom-based reporting (such as using mobile apps) may be adopted for preliminary case reports. Regular surveillance of wildlife reservoirs such as wild boars should be carried out. The comprehensive reports should be made available to relevant stakeholder to help decision making e.g., to industry to decide on vaccine(s) and drugs to be developed.
10. The ratio of livestock and veterinary professionals including vaccinators in the country should be optimized. Introduction of mobile veterinary units into the official veterinary services should be strengthened.
11. The extension education agencies such as Krishi Vigyan Kendra's (KVKs) and Agricultural Technology Management Agency (ATMA) could be enrolled to generate awareness on the ongoing FMD control program and other related activities. The state Animal Husbandry Department technical staff should be specifically mandated to act as agents of extension in Animal Husbandry, which is ill penetrated amongst livestock keepers so far.
12. There should be a regular review of biosafety levels of different microorganisms due to regularly changing scenario with proper clarity on different biosafety categories for field isolates, vaccine strains and challenge strains etc.

13. Academia-industry collaborations should be strengthened further to conduct rationalized animal studies, development of assays for virus detection, typing, DIVA and harmonization of such assays among different stakeholder laboratories.
14. Such deliberations amongst various stakeholders including academia, research, manufacturing, field and farmers should be made a regular feature

2. Foot and Mouth Disease

Foot and Mouth Disease (FMD) is a world organization for animal health (WOAH) listed disease and occurs due to *Apthovirus* (Family- *Picornaviridae*) that have seven strains (A, O, C, SAT1, SAT2, SAT3, and Asia1) prevalent in different parts of the globe (https://www.woah.org/en/disease/foot-and-mouth-disease/). The virus infects cloven-footed animals such as cattle, swine, sheep, and goats. The virus is transmitted through respiratory/oral routes and could be found in all the excretions/secretions of infected animals (https://www.woah.org/en/disease/foot-and-mouth-disease/). Clinical signs typically include blisters on the tongue, oral cavity, teats and above the toes; fever, lameness, hyper salivation and decrease in milk yield has also been reported. The disease causes huge economic losses and is a deterrent to livestock production in particular the bovine industry. As per the World Organization for Animal Health, there are 67 countries that are FMD-free (with or without vaccination) and many countries do not have official status for FMD and are considered FMD endemic (https://www.woah.org/en/disease/foot-and-mouth-disease/#ui-id-2). Currently, North America, Europe, the Caribbean and Central America are free from FMD.

There are reports that FMD was present as early as in 1864 in India (Subramaniam et al., 2022). The viral serotypes 'O', 'A' and 'Asia 1' are prevalent in the country. Several authors have reviewed the epidemiology of FMD in India (Subramaniam et al., 2013; Audarya, 2020). In India, the disease is often recorded in the outbreak form with huge economic losses and a barrier to trade (Subramaniam et al., 2022). In 2003-04, the official FMD control program (FMDCP) was launched in 54 districts and was gradually extended to cover the entire country by 2019. This control program adopted standard vaccine strain and vaccination strategy across the country (Subramaniam et al., 2022). Despite sincere government efforts, there are serious challenges and bottlenecks to control and eradicate FMD in India. Policy development and comprehensive future research plans are essential to aid the official FMD control program in India.

b. Recommendations

1. Each and every batch of FMD vaccine should be tested for its efficacy.
2. Suitability of the combined vaccine for FMD and HS (efficacy, production, delivery, dosage and schedule) in the ongoing FMD control program should be kept in focus. During Rinderpest eradication program, Rinderpest and FMD vaccines were administered at the same time on two sides of the neck. Such vaccination mechanisms may be examined when more than one vaccination programs are to be implemented at the same time (e.g., FMD, HS and LSD) at national/state level.
3. The use of high pay load monovalent vaccines in place of trivalent FMD vaccine as an emergency disease outbreak response should be further elaborated upon. This may be part of the vaccine/antigen bank for emergency vaccination. Antigen identification in each case of outbreak should help in taking locally relevant ring vaccination.
4. A National Commission on FMD should be set up to coordinate all FMD control and subsequent eradication program activities. Coordination mechanism with countries sharing land border with India must be established.
5. Early detection of an outbreak followed by rapid response is key to FMD control and elimination. Passive surveillance at livestock market, abattoirs, slaughter shops (for buffalo, sheep, goat and pigs) must be conducted regularly. Ongoing active surveillance for the disease and post-vaccination titers must be practiced more stringently. Sentinel surveillance using small ruminants, pigs and unvaccinated cattle herds should be implemented at a larger scale across India.
6. Risk factor investigation studies to understand the factors associated with the FMD outbreaks must be conducted. FMD outbreak media coverage and its scientific management are important.
7. The economic impact of FMD in livestock populations is largely unclear. In addition, the cost-benefit analysis of the ongoing FMD control program using different control scenarios should be conducted.
8. Cross-border risk assessment of the incursion of FMD from neighboring countries/states must be conducted. The government should have a sustained political commitment to build diagnostic capacity of the countries that share international borders with India. Creating an immune belt at international border is highly recommended.
9. In the control program, vaccination of pigs against FMD should be mandatory as pigs are amplifier host for FMDV. Thus, development and production of FMD vaccine for

pigs must be initiated. Until the period when suitable vaccine for pigs is not available locally, import should be allowed.

10. Research be directed towards the development of thermos-tolerant FMD vaccines. In addition, safety studies of FMD vaccines in pregnant animals must be conducted.
11. State extension agencies such as Krishi Vigyan Kendra's (KVKs) and Agricultural Technology Management Agency (ATMA) could be enrolled to generate awareness on the ongoing FMD control program and other related activities. Stakeholder involvement in the National FMD Control Awareness should be increased.

3. Lumpy Skin Disease

Lumpy skin disease (LSD) is an infectious disease prevalent in cattle and buffalo populations. LSD is trans-boundary in nature and the outbreak form is reported to bring huge economic losses in the cattle industry. It has been reported that LSD resulted in a direct loss of up to 1.45 billion USD to the livestock industry in South, East and South-east countries (Roche et al., 2020). The disease occurs due to lumpy skin disease virus (LSDV), a Capripoxvirus genus virus (along with Sheeppox virus and Goatpox virus) belonging to the family Poxviridae (https://www.woah.org/app/uploads/2021/03/lumpy-skin-disease.pdf). Arthropod vectors such as mosquitoes, biting flies and male ticks play an important role (as compared to direct contact) in the transmission of this virus. The virus is fairly stable in the environment and high virus loads have been recorded in skin nodules, scabs and crusts (https://www.woah.org/app/uploads/2021/03/lumpy-skin-disease.pdf). The vector transmitted disease has travelled at a slow speed of 7.3 km/week in the Balkans (Mercier et al., 2017), therefore animal movements are important drivers of disease spread in naive areas (Roche et al., 2020). The LSD virus is capable to survive long period of time at favourable temperature in dried scabs. However, the virus is susceptible to sunlight and easily inactivated by most of the detergents (Roche et al., 2020). Important clinical signs include fever, depression, cutaneous nodules, enlarged lymph nodes and a decrease in production. Abortion, infertility and death may also be recorded. The disease must be differentially diagnosed from the diseases such as cowpox, dermatophilosis, pseudo cowpox, rinderpest, tick bites and cutaneous tuberculosis. High yielding animals are believed to be more susceptible than indigenous cattle. The disease is commonly less severe and has low mortality in Asian water buffaloes (Roche et al., 2020).

Live animal (cattle & buffalo) trade (either legal or illegal), high livestock density, uncontrolled cross-border animal movements, abundance of blood sucking insects and community shared watering and grazing are important drivers of the LSD introduction and spread into previously disease free areas I countries such as India (Roche et al., 2020).

The disease was first reported in Zambia in 1929 and the virus has progressively entered many countries and continents after being discovered. In 2019, the disease entered in India (Sudhakar et al., 2019) and covered most of the country in the next 3-4 years. The establishment of LSD as an endemic disease is a serious concern and efforts are ongoing to develop a comprehensive LSD control and eradication plan in India. Barring rare case reports in humans, LSD is considered as a non-zoonotic disease by the international bodies.

c. Recommendations

1. Developing a comprehensive national LSD control program should be a top priority.
2. The possibility of administering both LSD and FMD vaccines on different sides of the neck at the same time may be examined when more than one vaccination programs are to be implemented at the national/state level.
3. Currently, only the heterologous vaccines (goatpox virus vaccine, GPV) are available to prevent LSD in India. Studies for rationalization of recommended dose for GPV should be conducted and published.
4. Homologous live-attenuated LSDV vaccine which has recently been developed by ICAR and has been shown to be highly efficacious should be got tested for relevant quality assurance parameters and thereafter made available commercially for mass immunization for effective control of the disease.
5. Looking at the pattern of existing cases of LSD, cattle population must be 100% vaccinated, while buffalo population must be kept under strict observation for clinical cases and disease outbreaks in coming times. In sporadic outbreaks of LSD in buffaloes, a ring vaccination approach may be followed. High risk like late pregnant and elite buffaloes / buffalo herds and buffalo bulls should be regularly vaccinated against LSD.
6. Prioritize vaccinating risk groups (for example exotic cattle) in case of limited vaccine supplies as an emergency disease outbreak response to reduce mortality.
7. Focus must be on LSD disease forecasting and epidemiology such as genomic surveillance, transmission dynamics, pathobiology, and understanding the vector

dynamics. Vector population control through fogging and spray of insecticides should be the priority strategy to control spread of LSD in endemic areas.

8. Develop risk communication plans and regularly conduct cross border risk assessment of the incursion of LSD from neighboring countries/states.
9. The government should make sincere efforts to strengthen diagnostic capacity and capability at primary animal health centers. There is need to build diagnostic and vaccination capacity for LSD within country and across bordering countries so as to create an immune belt at international border.
10. Strict biosecurity norms must be followed including vector control at the village level and individual farm premises.
11. Infected bulls could excrete the LSDV in the semen; although the disease transmission from infected semen has not been reported. This should be kept in mind when using semen from infected bulls. This issue needs further investigations, but before convincing results about role of semen mediated spread of LSD are obtained, frozen semen production from semen stations in endemic areas / farms should be stopped and semen produced 15 days prior to first detected LSD case should be discarded. Semen production should resume at such station only from 30 days after the last detected case of LSD at farm has recovered completely.

4. African swine fever

African swine fever (ASF) is an infectious disease of suids including pigs, warthogs, bush pigs and giant forest hog. The disease has caused a serious crisis in the pork production and drastic losses have been reported in the pork production in many countries (https://www.woah.org/en/disease/african-swine-fever/). The disease occurs due to African swine fever virus (ASFV) belonging to the family *Asfarviridae*. Lack of vaccine, high mortality and contagious nature make it a nightmare for pig farmers particularly those suffering with resource constraints such as backyard farmers. Although non-zoonotic, huge negative socioeconomic impact has been reported in the persons engaged in pork industry. The disease was first reported in early 1900s in domestic pigs in Africa followed by trans-continental spreads over a period of time (Montgomery, 1921). Direct or indirect contact with infected animal or its body fluids, faeces, fomites, carcasses, meat and its products are important source of infection for susceptible animals. Movement of live animals, infected carcasses, contaminated fomites and wild boars are believed to play an important role in transmitting the disease in naïve areas (Guinat et al., 2016). Soft ticks are also believed to

play a role in the disease epidemiology. In addition, free-roaming pigs are likely to play an important role in the spread of ASF in previously uninfected areas.

The disease has been reported to occur as peracute, acute, subacute or chronic forms. Clinical signs could vary ranging from sudden death, joint swelling, skin erythema and ulcers, emaciation and delayed growth (Sánchez-Vizcaíno et al., 2015). In 2020, the first outbreak of ASF was reported in domestic pigs in northeast India in the state sharing border with China, Myanmar and Bhutan (Rajkumar et al., 2021) and the virus rapidly spread into other parts of the country. Restrained by the non-availability of vaccine, developing and implementing ASF control program is a difficult task in countries such as India.

d. Recommendations

1. A research and development thrust must be given on ASF vaccine development following newer vaccine approaches and development of point-of-care diagnostics.
2. Inter-state and intra-state movement of animals particularly during the outbreaks must be regulated. Uncontrolled inter-state and intra-state movement of stray and wild animals' pigs should be regulated.
3. Active and Passive Surveillance systems must be in place to inform disease control programs. Passive surveillance at abattoirs, slaughter shops, piglet market must be conducted. Regular surveillance of wildlife reservoirs such as wild boars should be carried out.
4. Risk assessment and analysis should be carried out to determine disease hotspots as well as to develop an early warning system for ASF.
5. Establish and define a containment zone as per National Action plan (with an infected and protection zone) including all the disease outbreaks or infected premises. The containment zone boundary should be decided based on population density, disease dynamic pattern and geographical isolation.
6. Enforce WOAH recommendations for importation of live animals, meat, semen, bristles, embryos, manure, skins or other pig products.
7. Capacity building of veterinary services in disease epidemiology, diagnosis and control programs. Upgradation of laboratory facilities up to BSL2+ must be undertaken particularly in northeast India. Diagnostic lab on wheel for hilly border areas to cover international livestock migratory routes. Regional Bioinformatics infrastructure and repository for biosamples is also recommended.

8. Enhance biosecurity and develop biosecurity plans (Village and farm-specific) that could be implemented at the village and farm levels. Introduce biosecurity housing systems and strictly restrict uncontrolled entry in the village and farms.
9. Live wild boar and the infected carcasses should be properly disposed-off.
10. National and state-specific ASF preparedness plan and funds must be in place to control disease outbreaks or/and disease emergencies.
11. Brainstorming discussions are required for implementation of Zoning and Compartmentalization of ASF and other transboundary diseases to continue livestock business in endemic situation.

5. Proceedings of the Workshop and Brainstorming

A National Workshop and Brainstorming on "Strategy on Control and Eradication of Formidable Transboundary Viral Diseases of Livestock – Foot and Mouth Disease (FMD), Lumpy Skin Disease (LSD) and African Swine Fever (ASF)" was organized by the National Academy of Veterinary Sciences, India (NAVS), in association with the Guru Angad Dev Veterinary & Animal Sciences University (GADVASU) at Ludhiana during 14^{th}–15^{th} November, 2022 under the Chairmanship of Dr DVR Prakash Rao, President NAVS. The list of experts and other participants is given in Annexure.

a. Inaugural Session

Dr Yashpal Singh Malik, Dean, College of Animal Biotechnology and Dr JPS Gill, Director Research, GADVASU, co-organizing Secretaries of the event, formally welcomed all the eminent speakers, and participants from academia, industry, researcher institutes and farmers' associations. Dr Inderjeet Singh, Vice-Chancellor GADVASU, thanked the National Academy of Veterinary Sciences (NAVS) for entrusting GADVASU with the opportunity to host this National Workshop and Brainstorming, emphasizing that FMD, LSD and ASF cause substantial negative impact on the livestock economy due to lack of effective implementation of disease control, reporting and management strategies. He specifically pointed out that although vaccination programs against FMD are in place since past many years, the country remains far from achieving the goal of FMD control. Way forward can be charted only through thorough discussions amongst stakeholders and owning the responsibilities by various components of the chain including state and union departments, industry, field staff and farmers themselves. Dr Singh shared his own experiences and challenges involved in the implementation of vaccination program as well as possible corrective measures. His concerns included the quality of vaccines, vaccination

process, cold chain maintenance and disease under-reporting. Strong biosecurity measures, stakeholders' awareness and participation were delineated as important components for the control of transboundary animal (TBA) diseases for the prevention of huge losses to the farmers.

Dr DVR Prakash Rao, President NAVS, India in his inaugural address thanked GADVASU for taking initiative in organizing NAVS national workshop and brainstorming on "Strategy on Control and Eradication of Formidable Transboundary Viral Diseases of Livestock – FMD, LSD and ASF". He highlighted the initiatives undertaken by the Government of India for conducting intensive FMD vaccination programs under NADCP to make India FMD-free by 2030. Dr Prakash Rao emphasized the importance of vaccination, vaccine quality and cold chain maintenance to generate sufficient antibodies to develop protective herd immunity. He wished that the scientific deliberations will help policy development on the prevention and control of potential transboundary animal diseases.

The dignitaries then released an android mobile App developed by GADVASU on 'Vaccine Preventable Livestock Diseases" that introduces viewers to important infectious diseases of livestock including their etiology, symptoms, transmission route, management, prevention and control strategies.

b. Technical Session I: Current Status and Control Program for FMD

Dr RP Singh in his expert talk briefed about the current status and different FMDV serotypes prevalent in India. The data on the year, month, species, region and state-wise outbreaks of FMD and the involved virus serotypes were presented. Dr Singh discussed the ongoing FMD control programs and the national network of FMD laboratories. He opined that transmission in other species will also come down if FMD is tackled in cattle and buffalo. He emphasized the importance of stakeholder involvement for success of the ongoing FMD vaccination program and mentioned that sentinel surveillance in small ruminants and pigs should be practiced. Antibody titre of >1.8 log10 (@50PI) is considered protective at herd level and regular vaccination is practiced without fail in most of the organized farms. In order to bring FMD to zero level with vaccination, similar efforts need to be adapted across the country. He appraised the gathering about the National FMD Control Awareness Week celebrated from 12-17 September, 2022 involving different stakeholders as one of the measures for spreading awareness and control of FMD.

Dr Prakash Rao, Chairman of the session, suggested that the numbers and stature of professionals in animal husbandry departments need to be increased substantially for achieving better results. It was opined that monitoring agencies are required at state and district level with a target to eliminate the diseases. Dr AC Varshney, Co-chair, enquired about the probability of application of monovalent vaccine in place of trivalent vaccine where FMD 'O' serotype is more prevalent and to speed up the vaccine production. Dr R Sharma replied that as soon as antigenic pressure is removed, type A might resurface. While answering the idea of inclusion of sheep and goat in FMD vaccination program, Dr RP Singh stated that the option may be explored only in high prevalence areas. He mentioned that the proposal for offering diagnostic competence to border nations is under consideration of the union government. Creating an immune belt at international border will help to achieve the goal of preventing movement of diseases across borders.

Dr Abhijit Mitra opined that the FMD eradication program will not be a success until agencies like KVKs and ATMA are extensively involved for awareness programs and coordination between these agencies and animal husbandry department is improved. He also raised the issue of lack of interest of vaccinators and poor management of cold chain. Sh. SK Gulati supported the use of combined vaccine to restrict visits and convince farmers for vaccination. Dr Inderjeet Singh highlighted the flaws in FMD reporting system and also the importance of regional and national media/newspapers monitoring to log all such news items concerning disease outbreaks. Sh Daljit Singh highlighted the importance of vaccination and stressed on poor cold chain maintenance as the reason behind vaccine failure. He stated that there should be proper testing before vaccine distribution. Dr OP Chhikara, highlighted the importance of use of technological interventions for temperature monitoring during transit and storage of vaccines.

c. Technical Session II: Diagnostics and Vaccine Approaches for FMD

Dr NK Kakkar gave background information on prevention and control measures for FMD and Haemorrhagic Septicaemia (HS) and elaborated the concept of seromonitoring of FMD+HS combined vaccination and its genesis at different levels. He presented the significant research work carried out at LUVAS, Hisar and observations on anti-FMD, anti-HS antibody response in cattle and buffaloes. He informed that no adverse reaction in terms of temperature rise and milk yield in FMD+HS vaccinated animals was reported. Protective antibody titers were maintained in adult animals having 3 or more shots of FMD+HS vaccine. He recommended that calves and heifers need booster doses for

maintaining protective antibody titers. He concluded that FMD+HS vaccine is safe and results are encouraging.

Dr Ajit Singh Yadav briefed on the importance and ways to improve vaccine quality. He presented the role played by CCS NIAH, Baghpat in sterility, safety, potency and purity in FMD vaccine quality control. He also briefed about the central govt. funded National Animal Disease Control Program (NADCP-FMD) which coordinates bi-annual FMD vaccination with 100% coverage and unique identification of animals. On a query by Dr AC Varshney, if FMD virus is excreted in semen of infected bull, Dr RP Singh, clarified that virus does reach semen and could serve as a potential source of infection to the other healthy animals in the herd and therefore, it is mandatory to screen semen for FMD.

Further, discussions were held on the vaccination strategies to be adopted if the outbreak occurs during the phase of vaccination, whether the animals should be vaccinated or not? Dr RP Singh stated that if animal is in incubation stage, then there is no point of vaccinating infected animal because the animal will develop the infection. In this case, vaccination should be completed at the earliest in the healthy population and emergency response should be adopted in the form of ring vaccination. Dr Chhikara mentioned that in case a disease outbreak is reported during vaccination phase, only healthy animals are vaccinated while vaccination of infected animals will result in vaccination failure.

Dr RP Singh and Dr. Khosla emphasized the importance of extensive awareness programs involving all the stakeholders for building up the confidence in farmers towards vaccination. Dr Inderjeet Singh supported integrated approach for animal identification, vaccination and artificial insemination programs. He also appraised the gathering about the initiatives taken by GADVASU to control animal diseases. Dr Prakash Rao informed that the workforce for vaccination is very limited; therefore, outsourcing should be a better option. Dr RK Singh added that vaccination of migrating animals and imposing movement restriction is equally important for controlling the transmission of the disease. Dr Anirban Guha also suggested outsourcing for vaccination programs. Dr RP Singh said that village level entrepreneur could play an important role in conducting ear tagging and outbreak reporting. Further, Dr Singh suggested that the FMD + HS vaccine formulation should be designed in consultation with industry to maintain the antigenic mass of the vaccine.

Dr Balbir Bagicha Singh put forth important issues to be addressed by the experts such as stamping out of infected sheep, goat and pig population, guidelines for the usage of

combined LSD and FMD vaccine, use of needle free vaccination guns, and the role of stray and abandoned animals in the spread of diseases. Sh. Daljit Singh raised concerns regarding lapses in vaccination and improper storage and expiry of vaccines.

d. Technical Session III: Industry Role in Fulfilling the Goals towards Control for FMD

Dr Srinivas Karnati, representing industry, highlighted about IIL and different areas of animal and human vaccine developments. IIL is making vaccines against major livestock diseases such as FMD, HS, Black quarter, IBR, mastitis, brucellosis, LSD and Foot rot. He informed that around 3.2 billion doses of FMD vaccine have been produced so far. He further stated that there is expansion of facilities for FMD and FMD+HS vaccines and a capacity of 329 million doses of FMD, rabies and Biovac vaccines will be ready in coming 3 years.

Sh SK Gulati and Dr Inderjeet Singh inquired from industry speaker, if the combined vaccine of FMD and HS could be up scaled to fulfil the need of the country. Dr Srinivas responded that this is possible if they know the vaccine requirement well in time. Dr Srinivas highlighted that IIL has already started one more unit of combined vaccine manufacturing unit near Karkapatla unit, and that will be in operation soon. Dr RP Singh questioned, if a strategy of simultaneous vaccination of individual HS and FMD vaccine on either side of the neck is possible. Dr Srinivas replied that the same strategy had been followed 20 years ago with FMD plus Rinderpest vaccine, but he was not sure whether the same strategy could be implied in this context. Dr RP Singh recommended that the government should support supply of FMD+HS vaccines.

Dr Bhattacharya, representing Brilliant Pharma, presented his work to change the FMD vaccine testing to the lab animal model instead of target cattle. He highlighted that in-vivo PD-50 and PGP test or indirect VNT or LPB are done to assess the vaccine efficacy. He pointed out that getting seronegative (SN) cattle for efficacy testing is a daunting task. He discussed his findings after mentioning about the study design, and emphasized that guinea pigs are naturally SN to FMD, and the course of the disease is also same in guinea pigs. His results indicated that SN 50 titre value of vaccinated guinea pigs was less than that of cattle in all the batches. He stated that further studies must be conducted to establish a cut-off value. Dr RP Singh said that DFMD is also trying to establish cattle challenge v/s Guinea pig serology. Dr Manoj was of the opinion that there is a lot of scope of industry-

industry, and industry-academia collaboration as academia plays a major role in developing vaccines and conducting such trials.

e. Technical Session IV: Role of National & State Agencies in Controlling Emerging Infections

Dr Anirban Guha presented the mandate of the livestock health division of Dept. of Animal Husbandry & Dairying, Govt. of India and current scenario of livestock diseases. He discussed the challenges due to diseases of large and small ruminants, pigs and poultry. He also emphasized on the Livestock Health and Disease Control (LH&DC) scheme that includes components and budgetary allocations for (i) PPR Eradication Program (ii) CSF Control Program (iii) Establishment and Strengthening of Veterinary Hospitals and Dispensaries-Mobile Veterinary Units (ESVHD-MVU) and assistance to states for the control of animal diseases (ASCAD). He informed that NADCP program was launched to control FMD as well as Brucellosis in livestock by 2025. Dr Guha introduced the milestones of NADCP on ear tagging, vaccination, seromonitoring and serosurveillance. He mentioned about the design of NADCP that are based on OIE's recommendation with four important factors (i) Good quality vaccine monitoring (ii) Cold chain infrastructure (iii) Ground level implementation, and (iv) Post vaccination benefit, all of which are important for the success of NADCP. He addressed other key challenges and strategies to achieve FMD free status in India, which is currently in stage 3 of FMD control strategy. Dr Guha further mentioned about the activities conducted by DAHD to control FMD such as publicity through films and awareness programs, monitoring disease prevalence and collaborations to control FMD by 2025.

Sh. SK Gulati suggested providing reward to states and its respective veterinarians doing appreciable work towards FMD control and management. Dr MP Yadav in his comments emphasized to have a National Commission for Control of FMD. He elaborated that policy of zoning the country in case of RP control programme worked successfully and on a similar lines meticulous policy for FMD control is required. He further said that there are many issues at field level, management issues and social issues besides technical issues of vaccine development testing and standardization. We need to improve FMD vaccine at the same time effectively utilize the available killed virus vaccine. Countries like Mexico have irradicated FMD years ago using the same vaccine. A cost benefit analysis of FMD/HS combined vaccine needs to be done as they have been proven effective and can potentially

reduce vaccination visits to half. The major challenge in FMD is trans-boundary transmission across countries with poor disease control for that efforts at international level are required to be taken up by FAO/OIE. The response time of veterinarians and industry people is critical in containment of spread of disease after reporting. SOPs need to be developed for effective control in such situations. He opined that NIAH at Baghpat needs to be strengthened in all aspects of animal health rather than just the vaccine testing.

f. Technical Session V: Lumpy Skin Disease

Dr Manoj Kumar, representing Hester Biosciences Ltd. gave a brief background about the LSD virus, its 1st emergence in Odisha in the year 2019. Dr Kumar compared the mortality and morbidity pattern in livestock population during the outbreaks of 2019 and 2022. He informed that high morbidity and mortality in indigenous cattle were observed (leading to 1 lakh deaths) in the year 2022. He gave brief insight on the various homologues and heterologous LSD vaccine strains, their titers and doses. He also discussed about the 1st LSD guidelines issued by the GoI in the year 2019 and advisories released subsequently in the year 2021, July 2022 and in September 2022. He mentioned that DAHD guidelines on LSD recommends the vaccination of cattle and buffalo with goat pox vaccine (Uttarkashi strain). He further briefed, how Hester handles the goat pox virus vaccine demand and challenges in the vaccine supply, issues related to the safety of vaccine in pregnant animals, challenges of vaccinating multiple animals with same needle and discussed the lack of clarity on the use of virus titer and volume for vaccination. Dr Kumar emphasized a need to strengthen collaboration between the manufacturers, marketing people, sales services and R&D team and especially with industry-academia. He also discussed about the retrospective analysis of vaccine performance and prospective aspect of vaccine dose trial for production of neutralizing antibodies. He also highlighted placement of LSDV in biosafety level 3 category and requested the house to prepare a scientific guideline for allotment of biosafety level category.

Dr Naveen Kumar briefed on the LSD virus genome, circulating strains, introduction of virus in 2019, and current scenario of LSD in India in different animal species. He mentioned that Kenyan type LSD is prevailing in India, affecting 2 million animals and approximately 1 lakh deaths. He informed that the LSDV has also been isolated from camels and confirmed the presence of virus in skin nodule of horses and indicated that these animals might play a role in disease epidemiology. He also informed that LSD causes severe infection in cattle and mild infection in buffaloes. He further emphasized the

importance of developing homologous vaccine, as heterologous vaccine is less effective and imparts only a partial protection. He mentioned that research is in progress for developing a live attenuated homologous vaccine against LSD for use in bovine species. He shared his experimental results of homologous vaccine under trial (Lumpi-ProVacInd) and found it to be very safe with no side effect on animal health, milk yields and pregnancy except a mild inflammatory response at site of inoculation.

Dr JPS Gill asked whether buffaloes need to be vaccinated. There should be some policy for the inclusion or exclusion of buffaloes for vaccination and which dose is more effective for vaccination of bovines 3 ml or 1 ml. How this dose has been decided? Dr Naveen Kumar replied that the immune response has been observed in buffaloes but so far, no studies are available on this issue. The optimal dose of 3 ml has been optimized for use in bovines during outbreaks based on the doses used for goat and sheep. Dr Aniket Sanyal informed the house that homologous LSD vaccine has been developed, which is a good but there is a need to understand the transmission dynamics of LSD, its evolution and the efficacy of the vaccine. Dr BN Mishra (Brilliant Pharma) mentioned that people are getting sensitized to disease and their control. He appreciated the efforts of the Ministry to test the vaccine prior to its supply. The major difficulty he pointed as the testing of the vaccine immunogenicity and finding the seronegative animals. The animals in gaushala show a large variation in their immune status and many a times are less immune responsive. He proposed to have government farms maintaining animals for testing vaccines.

g. Technical Session VI: African Swine Fever

Dr NN Barman shared in detail his experience on African Swine Fever in the North Eastern Region. He presented an update on emergence of ASF in NE states, its history, susceptible hosts, structural properties of complex ASF virus, mode of infection in pigs, patho-mechanism, molecular characterization and temporal-spatial distribution. Movement of animals and animal products was identified as the primary reason of virus spread. He proposed several recommendations for the control of ASF in India.

Dr Rajukumar K briefed about the ASFV, its genomic properties, historical spread & distribution. He presented the institutional contribution towards preparedness for diagnostic vigilance, ASF diagnosis, its genetic characterization and complete genome analysis. The current control strategies and challenges involved were discussed. He suggested close coordination among pig owners, field veterinarians and lab services and need for rapid and reliable diagnosis, and proper disposal of samples. Dr Rajukumar pointed out the non-

availability of commercial vaccines and suggested newer approaches involving sub-unit vaccines and engineered live attenuated vaccines. He stated that there is a need to maximize vaccine safety without compromising immunogenicity. He also presented the national action plan and the challenges involved in its implementation. He suggested that there is a need for prevention and control based on early detection and strict and methodical implementation of sanitary and biosecurity measures based on National Action Plan for the control of ASF in India.

Dr YPS Malik raised concern on non-availability of vaccine. Dr. Barman stated that due to involvement of many proteins the immunological component has not been identified yet. Further, Dr Malik inquired that whether all the isolates from different regions are sequenced. Dr Rajukumar stated that WGS is yet to be carried out for all the states. However, Dr Barman stated that since 2020, they have not recorded any mutation. Dr Barman stated that same approach as that for SARS_CoV2 needs to be adopted to control ASF. Dr Oberoi concluded the session by his recommendations that there is need for detailed contingency and risk communication plans.

Overall, the experts agreed that emerging infectious diseases (EIDs) are a serious threat to livestock production in India. The ongoing Coronavirus disease 2019 (COVID–19) pandemic has demonstrated that EIDs have substantial potential to undermine the global economy. Resource poor countries or those living under poverty are most vulnerable and victims of these EID outbreak events. Multiple factors such as climate change, human and livestock movements and deforestation have substantially enhanced the threat and epidemic potential of novel pathogens. The country is predicted to be a hotspot for disease emergence. Recently, it has been reported that climate change is likely to increase the risk of introduction of novel species-jumping pathogens in India. In the past decade, many novel transboundary and emerging animal diseases have been reported in India. During 2011-2020, a total of 2226 foot and mouth disease (FMD) outbreaks have been recorded in both domestic livestock and wildlife in India. In 2019, the lumpy skin disease (LSD) was introduced and the first disease outbreak was reported from Odisha. Within three years of its entry, the LSDV has spread across most of the country. African swine fever has emerged as a serious threat to pork production in India.

6. List of Panel Experts

NAVS Officials

1. Dr DVR Prakash Rao, President NAVS, & Chairman and MD, Prakash Food & Feed Mills (P) Ltd, Chennai
2. Dr AC Varshney, Vice-President NAVS & Ex-VC, DUVASU
3. Maj Gen ML Sharma, Secretary NAVS, India (online)
4. Maj Gen Shrikant Sharma, Ex-President NAVS, Ex-Vice-chancellor LUVAS (online)
5. Dr. MP Yadav, Executive Member, NAVS, Ex-Director IVRI (Online)
6. Dr Nem Singh, Executive Member, NAVS & Ex-JD Research, ICAR-IVRI
7. Dr Ravindra Sharma, Executive Member, NAVS & Former Director Research, LUVAS
8. Dr VK Gupta, Executive Member, NAVS, CSK HPKVV, Palampur

Dept. of Animal Husbandry – Govt. of India and States

9. Sh SK Gulati, Ex-Secretary Animal Husbandry, Govt of Haryana
10. Dr Ajit Singh Yadav, Director, CCS National Institute of Animal Health, Baghpat, U.P.
11. Dr OP Chhikara, Former Director General, Dept. of Animal Husbandry, Haryana
12. Dr S Khosla, Former Director, Dept. of Animal Husbandry, Punjab
13. Dr Sireesha G, Deputy Director, Dept. of Animal Husbandry, Andhra Pradesh
14. Dr Anirban Guha, Assistant Commissioner (NADCP), DAHD, GOI, New Delhi
15. Dr Amit Nain, Member, Veterinary Council of India, and Veterinary officer, Fazilka
16. Dr Charanjeet Sarangal, Bacteriologist, NRDDL, Jalandhar, Punjab
17. Dr Anupma Kumari, Punjab Veterinary Vaccine Institute, Punjab

Industry & Farmers' Representatives

18. Dr Manoj, Chief Scientific Officer, Hester Biosciences Ltd., Ahmedabad, Gujarat
19. Dr T Bhattacharya, Brilliant Bio Pharma Pvt. Ltd. Hyderabad
20. Dr. BN Mishra, Brilliant Bio Pharma Pvt. Ltd. Hyderabad (Online)
21. Dr Srinivas Karnati, Indian Immunologicals Ltd, Hyderabad
22. Dr Nitin Bhatia, Intas Animal Health, Ahmedabad (online)
23. Sh. Daljit Singh, President, Progressive Dairy Farmers Association
24. Sh. Sandeep Singh Randhawa, President, Progressive Livestock Farmers Association
25. Sh. Bikramjeet Singh, Representative, Pig Farmers Association
26. Sh. Kunal Sharma, Representative, Pig Farmers Association
27. Sh. Harkeerat Singh, Representative, Pig Farmers Association

ICAR and Other Research Institutes

28. Dr RK Singh, Ex-Director, ICAR-IVRI, Izatnagar
29. Dr Abhijit Mitra, Director, ICAR-Central Institute for Research on Cattle, Meerut

30. Dr Aniket Sanyal, Director, ICAR-NIHSAD, Bhopal (online)
31. Dr RP Singh, Director, ICAR -Directorate of FMD, Argul, Jatni, Odisha
32. Dr JK Biswal, ICAR-International Center for Foot and Mouth Disease (ICFMD)
33. Dr Sharvan Sehrawat, Biological Sciences, IISER, SAS Nagar
34. Dr NN Barman Professor & Head, Dept. of Veterinary Microbiology, Khanapara
35. Dr NK Kakker, Former Head, Dept. of Vet. Microbiology, LUVAS
36. Dr Naveen Kumar, Principal Scientist, ICAR-NRC- Equines

GADVASU, Ludhiana Faculty

37. Dr Inderjeet Singh, Vice-chancellor
38. Dr JPS Gill, Director Research
39. Dr. PS Brar, Director Extension Education
40. Dr Yashpal Singh Malik, Dean, College of Animal Biotechnology
41. Dr MS Oberoi, Former Dean & FAO Expert, College of Vet. Sci., Ludhiana
42. Dr RS Sethi, Additional Director Research
43. Dr VK Dumka, Coordinator Research
44. Dr SS Randhawa, Director, Teaching Veterinary Clinical Complex
45. Dr Deepti Narang, Prof & Head, Dept of Vet. Microbiology
46. Dr Paviter Kaur, Dept of Vet. Microbiology
47. Dr Gurpreet Kaur, Dept. of Vet. Microbiology
48. Dr Mousumi Bora, Dept. of Vet. Microbiology
49. Dr BBS Dhaliwal, College of Animal Biotechnology
50. Dr Rattan Choudhary, College of Animal Biotechnology
51. Dr Neeraj Kashyap, College of Animal Biotechnology
52. Dr BV Sunil Kumar, College of Animal Biotechnology
53. Dr Satparkash Singh, College of Animal Biotechnology
54. Dr JS Bedi, Director, Centre for One Health
55. Dr Simranpreet Kaur, Centre for One Health
56. Dr Rajnish Sharma, Centre for One Health
57. Dr Deepali, Centre for One Health
58. Dr Vishal Mahajan, Animal Disease Research Centre
59. Dr Taniya Gupta, Animal Disease Research Centre
60. Dr Jaswinder Singh, Veterinary Animal Husbandry Extension Education
61. Dr Harpreet Singh, Public Relation Officer

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ISBN 978-8119072-31-6

NATIONAL ACADEMY OF VETERINARY SCIENCES (INDIA)
&
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LUDHIANA, PUNJAB

Printed By:
KANAV PRINTERS: 99153-51058