Towards field specific phosphate application norms with machine learning

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100years
1918 — 2018

Nutrient cycle

Animal

Crops

Balance

Manure

Field

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100years 1918 — 2018

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Current situation

Fixed phosphate application norms for crops / grassland

- 3 classes, based on P status of field
- For crops: 50 / 60 / 75 kg P_2O_5 (app. 22 / 26 / 33 kg P)

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

- Field
- Crop
- Weather
- ……

Goal

To predict future maize yields

based on farm data and

open source weather data

Dataset from “KTC De Marke”

162 records of maize yields

24 different fields

Years 1996 – 2014

On average 7 times maize

Information on:

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

Predicted variable

Maize yield, expressed in kg P per ha per year

Average yield: 22 kg P (13 - 36)

Generalized boosted regression models

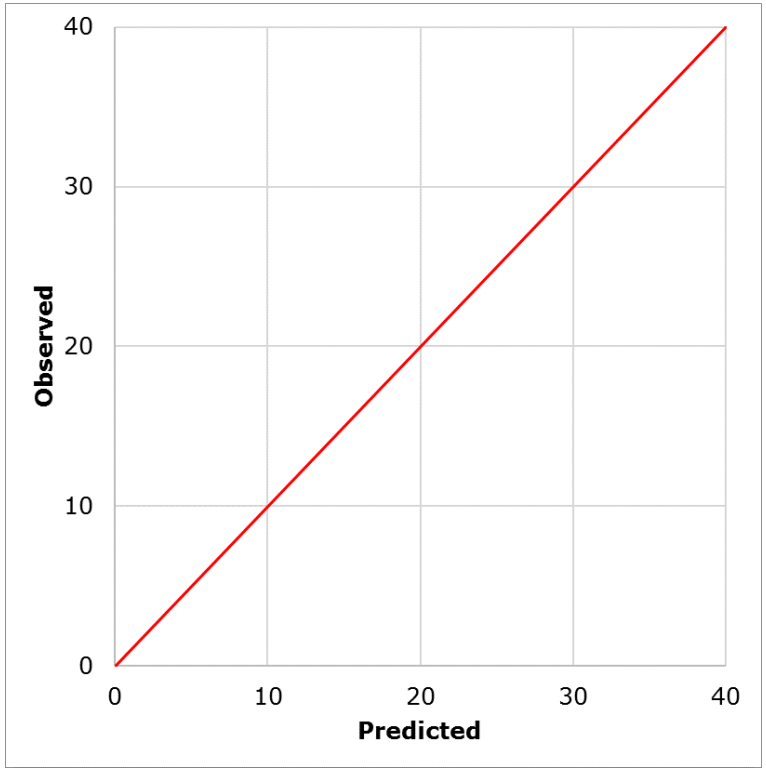
gbm package in R

Validation

70% train, 30% test, 1 year validation

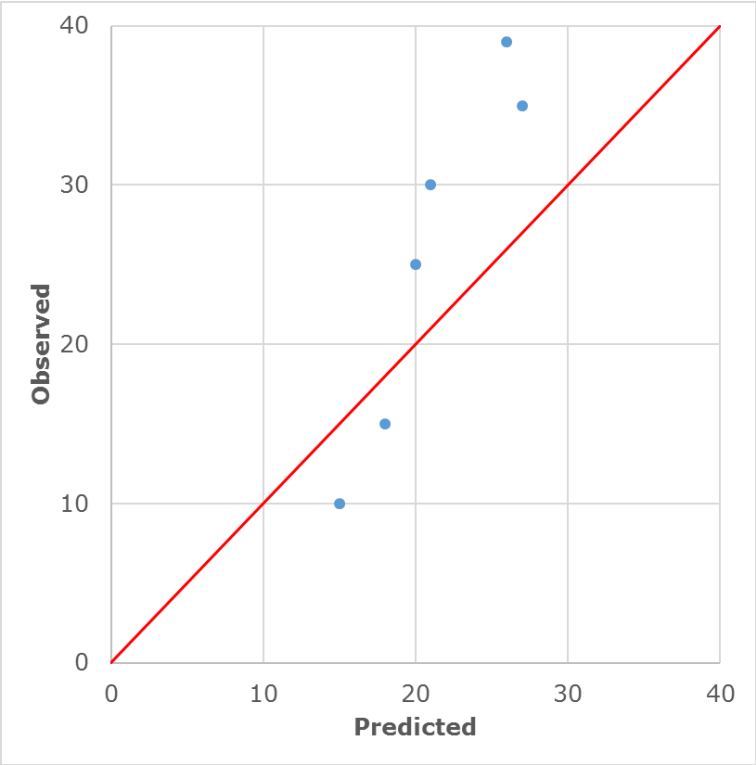
Final performance: 5 validation years combined

Performance criteria



Ideal situation: y = x

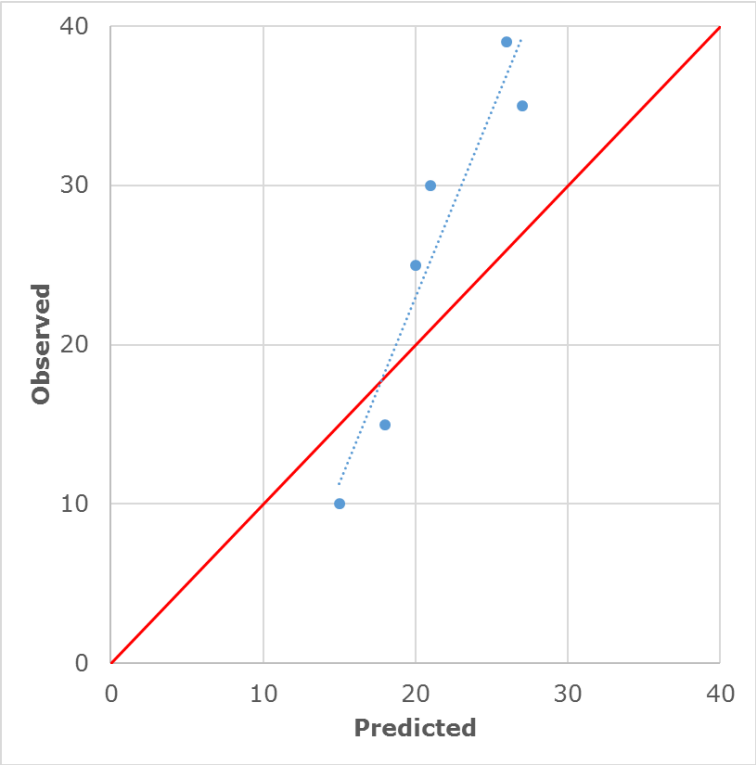
Performance criteria



RMSE – root mean squared error

Deviation from y=x

Performance criteria



RMSE root mean squared error

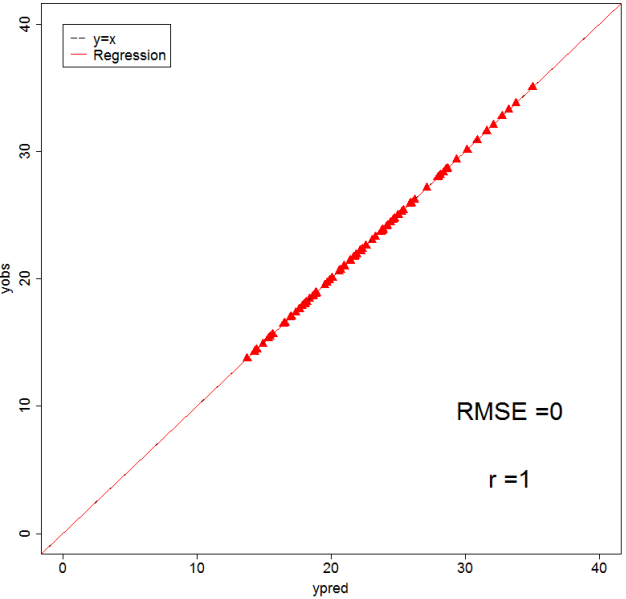
Deviation from y=x

r relative to linear fit

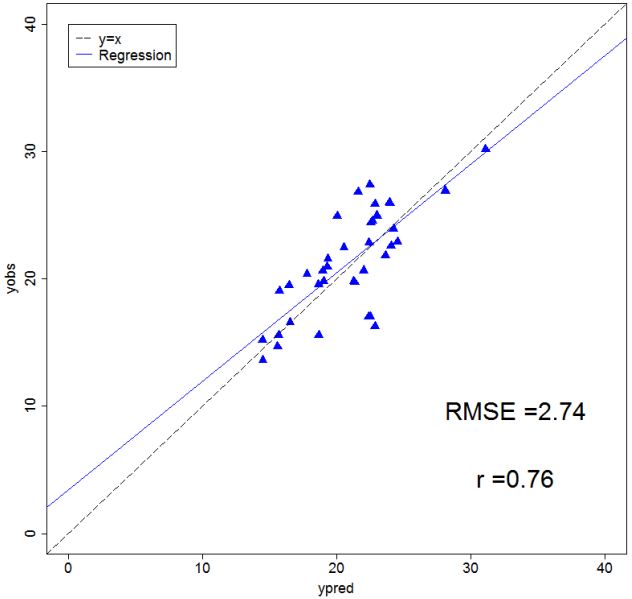
How much variation is explained (trend)

Pyield 2010 – Observed vs predicted

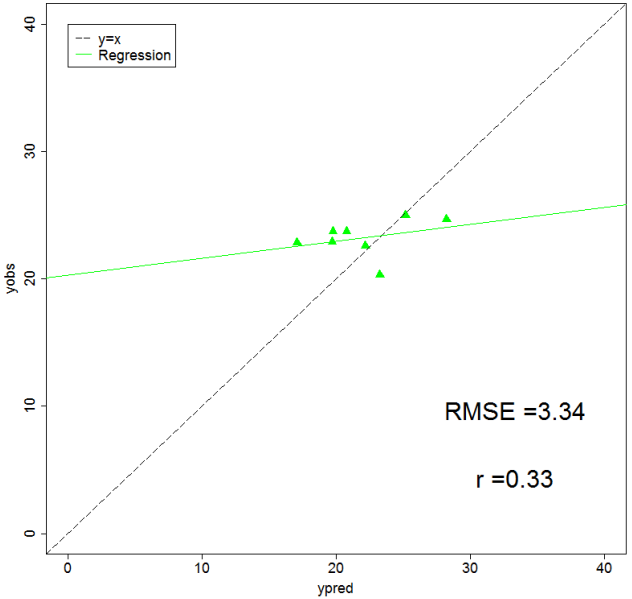
Train



Test

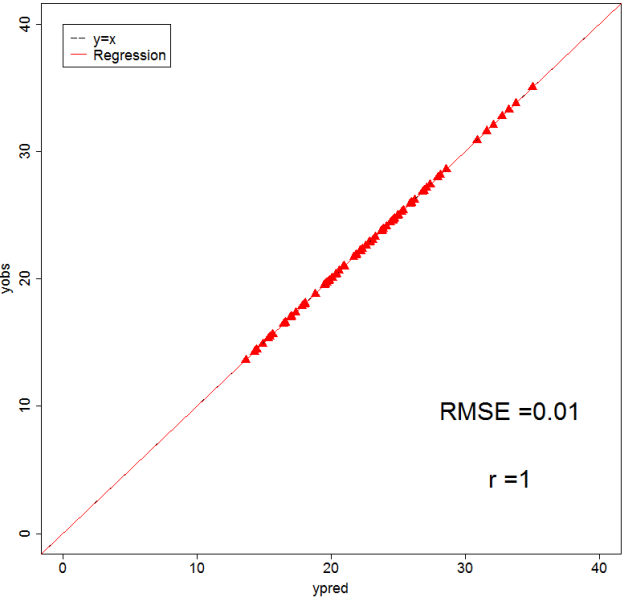


Validation

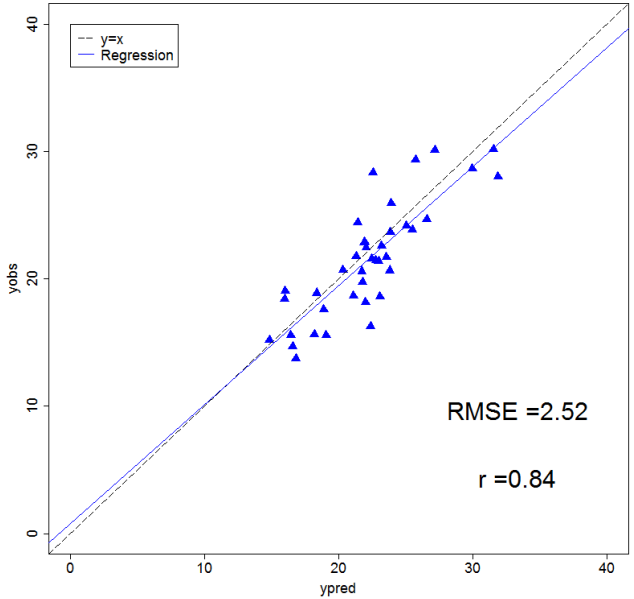


Pyield 2011 – Observed vs predicted

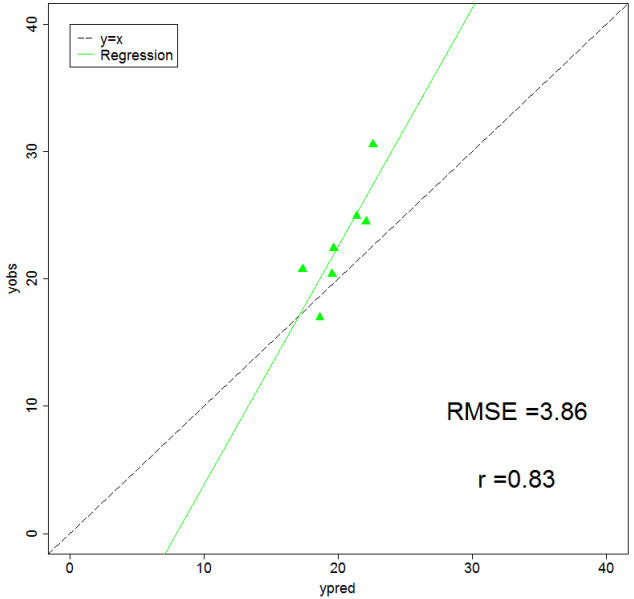
Train



Test

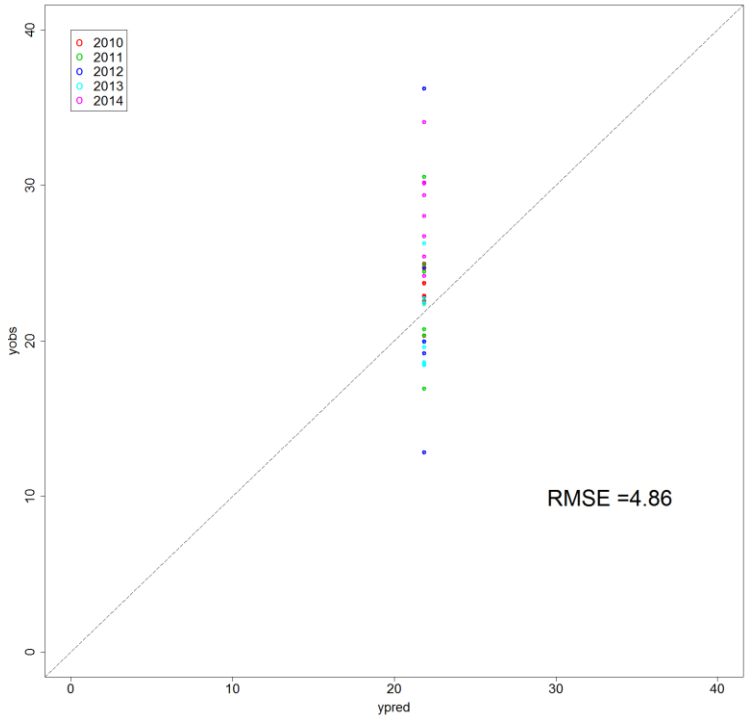


Validation

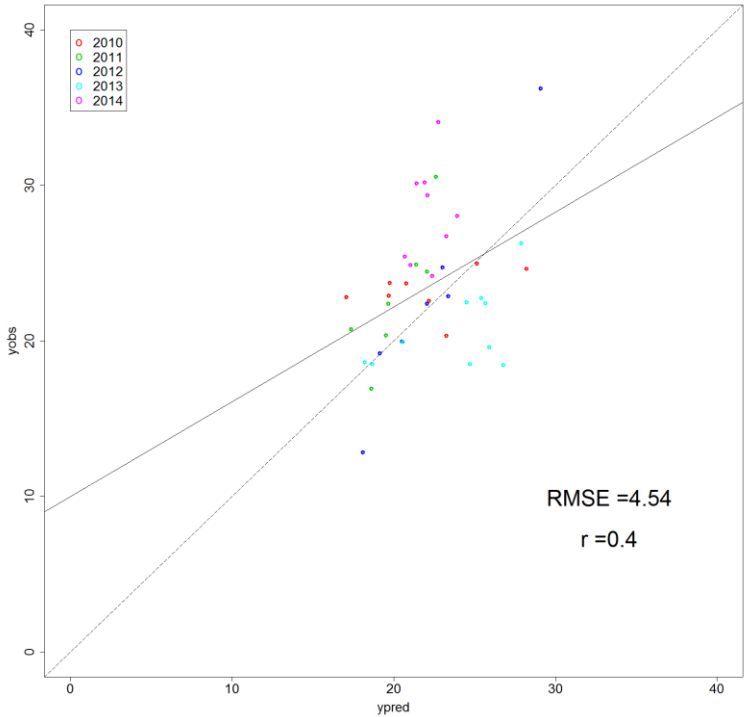


Norm vs model

Norm (50 kg P_2O_5 = 22 kg P)



Predicted (validation sets)



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100years
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Most important variables

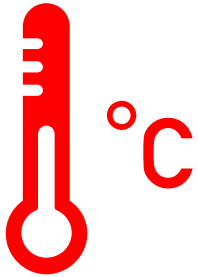
Cropping scheme

Crop in previous year (grass/maize)

Soil status

Phosphate status field

Weather



Maximum temperature in July

Yield history

Average Pyield maize same field past 7 yrs

Conclusions

Machine learning is marginally better in predicting P yield than a generic norm (similar RMSE)

Furthermore, a trend could be shown in P yield (r = 0.40)

Multiple data sources are utilized

To be further explored, e.g., by including grassland

Lessons learned

- Gained knowledge and expertise in machine learning
- Long term predictions are possible on available data
    - Detailed farm records
    - Open source data
- Importance of domain knowledge

Acknowledgements

KTC De Marke

Gerjan Hilhorst

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