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calculated indirectly and five are currently not digitized. For the calculation of greenhouse gas emissions from livestock (beef cattle and dairy cattle) 43 different input data are required: 26 are already directly readable via digital sources, two have to be calculated indirectly via several input data and 15 are not yet available automatically.

This thesis explains that it is possible to calculate greenhouse gas emissions in agriculture using digital sources. For some of the required values, however, literature values must be used. In order to further advance research in this area, it is recommended to examine the perspective of farmers regarding automated greenhouse gas calculation and to compare automatically calculated greenhouse gas values with average values.

Comparing the Artificial Neural Networks and Multi Linear Regression Models to Predict the Energy Output of Fruit Production

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Several researchers have used Multi Linear Regressions (MLR) or Multi-Layer Perceptron (MLP) artificial neural networks to model the energy audit of agricultural production. A literature review showed that no previous analytical work has been reported on the comparison of MLR and ANN models to predict the energy output of fruit production. Therefore, the main goal of this research is to compare the MLR with MLP artificial neural networks modeling and select the best one to predict the energy output of peach production in Iran. For this purpose, the same data were used to train the MLR and MLP models and thus, 60, 70, 80 and 90% of data were selected to train the models. Levenberg–Marquardt learning algorithm was employed to train ANNs models. The results showed that 3.41 MJ of energy was consumed to produce one kilogram of peach in Iran. The application of the models highlighted that the differences between the actual and predicted values for the two models were not statistically significant. The performance indices such as coefficient of determination (R2), Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), and Efficiency (EF) for the best ANN architecture were determined to be 0.96, 2297.75 kg, 11.79% and 0.96%, respectively. While, these indices for the best MLR model were 0.91, 3418.27 kg, 14.80% and 0.91%, respectively. Overall, it was concluded that the MLP models could better predict the energy output than those of MLR models and the performance of MLP highlighted that this model can be applicable to prognosticate the energy output of peach production.

Integration of Principal Component Analysis and Artificial Neural Networks to Better Predict Agricultural Energy Flows

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There are some studies regarding the prediction of agricultural energy flows using Artificial Neural Networks (ANNs). These models are quite sensitive to correlations amongst inputs. And, there are often strong correlations amongst energy inputs for agricultural systems. One potential method to remediate this problem is to use Principal Component Analysis (PCA). Therefore, the purpose of this research was to predict energy flows for an example agricultural system (Iranian tea production) via a novel methodology based on ANNs, using principal components as model inputs, not raw data. PCA results showed that the first and second components could account for more than 99% of variation in the data, thus the dimensions of the data set could be decreased from six to two for the prediction of energy flows for Iranian tea production. Using these principal components as inputs, an ANN model with 2-15-1 structure was determined to be optimal for energy flow modeling of this system. Results from this optimal model demonstrated that the difference between actual and predicted amounts of energy was not significant at the 1.0% level. Ultimately, these results indicate that a PC+ANN model could be used to reliably predict this agricultural system. To conclude, the results of this study highlighted that the use of PC as ANN inputs improved ANN model prediction through reducing its complexity and eliminating data colinearity. Many agricultural systems could benefit from using this methodology for modeling.

Development of In-House Lattice-Boltzmann Simulator of Anaerobic Bioreactors for Vinasse Treatment: Preliminary Dimensionless Modelling and Sensitivity Analysis

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Sugarcane vinasse is a by-product from the ethanol industry whose large-scale exploitation has long pointed to ferti-irrigation in sugarcane crops after it undergoes anaerobic treatment. Anaerobic packed bed reactor (APBR) comes forward as an attractive treatment system so as to preserve vinasse quality as bio-fertiliser while allowing energy to be recovered as biogas, thus mitigating greenhouse gas emission as well as groundwater contamination. Bearing in mind the computational modelling of APBR towards cost-effective and sustainable operation, an in-house numerical simulator has been developed via lattice Boltzmann method (LBM). Claimed as a promising method, LBM has the ability of numerically simulating transport phenomena, fluid flow and moving boundaries without solving Navier-Stokes equations. Inspired by the Anaerobic Digestion Model Number 1 from International Water Association, such in-house LBM simulator has initially relied on a time-dependent one-dimensional model in primitive variables. In view of supporting (while simplifying) prospective scale-up, this work aims at casting this preliminary model and LBM simulator in dimensionless form. Original model parameters (e.g. interstitial fluid velocity, species diffusivity, kinetic coefficients, and reactor length) were successfully lumped into fewer dimensionless parameters (e.g. mass-transfer Péclet and Damköhler numbers). Computationally implemented in D1Q2 lattice, the LBM simulator remained fully operational in dimensionless form. A sensitivity analysis indicated that gradients of dimensionless species concentrations were smoothed not only with respect to axial variation but also in terms of time variation in diffusion-dominant APBR operation.