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Machine learning models for predicting the use of different animal breeding services in smallholder dairy farms in Sub-Saharan Africa

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Abstract

This study is concerned with developing predictive models using machine learning techniques to be used in identifying factors that influence farmers' decisions, predict farmers' decisions, and forecast farmers' demands relating to breeding service. The data used to develop the models comes from a survey of small-scale dairy farmers from Tanzania (n = 3500 farmers), Kenya (n = 6190 farmers), Ethiopia (n = 4920 farmers), and Uganda (n = 5390 farmers) and more than 120 variables were identified to influence breeding decisions. Feature engineering process was used to reduce the number of variables to a practical level and to identify the most influential ones. Three algorithms were used for feature selection, namely: logistic regression, random forest, and Boruta. Subsequently, six predictive models, using features selected by feature selection method, were tested for each country—neural network, logistic regression, K-nearest neighbor, decision tree, random forest, and Gaussian mixture model. A combination of decision tree and random forest algorithms was used to develop the final models. Each country model showed high predictive power (up to 93%) and are ready for practical use. The use of ML techniques assisted in identifying the key factors that influence the adoption of breeding method that can be taken and prioritized to improve the dairy sector among countries. Moreover, it provided various alternatives for policymakers to compare the consequences of different courses of action which can assist in determining which alternative at any particular choice point had a high probability to succeed, given the information and alternatives pertinent to the breeding decision. Also, through the use of ML, results to the identification of different clusters of farmers, who were classified based on their farm, and farmers' characteristics, i.e., farm location, feeding system, animal husbandry practices, etc. This information had significant value to decision-makers in finding the appropriate intervention for a particular cluster of farmers. In the future, such predictive models will assist decision-makers in planning and managing resources by allocating breeding services and capabilities where they would be most in demand.

Keywords

Breeding service; Dairy; Livestock; Machine learning; Predictive models