Machine learning to realize phosphate equilibrium at field level in dairy farming

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100years
1918 — 2018

Nutrient cycle

Animal

Crops

Balance

Manure

Field

John Doe/Shutterstock.com
Petra Siebelink/Shutterstock.com

Current situation

Fixed phosphate application norms for crops / grassland (lowest class)

- For grass: 80 kg P_2O_5 (app. 35 kg P)
- For crops: 50 kg P_2O_5 (app. 22 kg P)

However, differences in P yield dependent on, e.g.:

- Field
- Crop
- Weather
- ……

Goal

To predict future P yields

based on field and weather data

using machine learning

before first manure application

Dataset from "KTC De Marke"

Years 1993 – 2016

640 records of yearly crop yields

26-28 fields per year

- 6 permanent grassland
- rotation: 3 grass, 2 maize, 1 cereal

Information on:

- N and P input and output
- Irrigation, P status of field
- Weather data (own weather station and open source)

Predicted variable

Crop yield, expressed in kg P per ha per year

Average yields:

grass 36 kg P (16 - 64)

maize 22 kg P (11 - 36)

cereals 28 kg P (18 - 43)

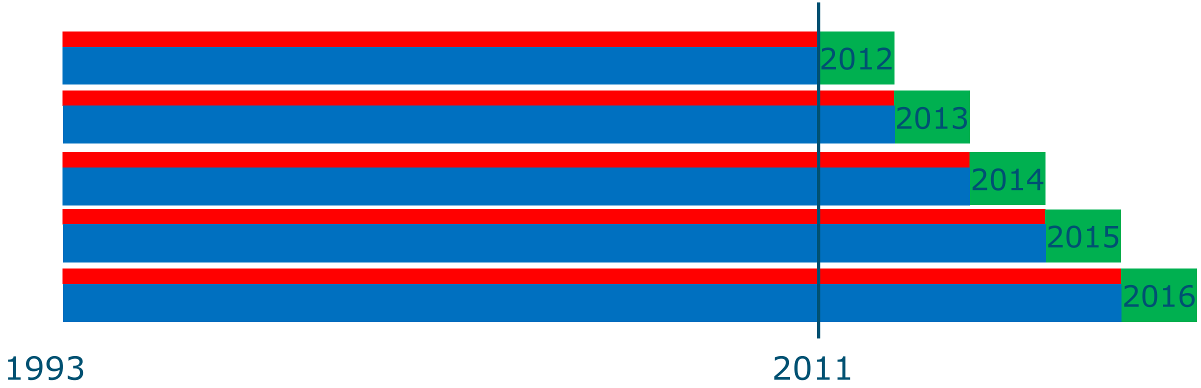
P application
norms:
grass 35
crops 22

Generalized boosted regression models

h2o.gbm package in R

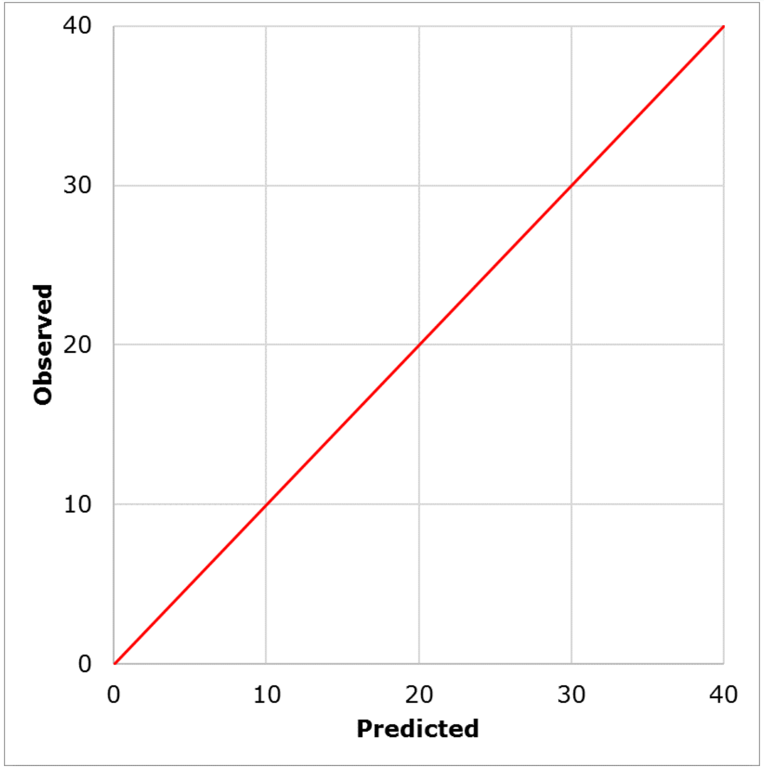
Validation

70% train, 30% test, 1 year validation



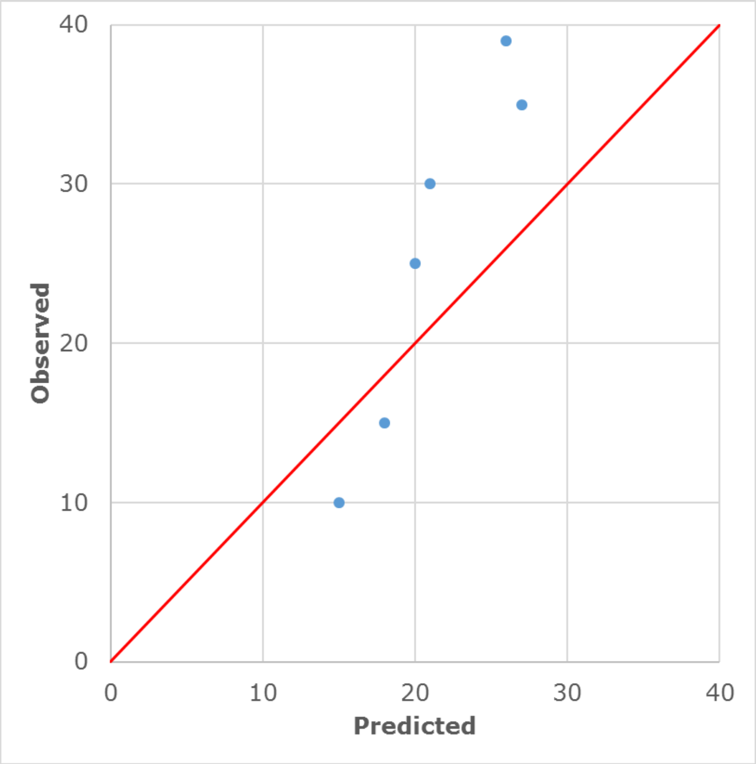
Final performance: 5 validation years combined

Performance criteria



Ideal situation: y = x

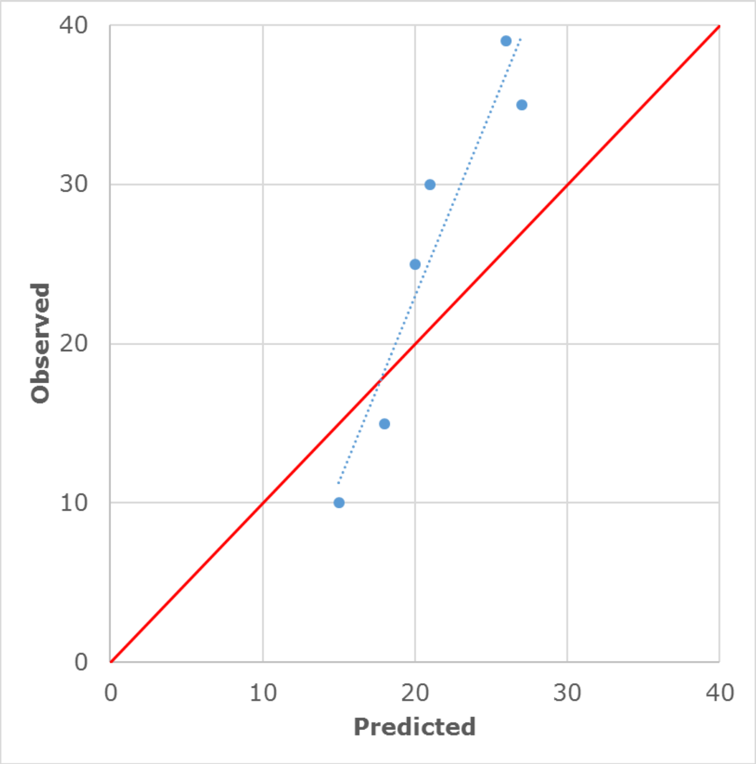
Performance criteria



RMSE – root mean squared error

Deviation from y=x

Performance criteria



RMSE root mean squared error

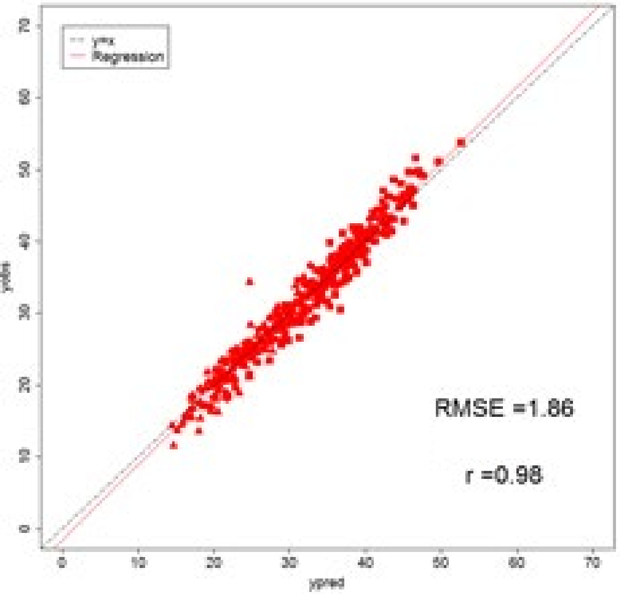
Deviation from y=x

r relative to linear fit

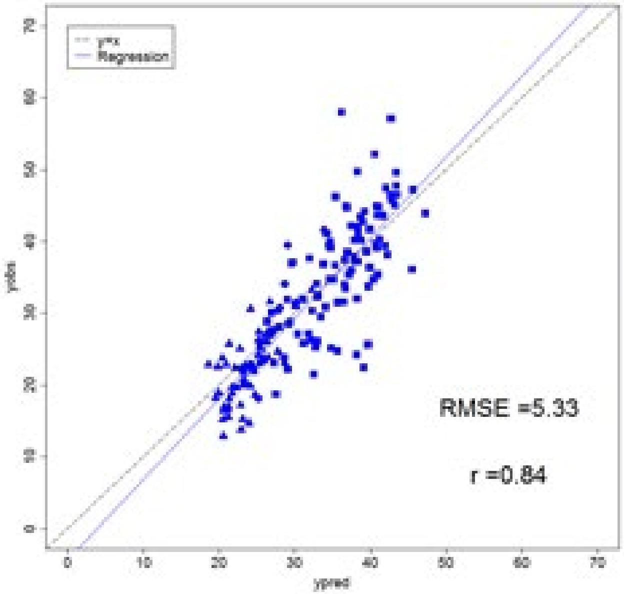
Trend

Pyield 2013 – Observed vs predicted

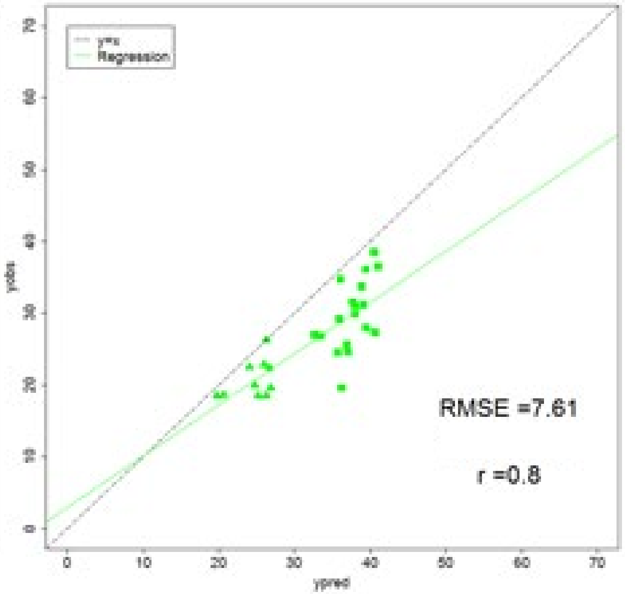
Train



Test

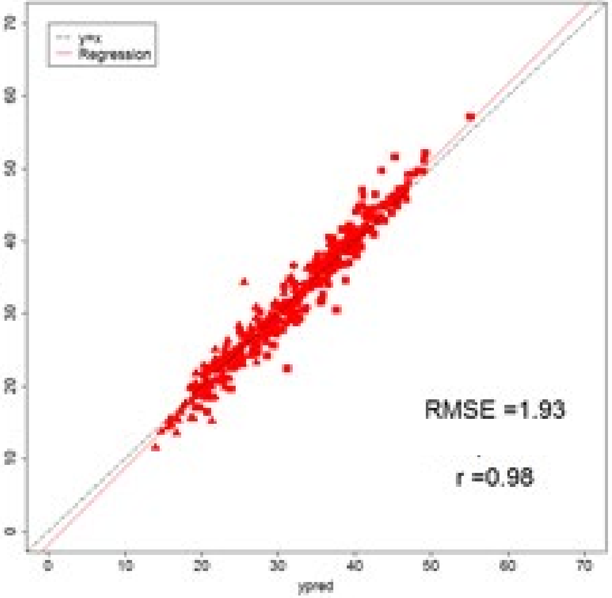


Validation

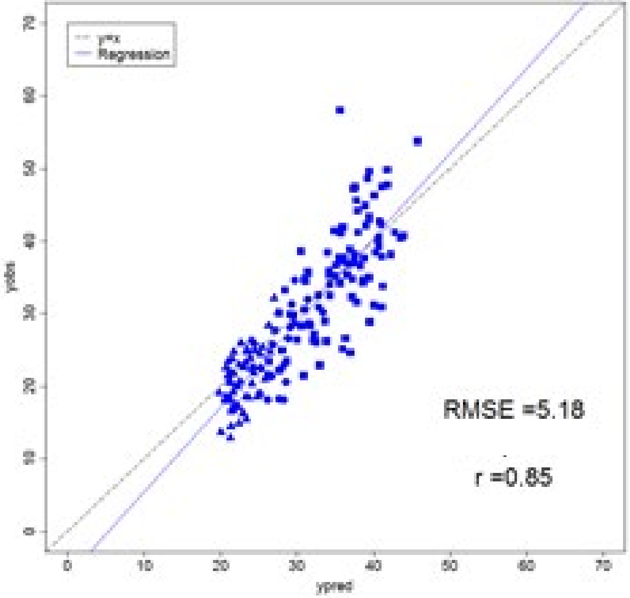


Pyield 2014 – Observed vs predicted

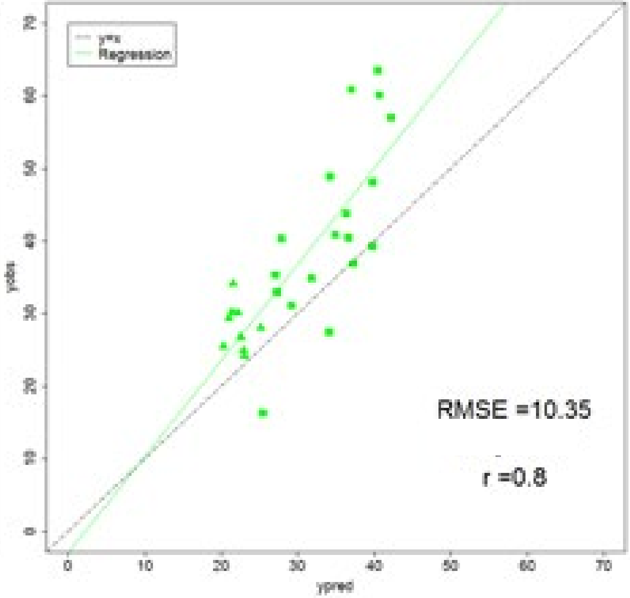
Train



Test



Validation



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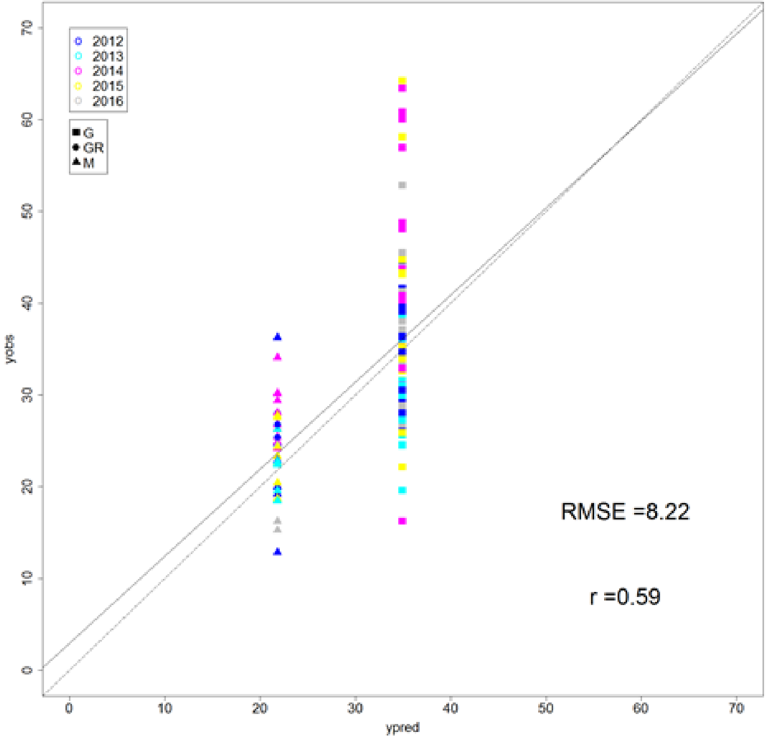
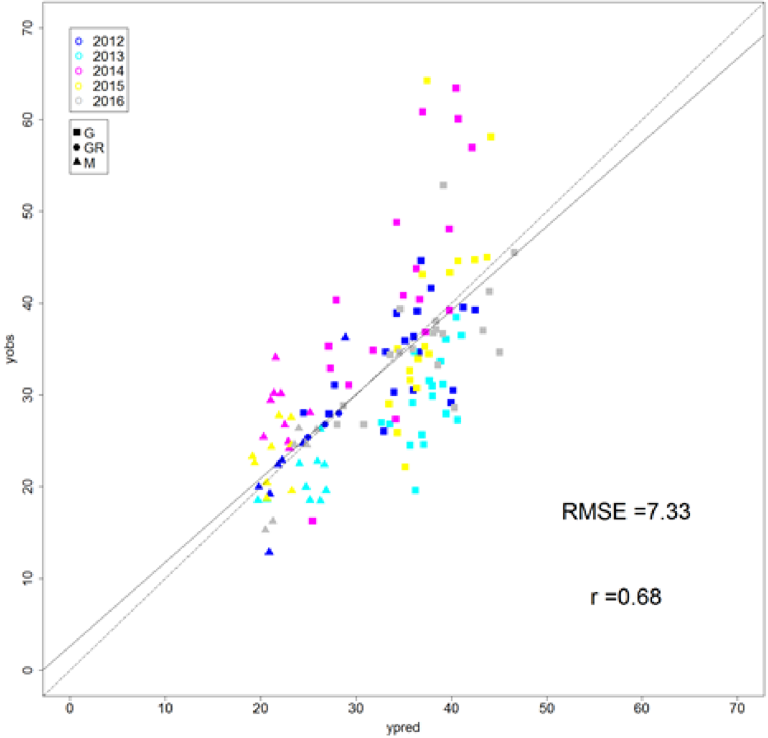
Norm vs model

Norm



Predicted (validation sets)



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Conclusions and recommendations

Machine learning is better in predicting levels of P yield than a generic norm (lower RMSE, higher r)

Multiple data sources were utilized to define flexible P application norms

To be further explored, e.g., by including proximal and remote sensing technologies and in-season prediction on several farms

Acknowledgements

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