Towards field specific phosphate applications norms with machine learning

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Efficient use of animal manure is an important link in the nutrient cycle in agricultural systems. On Dutch dairy farms, most manure is applied on grass and cropland, with maize as main crop. With the aim of balancing P input and output at field level, which is the idea behind the currently used, but rather fixed, legal manure application norms, predicting future yields could be a first step to move towards flexible application norms. Machine learning techniques might be useful to predict nutrient harvest more precisely than current norms, because they can be trained based on previous yields and other related variables, without modelling the detailed relationship. This study's objective is to predict future maize yields based on farm data and open source weather data. Data were available from a Dutch dairy research facility, containing 162 records of maize fields between 1996-2014 with information on N and P input and output, irrigation, and P status at field level as well as local weather data. Records covered 24 different fields, with on average 7 times maize in 19 years. Maize yields ranged from 13 to 36 kg P per ha with a mean of 22 kg P. Generalised boosted regression was used to predict maize yields for the years 2010-2014 in kg P per ha per year, for each year based on information from all previous years. By doing so, the model was validated on an independent dataset. Model performance was evaluated by computing the RMSE and the correlation coefficient, and compared to currently used rather fixed legal manure application norms. Results showed an RMSE of 4.6 kg P per ha per year and r was 0.37 for the model, whereas the current, rather fixed norm resulted in an RMSE of 4.9 kg P without a correlation to P yield. The positive correlation shows that the model, although to a minor extent, was able to show a trend in P yields with a somewhat lower RMSE compared to fixed norms. In conclusion, with the limited data available, prediction of P yield, and therewith, defining flexible P application norms for maize, is marginally better than current fixed application norms. This approach, therefore, will be explored further for, e.g., grassland, and for predicting animal manure production in order to replace these fixed norms as well.