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# Application of Artificial Intelligence

## for livestock disease prediction

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*Diseases have emerged as a major constraint to the sustainable growth of the national economy. Several diseases have reduced the productivity of the livestock and have slowed the growth of the sector. Many diseases are linked to environmental deterioration and stress associated with farm intensification. According to the epidemiological triad, for a disease to occur it is the environment which helps the pathogen/vector to move towards the susceptible host. Thus based on the environmental parameters of the particular area early recognition of a serious or exotic animal disease can be done which is one of the most important factors influencing the chance of controlling the disease and reducing its economic and social impact on the whole country.*

**Key words:** Artificial intelligence, Disease outbreak prediction, Livestock

PREDICTING the occurrence of livestock disease outbreaks can be of considerable value to the long-term sustainable development in India. Prior research on disease prediction has essentially depended upon traditional statistical models with varying degrees of prediction accuracy. Furthermore, the application of these models in sustainable development and in controlling environmental deterioration has been very limited. The geographic and seasonal distribution of many infectious diseases are associated with climate and therefore the possibility of using seasonal climate forecasts as predictive indicators in disease early warning system (EWS) is an interest of focus. Geographic Information system (GIS), remote sensing (RS) and Global Positioning system (GPS) are the three commonly used veterinary geo-informatics technologies employed in this digital era for rapid communication of data for better management of animal diseases. Early recognition of a serious or exotic animal disease can be done which is one of the most important factors influencing the chance of controlling the disease and reducing its economic and social impact on the whole country.

In an attempt to look for a more reliable model, we developed a disease-climate relationship models using artificial intelligence and GIS to predict 13 economically important livestock disease outbreaks in India.

Often conflated with Artificial Intelligence, machine learning is a subfield and one application of AI. In practical terms, machine learning is a method for automating data analysis by using algorithms that iteratively identify patterns in data and learn from them. Machine learning applications are generally classified into three broad categories: (1) supervised learning, (2) unsupervised learning and (3) reinforcement learning. Supervised learning uses patterns already identified in data (ie, training data). Data mining is related to unsupervised machine learning and involves identifying patterns in large datasets.

### Disease outbreaks prediction

Combining Artificial Intelligence techniques and copious amounts of livestock disease data provide new opportunities around the animal healthcare sector.

Disease outbreaks data collected from 31 AICRP centres is stored and maintained in NADRES v2 (National Animal Disease Referral Expert System version 2) (Fig. 1 and 2) database since year 1987. The risk factors data consisting of environmental variables such as precipitation, soil moisture, potential evaporation, wind speed, temperature, specific humidity, surface pressure were retrieved from GES DISC "GLDAS_NOAH025_M.2.1" dataset and remote sensing variables such as NDVI, LST (MODIS data product).

The HDF files for LST (°C), NDVI were downloaded from the MODIS website using the MOD11A2 and MOD13A1 products respectively by specifying the coordinates and time period (dates). The Livestock population data was derived from 19th livestock census 2012, Department of Animal husbandry, dairying and Fisheries, Krishi Bhavan , New Delhi.

The risk data generated at village level were aggregated to block level

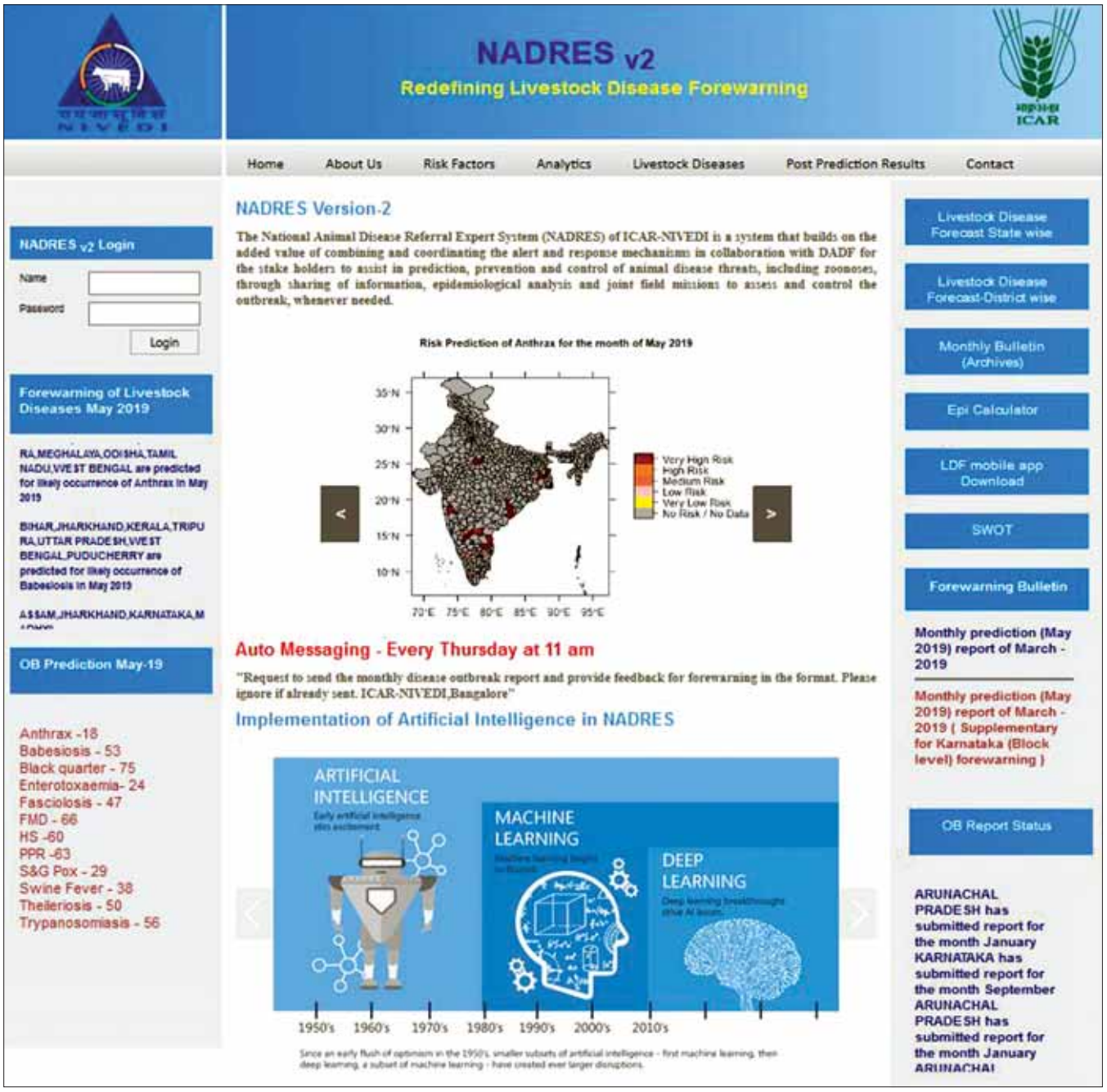


Fig. 1. Preview of NADRES home page

and month for suitable representation. Disease outbreak data were aligned with generated risk variables to the respective latitude and longitude, which were subjected to climate-disease modelling. A number of models were fit to aligned data and tested for accuracy in terms of discrimination power. Two regression models, Generalized Linear Models (GLM) and Generalized Additive Models (GAM) and six machine learning algorithms, i.e. Random Forest (RF), Boosted Regression Tree (BRT), Artificial Neural Network (ANN), Multiple Adaptive Regression Spline (MARS), Flexible Discriminant Analysis (FDA) and Classification Tree Analysis (CTA) were employed for disease modelling. Different modelling methods return different types of 'model object' and all these model objects could be used for the predict function to make predictions for any combinations of values of independent variables. Response plots were created to explore and understand model predictions. Anthrax outbreak on livestock is forcasted for the month of April 2019 in Karnataka, as shown in Fig. 1.

The fitted models were assessed for their discriminating power using Receiving Operating Characteristic (ROC) curve, Cohen's Kappa (Heildke Skill Score) and True Skill Statistics (TSS). These measures were used to evaluate the quality of predictions based on presence-absence data. Raster Stack was used to combine the results of individual predictions by different model methods. All the models were assessed for overfitting because it can cause misleading of estimated co-efficient, p values and R-Squares values. Overfitting is suspect when the model accuracy is high with respect to the data used in training the model but drops significantly with new data. In

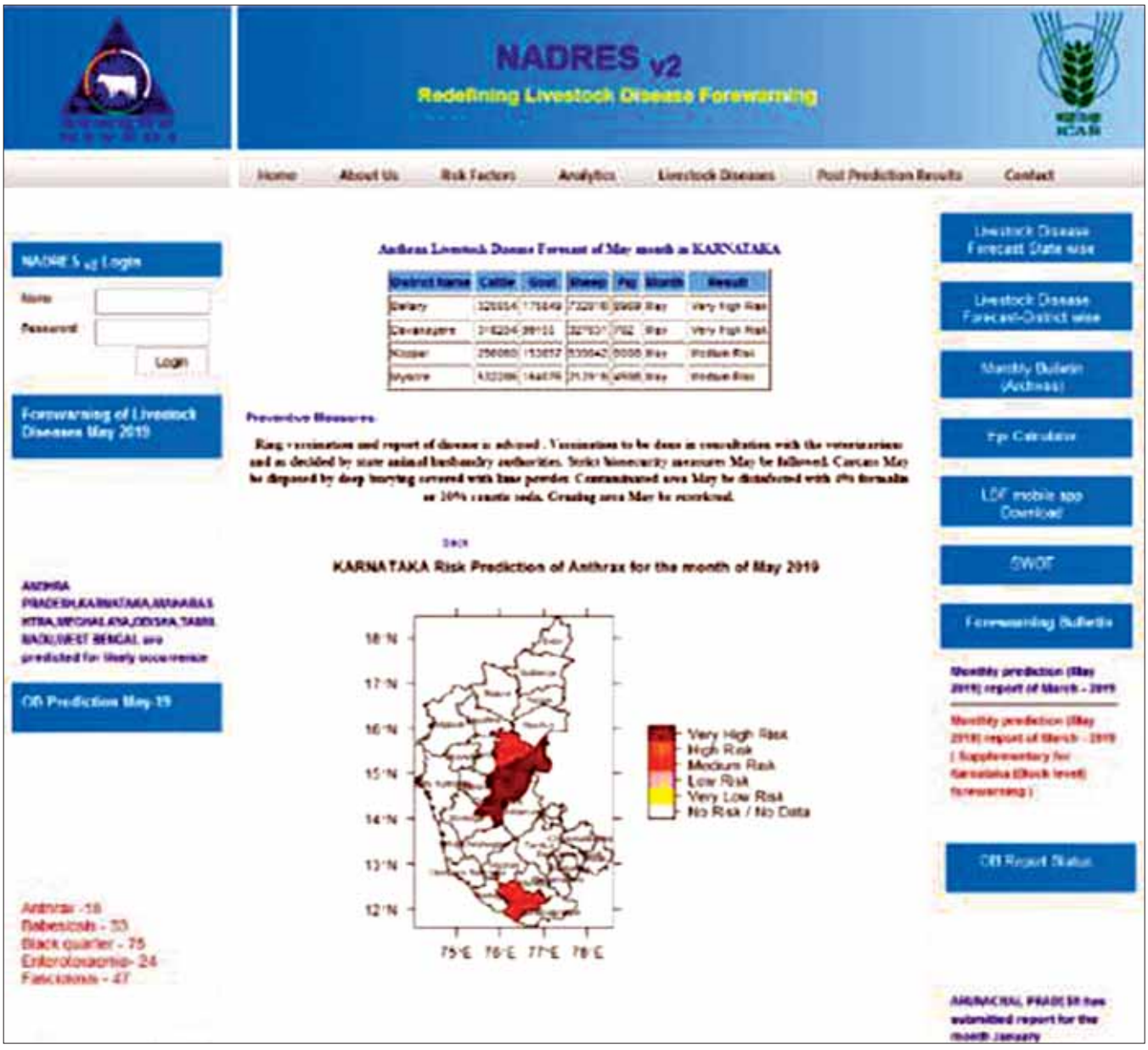


Fig. 2. Disease prediction view of NADRES v2

this study, the cross-validation procedure was adopted to assess the overfitting of models by keeping 30% data on hold while, the rest was used for training. The accuracy of held out data was used to compare the accuracy derived from data used in the training and the significant variance in these two flags overfitting.

The outcome of best fitted model/s were in probability of disease occurrence and was categorised into 6 risk levels-No risk (NR), Very low risk (VLR), Low risk (LR), Moderate risk (MR), High risk (HR) and Very high risk (VHR). The results forewarning were sent to all the state animal husbandry departs and DADF for taking preventive measures in advance to avoid the occurrence of disease incidence. The Forewarning results are generated at block level for 4 economically important diseases in Karnataka state as pilot mode were communicated to 2,000 veterinary officers via auto-messaging (Fig. 1). The results are also available in website (http://www.nivedi.res.in/Nadres_v2/) and mobile app developed for the purpose provide the similar features.

## NADRES v2 Outlook

NADRES v2 an interactive and dynamic web applications built using HTML and PHP software as front-end tool and MySQL as back-end tool. The applications provides forewarning of disease occurrence in two months advance for all the 700 districts for 13 important livestock diseases in Pan India. Application has been optimized by making it easy to navigate, so that users stay on and engage on content (Figs. 1 and 2). This web application provides several other features such as analysis results of disease pattern in each state, disease maps, distribution of livestock population, impact analysis etc. Epi calculator for developing sampling plan was incorporated in the application. All the results in the application is dynamic and automated.

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