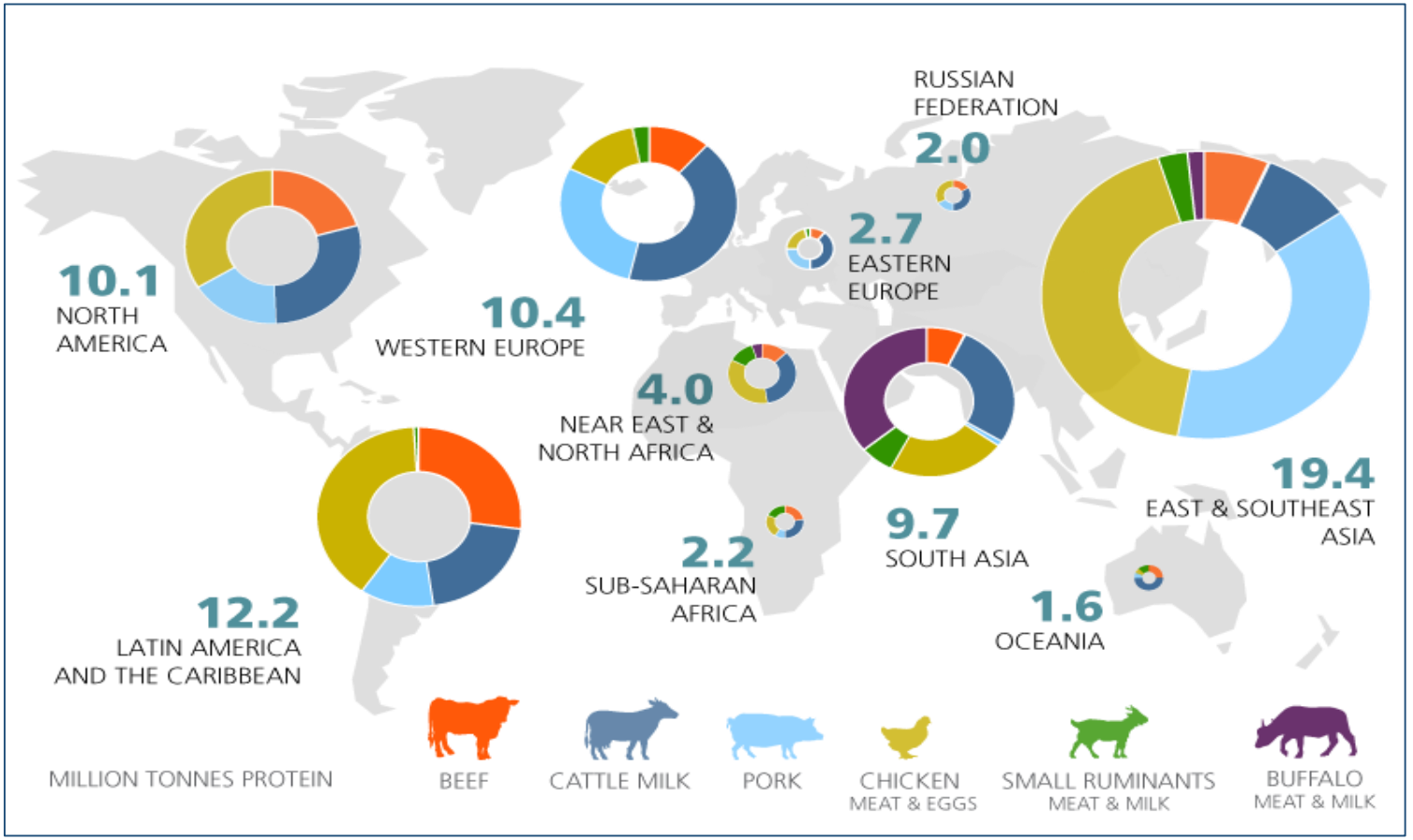
Emerging biotic stresses affecting crops and animals and their management under drylands

Dr. N. Bakthavatsalam, Director
ICAR-National Bureau of Agricultural Insect Resources, Bengaluru
Dr. V. P. Singh, Director
ICAR-National Institute of High Security Animal Diseases, Bhopal
Indian Council of Agricultural Research
Ministry of Agriculture and Farmers Welfare
New Delhi (India)



(FAO, http://www.fao.org/gleam/results/en/#c300947)

- Dryland crops cultivated in 68% of cultivated area and supports 40% of human and contributes 44% of food requirement
- Livestock production represents 40% of the world agricultural production.
- Contributes to the livelihoods and the food security of nearly 1.7 billion people around the world (www.fao.org).
- The sustained improvement of incomes and rapid urbanization during the last three decades in parallel to a population growth have prompted a higher demand on meat and other animal products particularly in developing countries.

Biotic Stress

- Stress is an intrinsic part of life, and successfully adapting to stimuli that induce stress is essential for the survival of dryland crops and farm animals kept in a complex and ever-changing environment.
- Crops and Farm animals experience various stressors in their lives which include
  - Abiotic - non-living factors
  - Biotic - caused by other living organisms, such as weeds, arthropod pests (insects including animal parasites mites), bacteria, viruses, fungi, other pathogens etc.
- Emerging biotic stressors: are emergence of new pathogens, invasive insects, new intermediate hosts, changed epidemiological patterns, high potential of emergence of vector borne pathogens etc.,

Priority diseases to be monitored and tracked

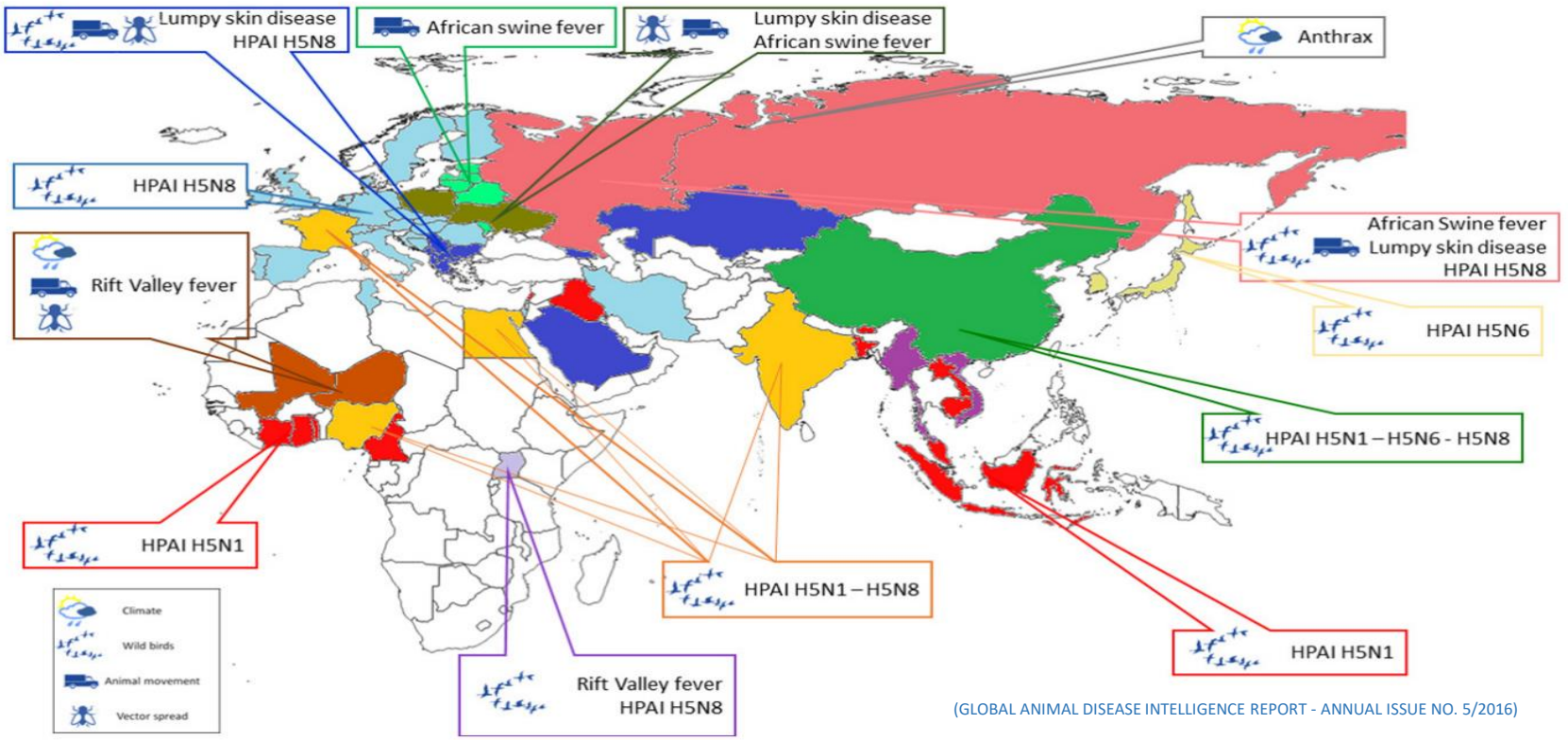
Rift Valley Fever
Unknown disease
African Swine Fever
Lumpy Skin Disease
Peste des Petits Ruminants
Foot-and-Mouth Disease
Avian influenza
Middle East Respiratory Syndrome Coronavirus Virus
any new emerging disease event (e.g. Ebola in a new affected country)

Source: 2019 EIOS Global Technical Meeting 12-14 November 2019, Seoul, Republic of Korea

Economically important pests and diseases of crops

- In drylands the yield loss is 8% millets, 15% in pulses and 20% in oil seed crops
- Weeds are major cause for reduction in yields in dryland crops
- Date Palm is one of most important tree crops of the kingdom. Severely infested with the Red Palm Weevil. Red ring disease caused by a nematode, *Bursaphelenchus cocophilus*, is another serious threat to date and other palms
- In greenhouses - spider tes, whiteflies, thrips, aphids, nematodes and leafminers.
- outdoor vegetables suffer from infestations by root flies, aphids, Lepidopteran caterpillars, nematodes, beetles, thrips.
- The most severe disease problems in vegetables are caused by air-, seed- and soil borne fungal pathogens, bacteria, virus and nematodes.
- Potato, wheat, sorghum barley, cucumber, eggplant, onion, date palm citrus etc are serially infected with several species of nematodes
- Invasive insects such as tomato pin worm, fruit flies and other sucking pests pose serious threat to dryland crops
- Storage insects such as *Sitophilus oryzae Rhyzopertha dominica* , *Callosobruchus chinensis Tribolium castaneum* , *Sitotroga cerealella* and *Corcyra cephalonica* cause heavy damage to the crops

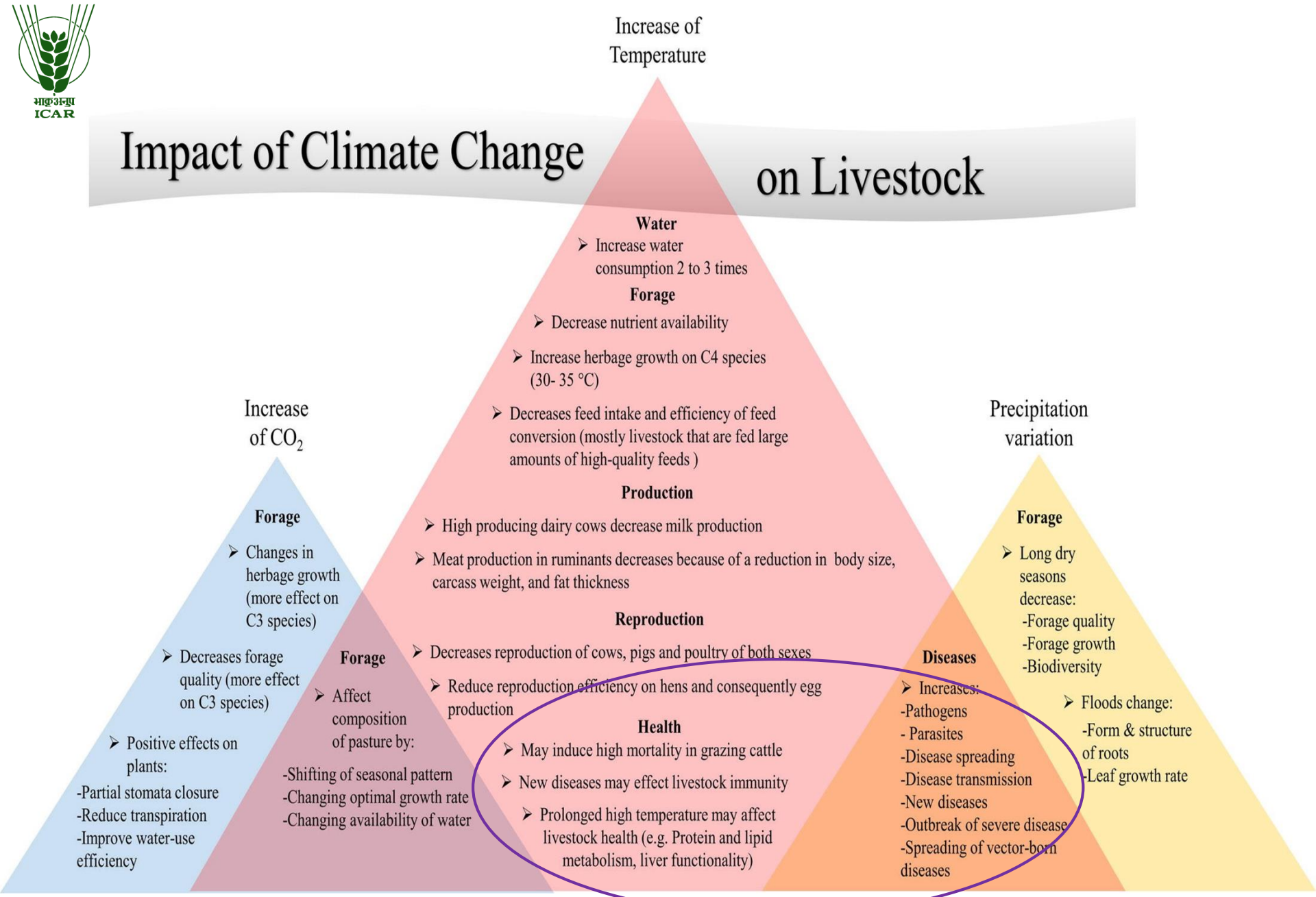
Important emerging infectious animal diseases



(GLOBAL ANIMAL DISEASE INTELLIGENCE REPORT - ANNUAL ISSUE NO. 5/2016)

- Animal diseases impacting economy -117 diseases (OIE, 2020) and 60% of human pathogens are of animal origin,
- Over 20% of animal production losses are linked to animal diseases,

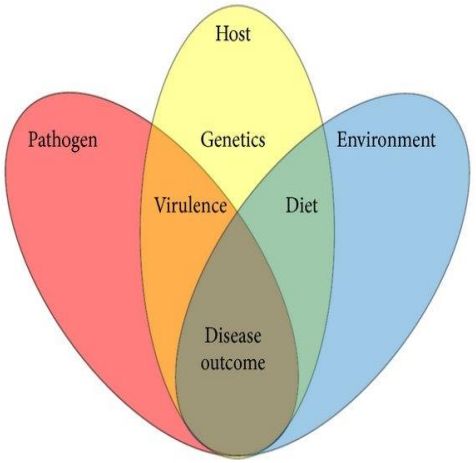
Impact of Climate Change on Livestock



Downing *et al.*, 2017

Impact of climate change on crop and animal health

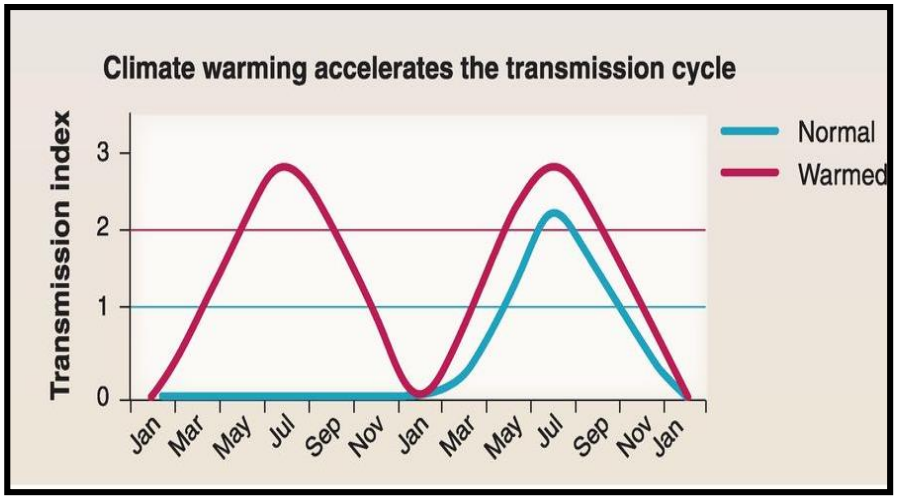
- Seasonal warming and increasing atmospheric [CO_2] alter pest fecundity and population dynamics, shifts in geographic or elevational ranges of pests, expression of plant resistance factors affecting pests, acceleration of pest resistance to pesticides and Bt (*Bacillus thuringiensis*) genetically engineered crops, changes to feeding behavior, phenology, and voltinism, and alterations to trophic interactions and biological control mechanisms
- In dry areas, global warming may increase the intensity of aridity changing the interaction pattern between host, pathogen and environment.
- Disease reproductive ratio (R0) of certain pathogens may be altered due to climate change.
- Among all animal pathogens, parasitic diseases will be of major concern due to the dependency on microclimatic variations (Morgan & Wall, 2009).

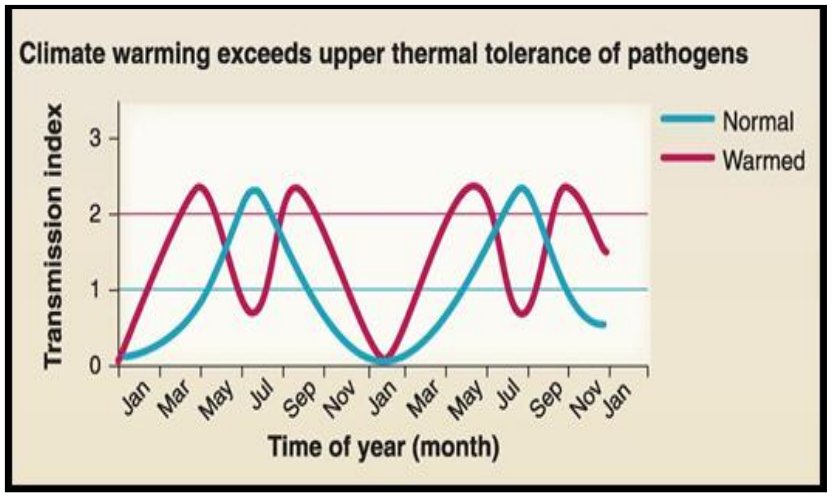


- The ticks species (*Hyalomma dromedarii*), which could survive in hot climatic conditions with limited host like camels are expected to increase their host range and area of distribution. Increased frequency, changed pattern of protozoal and helminthic diseases are anticipated in drylands.

Impact of climate change on animal health

- Emergence of vector borne pathogens viz. Arboviruses due to the effects of global warming has increased.
- Transmission of existing vector borne diseases like blue tongue virus and its distribution in new geographical regions is expected to increase.
- Environmental stresses due to climate change will affect the innate and acquired immunity of livestock to pathogens (Sheldon & Verhulst, 1996), increases the host susceptibility to new pathogens.
- High host susceptibility also increases rapid spread of endemic diseases and emergence of new subtypes in arid regions.





Mitigation strategies

- Adoption of climate resilient agronomic practices like shifts in dates of sowing, use of climate resilient/drought tolerant crops/ use of intercrops and need based insecticide application to manage the crop pests.
- Strengthening disease surveillance system with special focus on vulnerable regions sharing international borders and hot spots of emergence of new disease outbreaks.
- Control and elimination of priority animal diseases.
- Promote research, innovation and technology in areas of animal health to enhance our ability to forecast the emergence of future threats and to develop disease resistant livestock breeds.
- Efficient animal husbandry management will ensure correct livestock nutrition and good health and welfare (reduced susceptibility to parasitism and infectious disease).
- Early warning systems and improved climate information can help farmers to take appropriate actions in a timely manner depending on expected weather conditions.
- Development of Market-based risk management mechanisms.
- One Health approaches to disease control – involving multiple stakeholders viz., Human health, veterinary, wildlife and environmental health sectors.

➢ **Change in farming practices**

- Mixed livestock farming - sheep, goat, cattle, poultry and camel - reducing the damage caused by disease outbreaks which may affect particular species, minimize multiple risks.

➢ **Livestock migration as coping strategy**

- In the arid and semi-arid regions of India, an important traditional survival strategy that has been developed by the people to cope with the seasonal changes through nomadic and transhumance systems.
- In India, it is estimated that about 30-40 % of the total small ruminant population is on the move annually.
- It allows humans and livestock to use the vast natural resources in a landscape without overexploiting specific sites.
- Dryland development policies should recognise and enable pastoral mobility as a strategy for climate change adaptation and sustainable land management.

➢ **Integration and strengthening of sustainable land-livestock system**

Approaches to alleviate the biotic stress

❖**National level Disease forecasting system.**

- Weather based animal disease forecast - will facilitate the demarcation of disease specific eco-pathozones of the country based on the high, medium and low disease frequencies observed over the long period.

❖**National level disease monitoring and surveillance of important livestock diseases.**

- Web based National Animal Disease Referral Expert System (NADRES) for disease reporting for field veterinarians, administrators, technocrats, research personnel, farmers, veterinary colleges and students.
- Diagnostic preparedness, outbreak investigation and control strategies for exotic and emerging animal diseases including vector borne diseases like Rift valley fever, Nairobi sheep disease, African swine fever, Crimean Congo Haemorrhagic Fever etc.
- Multi-site research projects on important animal diseases such as Bluetongue, gastro intestinal parasites, ectoparasites considering the threats due to climate change.

❖**Genetic improvement/development of disease resistant breeds**

❖**Policy level decisions to encourage climate smart livestock farming systems.**

Pest Management practices in dryland crops

- Pesticidal management is the common practice in the management of weeds, insects and plant diseases.
- Varieties of date palms evaluated ‘Ghasb’ tolerant to lesser date moth, ‘Mastrig Wad Laggi’ tolerant to green pit scale, varieties and with more calcium are less preferred by Red palm weevil. Varieties Khasab and Shahal exhibited non-preference by RPW.
- Semiochemicals used for red palm weevil and lesser date moth for mass trapping and attract and infect with microbial insecticides. New technology HOOK-RPW very advantageous
- Microbials insecticides Bacillus thuringiensis was found effective in managing lesser date moth
- Predatory mites and trichogramma were attempted. But issues like mass production and field establishment persists

Strengths of ICAR in managing crop and animal biotic stresses in dryland

- Insect biosystematics, non-pesticidal approaches for the management of insect pests, diseases and nematodes including mass rearing technologies for parasitoids, predators, microbial pathogens and entomopathogens.
- Pheromone, parapheromone and including soft dispensers technologies for monitoring, mass trapping and mating disruption of agricultural insect pests
- Invasive arthropod pest surveillance and management
- Several non-pesticidal pest management technologies developed can be shared https://www.nbair.res.in/ITMU/technologies.php
- Diagnostics and vaccines development for animal health, cross breeding among heat tolerant live stock breeds of different arid regions
- Developing forecasting models, epidemiological monitoring of emergence of new diseases/vectors under one health approach.

Areas of collaborations

- Biosystematic studies using traditional morphological and modern molecular tools for several groups of insects
- Mass rearing technologies of pest spp. , parasitoids (*Trichogramma*, *Bracon* etc.) Predators (Chrysopids, Coccinellids etc.),
- Microbial production and formulation technologies (Bacterial, entomofungal, viral pathogens and Entomopathogenic nematodes)
- Biopesticides (botanical formulations, pheromones, parapheromones)
- Training and Education on insect biosystematics, non-pesticidal approaches along with sharing technologies, Biosafety & biosecurity measures in handling animal diseases.

Areas of collaborations

- Pooling of resources, sharing of knowledge, diagnostics and vaccines will help in tackling the effects of climate change on animal health.
- Cross breeding among heat tolerant crop varieties live stock breeds of different arid regions and adaptability.
- Collaboration in developing forecasting models, epidemiological monitoring of emergence of new diseases/vectors under one health approach.
- Strengthening global networks, infrastructures and tools to prevent, prepare and respond to animal health-related emergencies triggered by climate change.
- Advisories/policy decisions will be taken in a collaborative mode for better implementation of mitigation strategies.


Thank You