PRELIMINARY RESULTS

Yield gaps in Dutch forage production

René Schils, Wim van den Berg, Johan Booij, Jos Groten, Gertjan Holshof, Jantine van Middelkoop, Bert Rijk, Jan Rinze van der Schoot, Gerrie van de Ven, Koos Verloop, Martin van Ittersum

Practical innovations for sustainable forage production

agrifirm

LOUIS BOLK INSTITUUT

Plantum

Bionext

LTO Nederland

WAGENINGEN UNIVERSITY & RESEARCH

CUMELA NEDERLAND
Voor specialisten in groen, grond en infra

for farmers
the total feed business

ZuivelNL
KETENORGANISATIE VAN DE ZUIVELSECTOR

JOORDENS ZADEN

Nordic Maize breeding

DSV

DLF SEEDS & SCIENCE

DUPONT PIONEER

VANDINTER SEMO

BARENBRUG

Limagrain

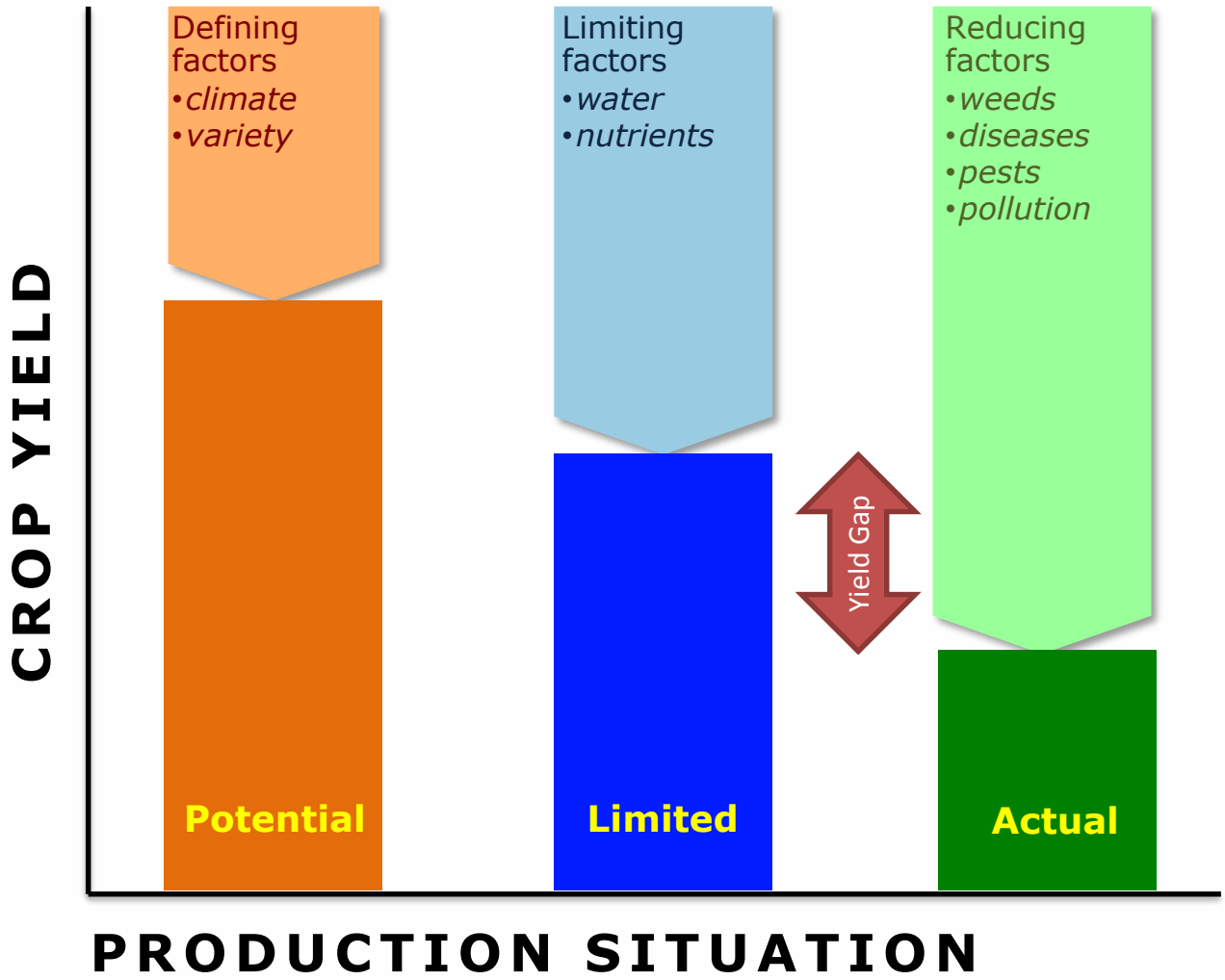
EURALIS
Creating seeds and trust

MOVO-Zaden
Agrarische handel

syngenta

Ruwvoer & Bodem

Theoretical production ecology

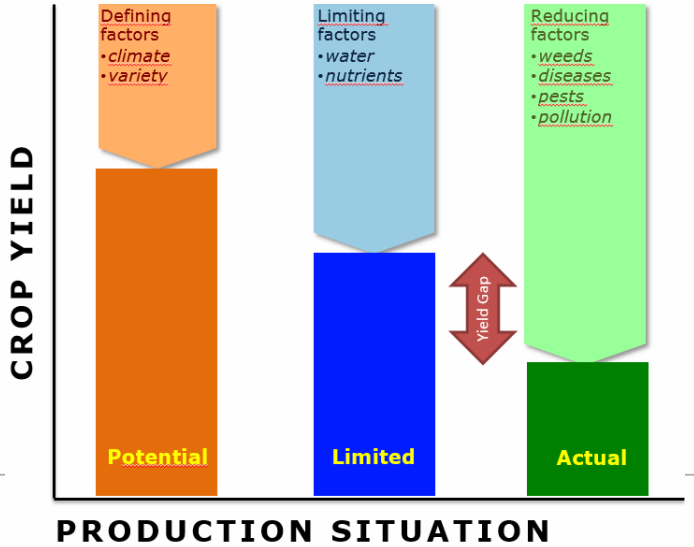


H. Lövenstein, GFFCx-MOOC, 2015

Quantifying…

- Yield levels
  - Y_P Potential yield
  - Y_W Water-limited yield
  - Y_N Nitrogen-limited yield
  - Y_{WN} Water- and nitrogen-limited yield
  - Y_A Actual yield
  - Y_G Yield Gap

- Genetic progress



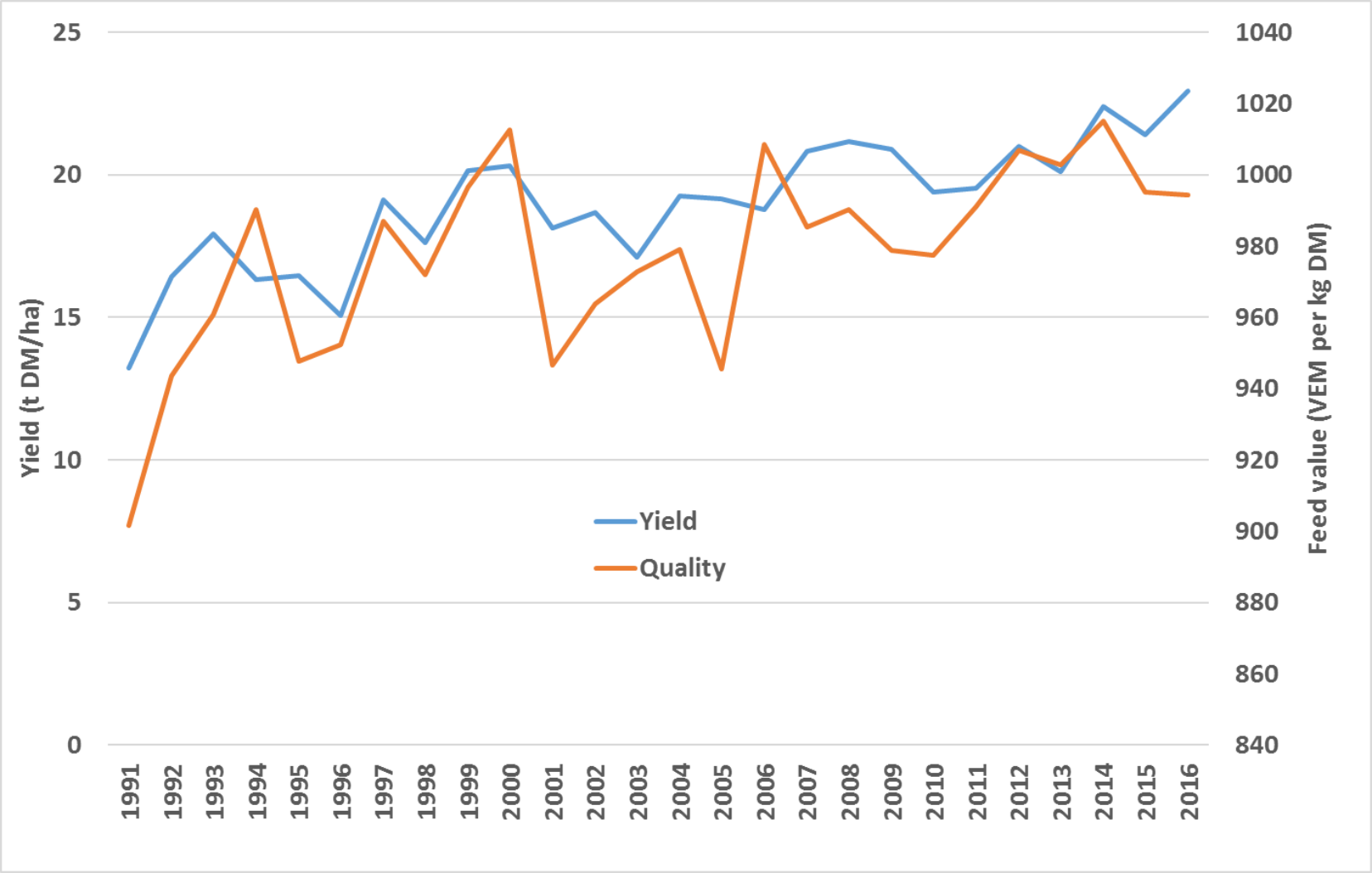
Genetic progress

Value for Cultivation and Use (VCU) trials

	Perennial ryegrass	Forage maize
Period	1975 - 2015	1991-2015
Experiments	180	120
Harvest years	3	1
Soil	Clay - Sand	Clay - Sand
Varieties	1147	1187
Types	Late - Medium	Early - Late
Ploidy	Diploïd - Tetraploïd	-
Management	Cutting – Grazing	-
Traits	Yield, Sward quality	Yield, NEL

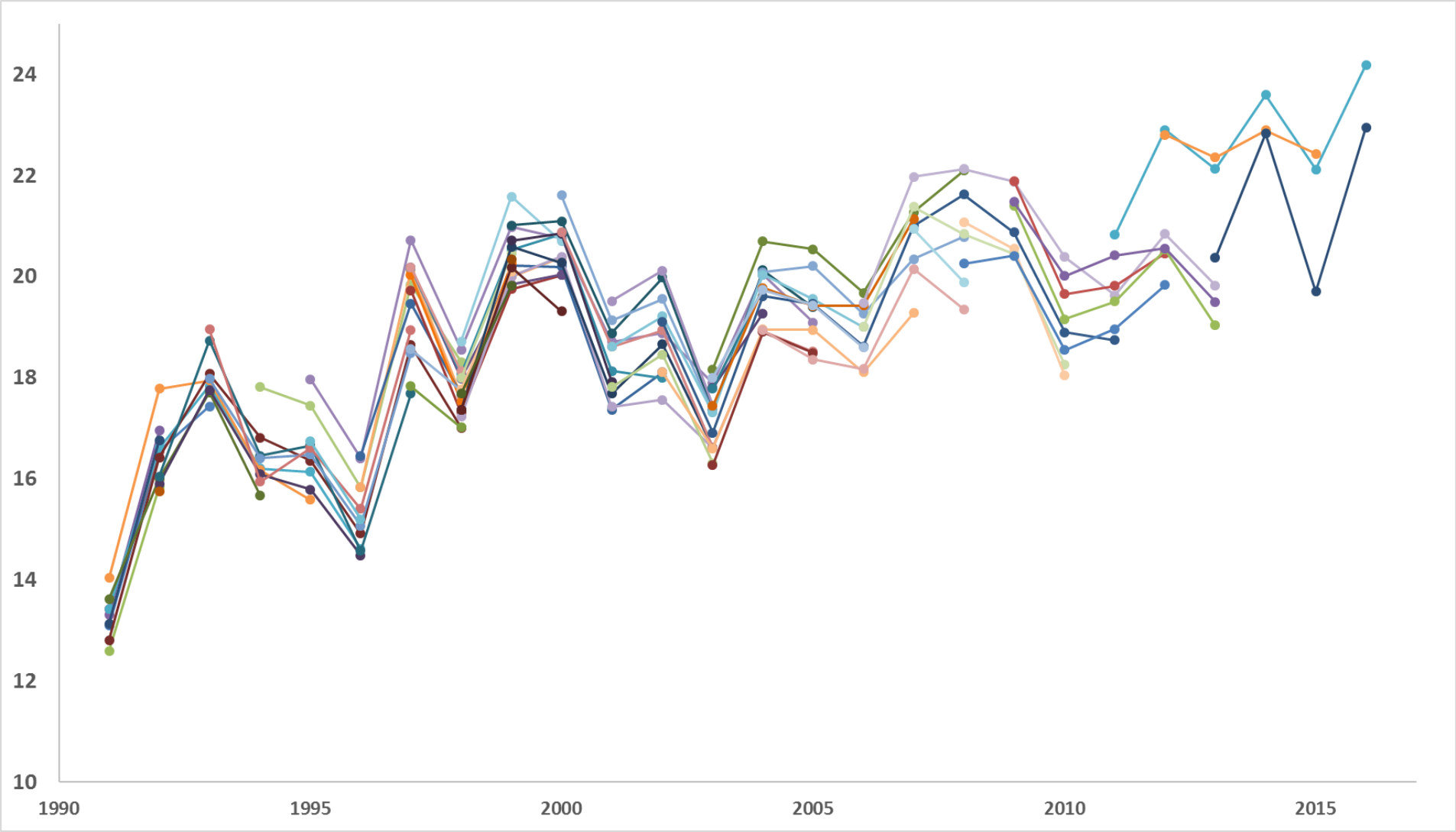
Ruwvoer & Bodem

Forage maize – VCU trials



Genetic and non-genetic trends

(incomplete set, as example)



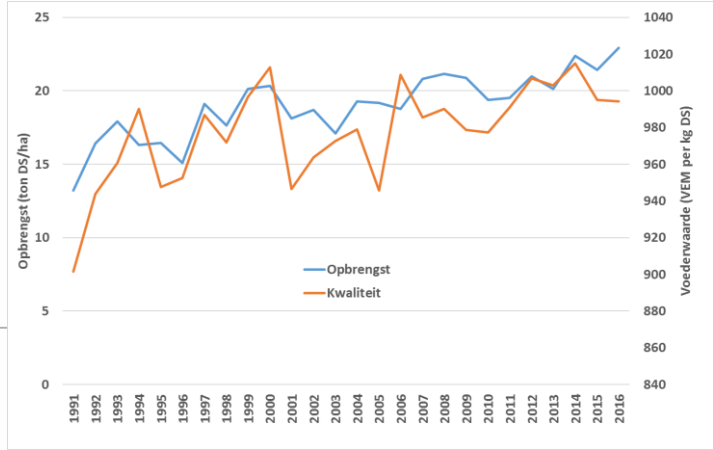
Forage maize – VCU trials

Genetic progress per year

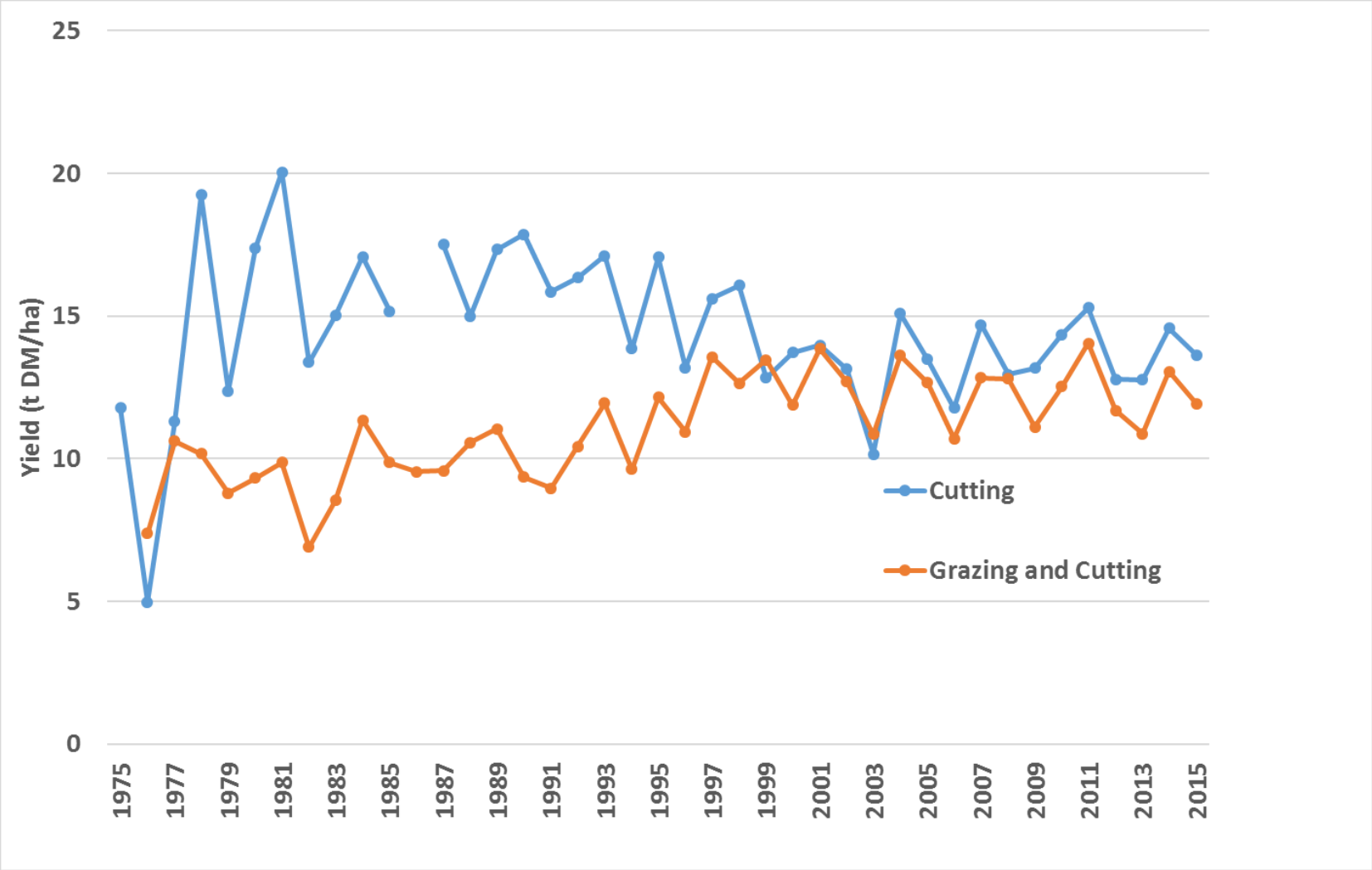
- Dry matter yield: 185 kg DM per ha
- Feed value: 1.2 VEM per kg DM

Non-Genetic progress per year

- Dry matter yield : 23 kg DM per ha
- Feed value : 0.9 VEM per kg DM



Grass – VCU trials



Ruwvoer & Bodem

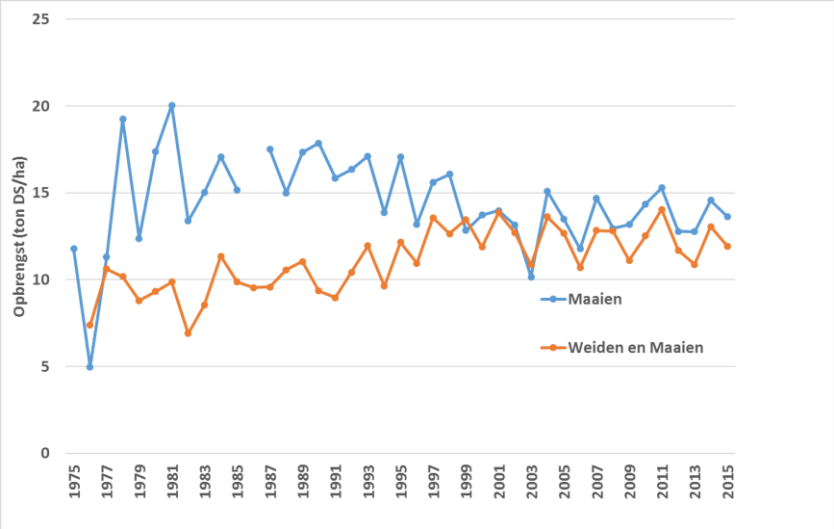
Grasland – VCU trials

Genetic progress per year

- Dry matter yield: 52 kg DM per ha

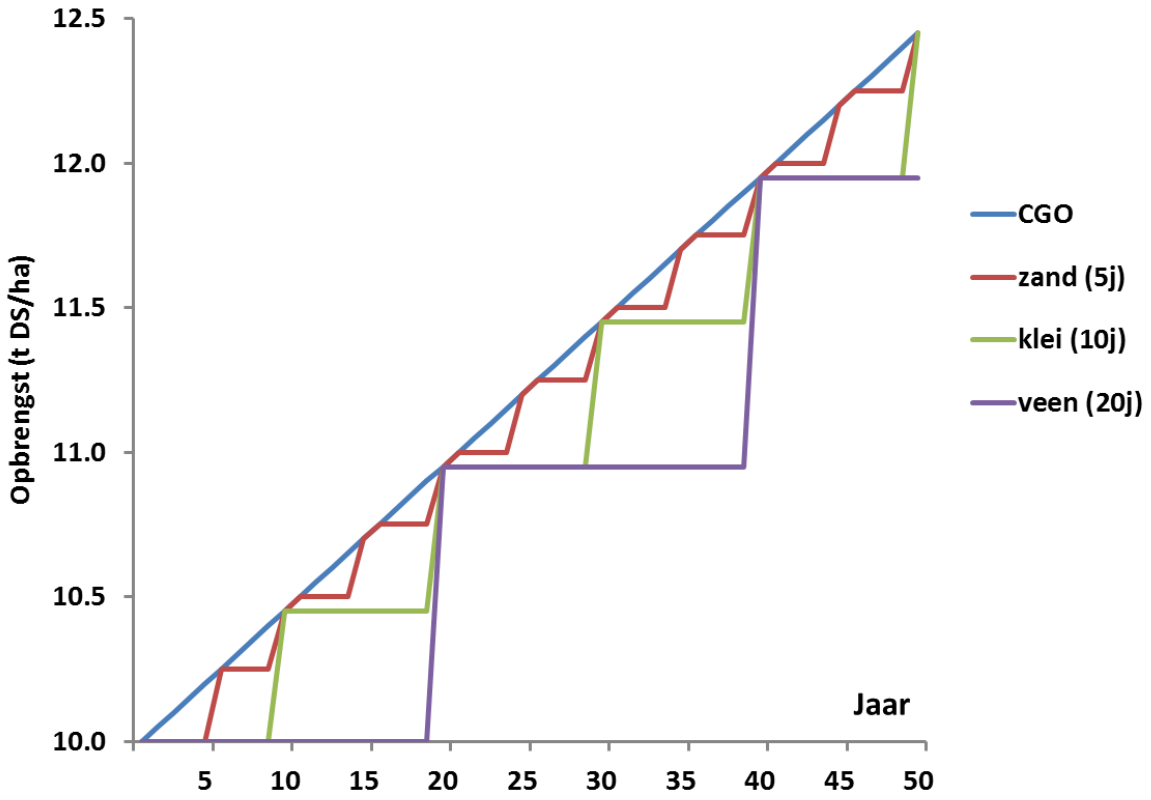
Non-genetic progress per year

- Dry matter yield: -11 kg DM per ha
  - Cutting - 77 kg DM per ha
  - Grazing and cutting + 54 kg DM per ha



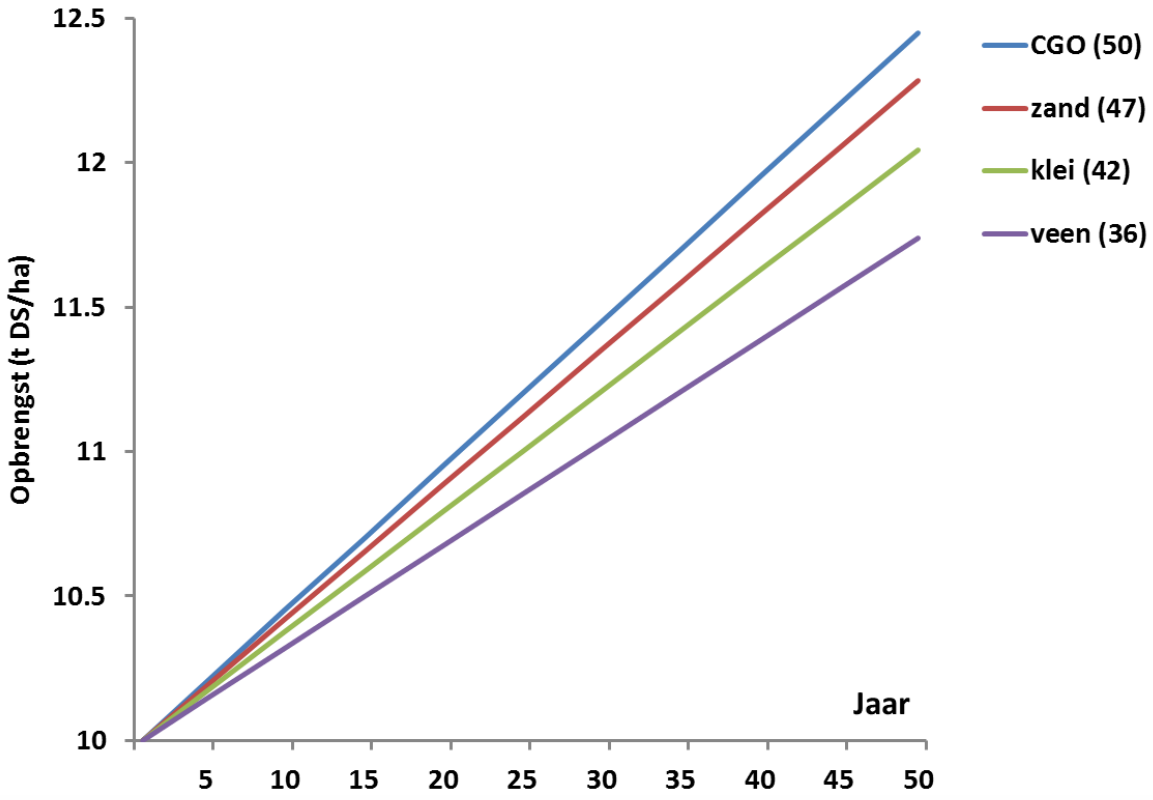
Actual genetic progress

- Grass : 50 kg DM per ha



Ruwvoer & Bodem

Actual genetic progress



Yield Gap

Quantifying…

- Yield levels
  - Y_P Potential yield
  - Y_W Water-limited yield
  - Y_N Nitrogen-limited yield
  - Y_{WN} Water- and nitrogen-limited yield
  - Y_A Actual yield
  - Y_G Yield Gap

Models

Regional statistics

Nitrogen-limited yield (Y_N)	N-input *(kg N/ha)*	N standards *(kg N/ha)*
Grass (cutting only)	345	300 - 385
Grass (cutting & grazing)	300	250 - 345
Maize	120	112 - 185

Ruwvoer & Bodem

Challenges in grasslands

- Function (production, biodiversity)
- Botanical composition (monocultures, mixed swards)
- Ploidy (diploid, tetraploid)
- Variety
- Heading date (early, late)
- Sward age (newly sown, temporary, permanent)
- Management (cutting, grazing)
- Harvest stage (continuous grazing, rotational grazing, silage, hay)
- Dry matter, Feeding value

Ruwvoer & Bodem

Grassland terminology

- Cutting (target = 3.5) 4.5 - 2.0 t DM/ha
- Grazing (target = 1.7) 2.0 – 1.1 t DM/ha

- Number of cuts

Cuts per year	Formal name	Silage cuts	Grazing events
0	Only grazing	0	7-8
1	100% mowing	1	5-7
2	200% mowing	2	4-6
5-6	Only cutting	5-6	0

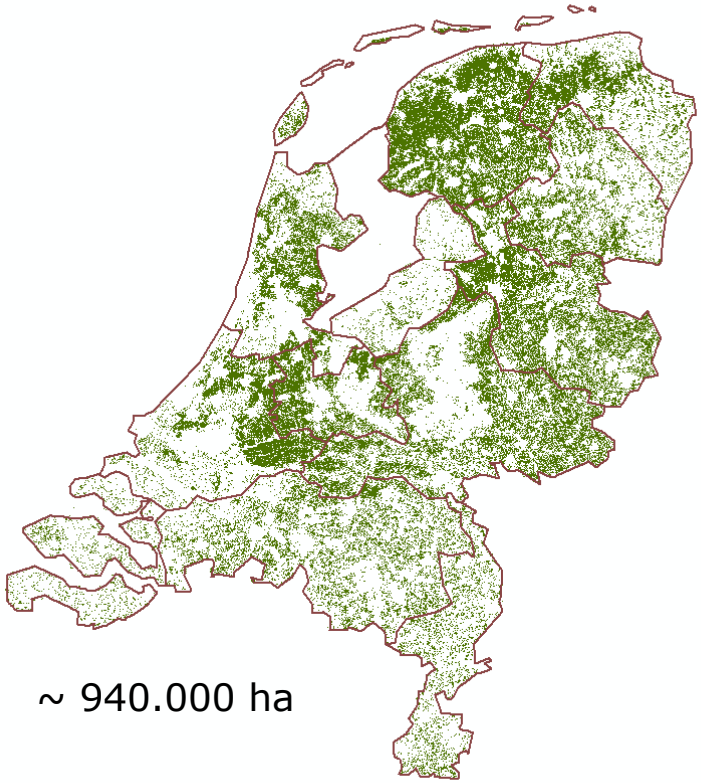
Ruwvoer & Bodem

Crop models

- Grass: GRAS2007
  - Empirical model
  - Robust N response curve
  - Flexible and realistic management settings
  - DM yield, NPK uptake, feeding value
  - Corrections for daily temperature and water balance
  - Not consistent with theoretical production ecology
- Forage maize: WOFOST
  - Process based crop model
  - DM yield
  - Nitrogen limitation via empirical relations

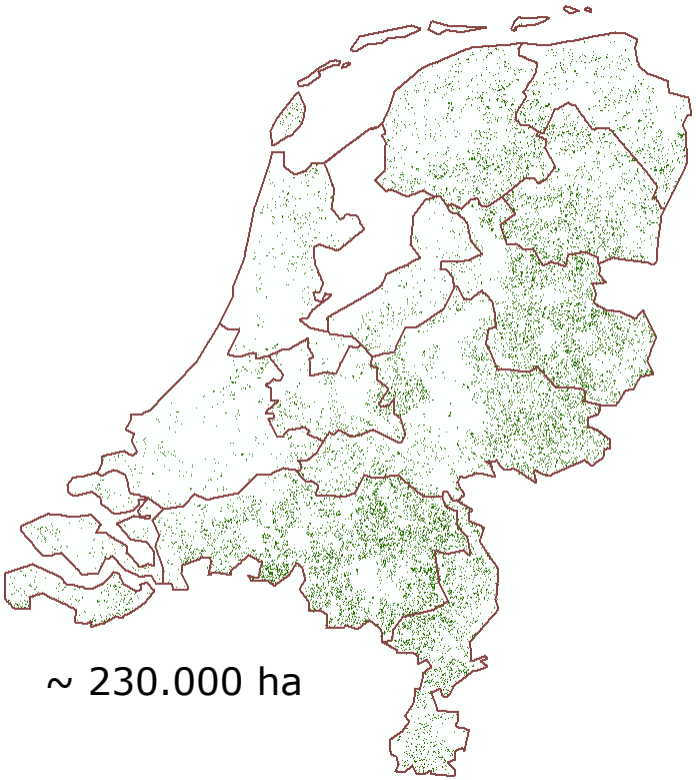
Ruwvoer & Bodem

Grass



~ 940.000 ha

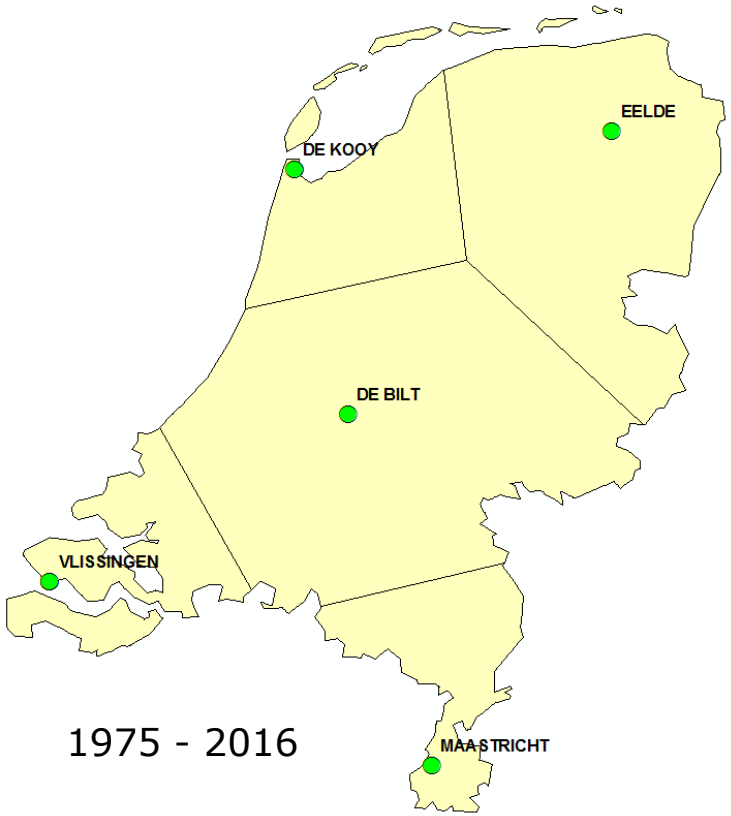
Forage maize



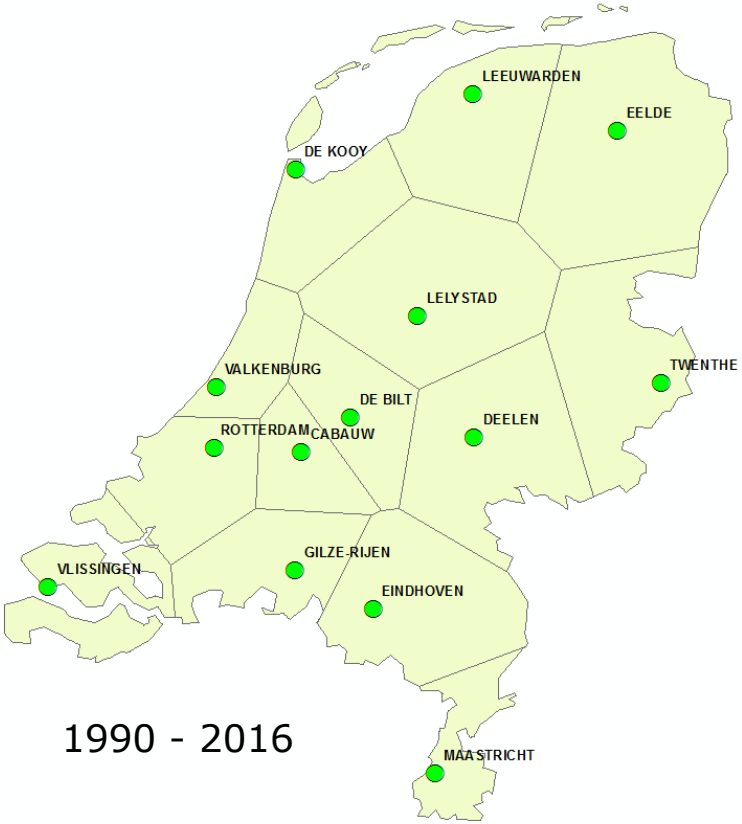
~ 230.000 ha

LGN7, 25m x 25m (2012)

Daily weather data



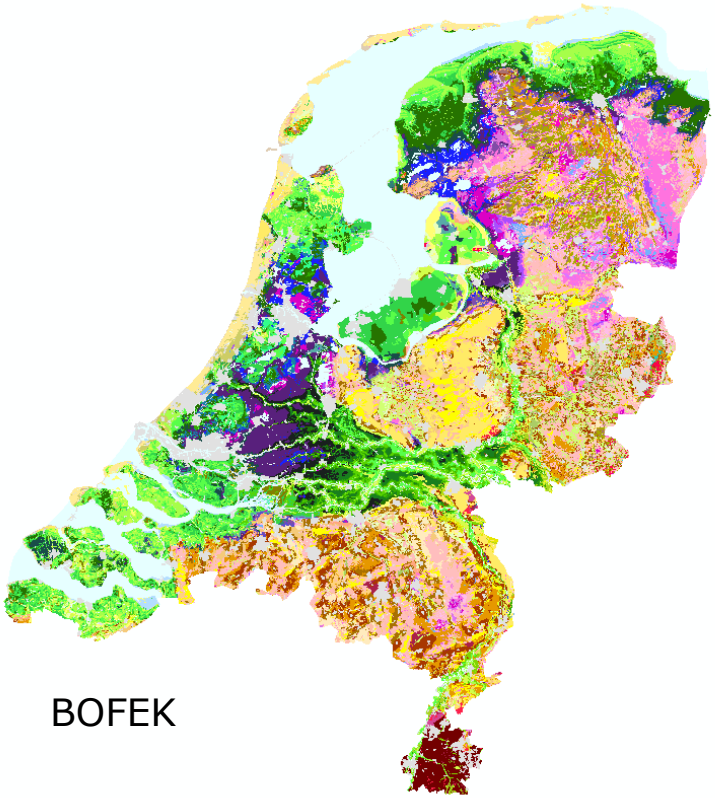
1975 - 2016



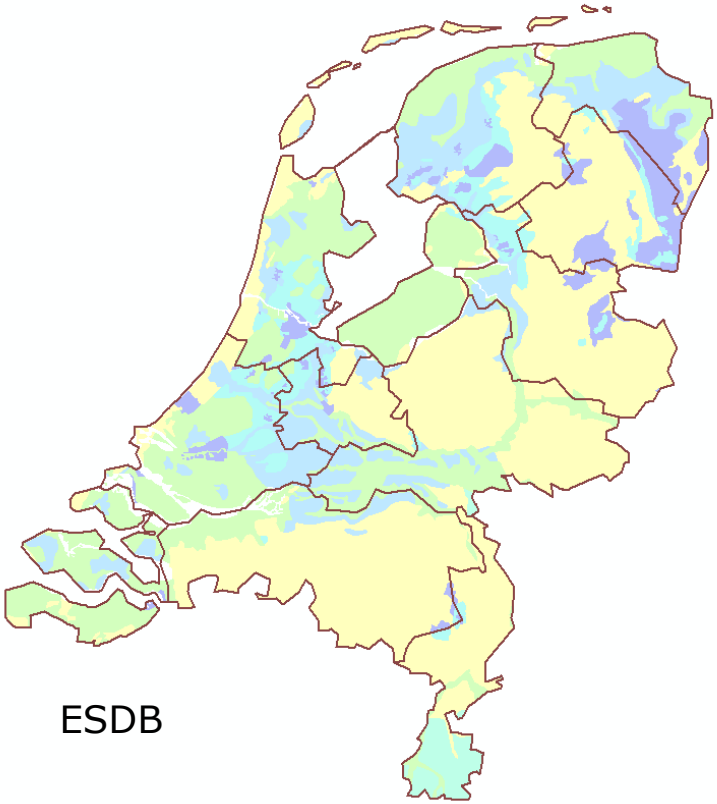
1990 - 2016

KNMI

Soils



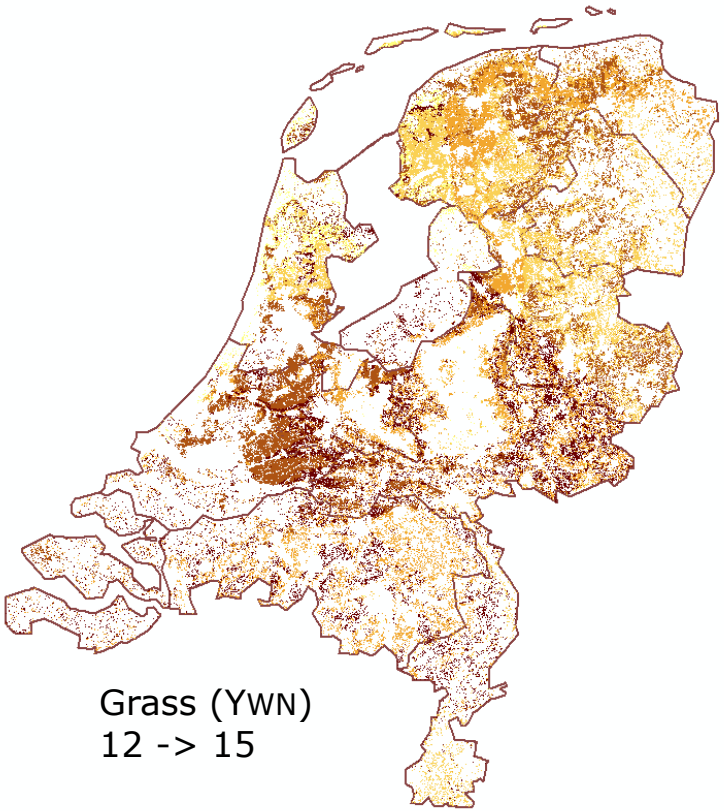
BOFEK



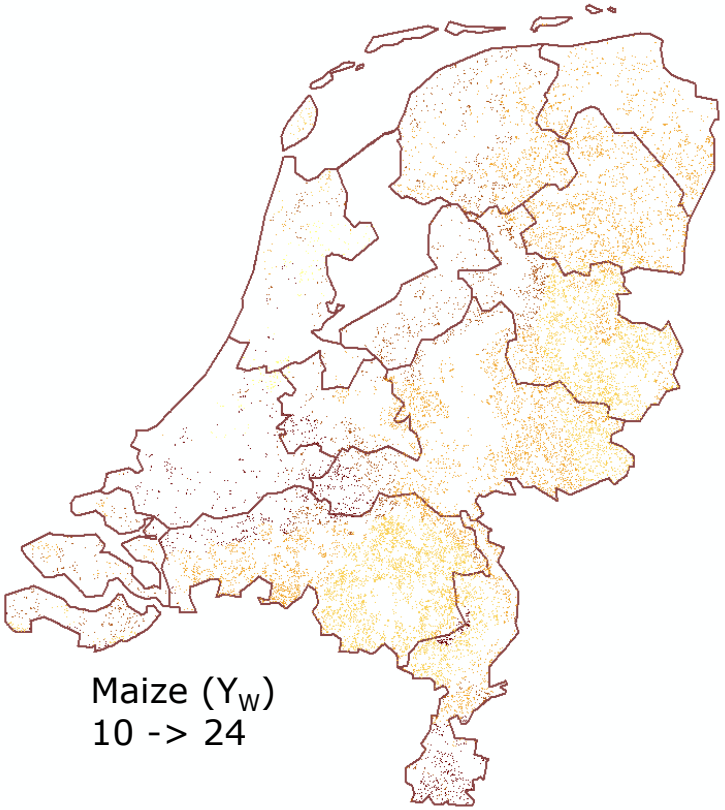
ESDB

BOFEK: Bodemfysische eenheden
ESDB: European Soil DataBase

Output

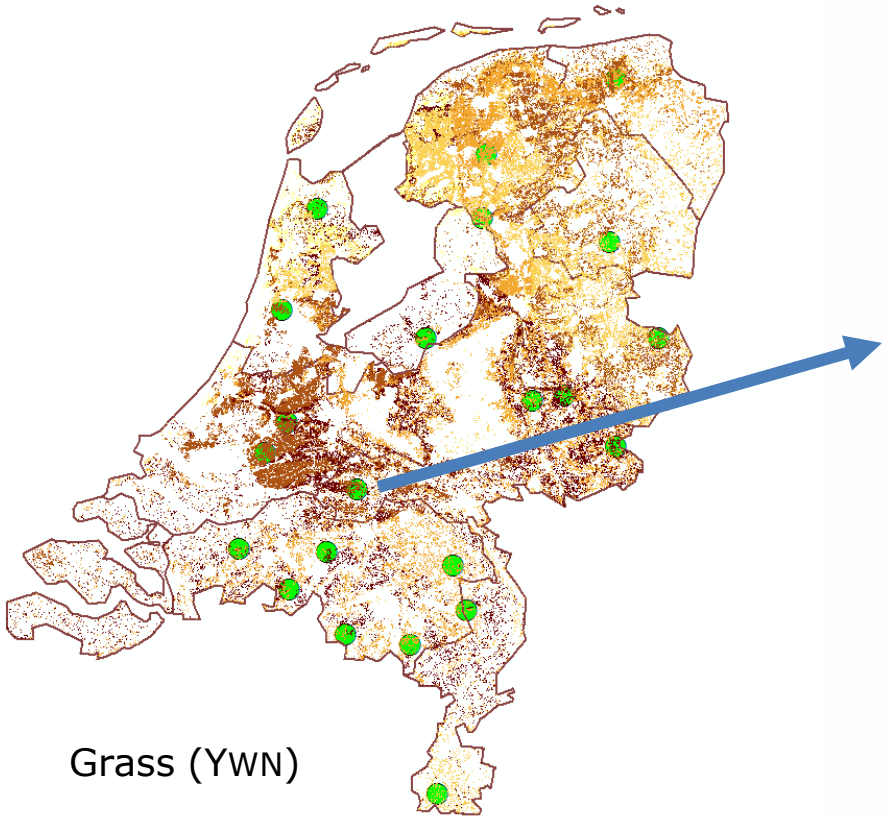


Grass (YWN)
12 -> 15

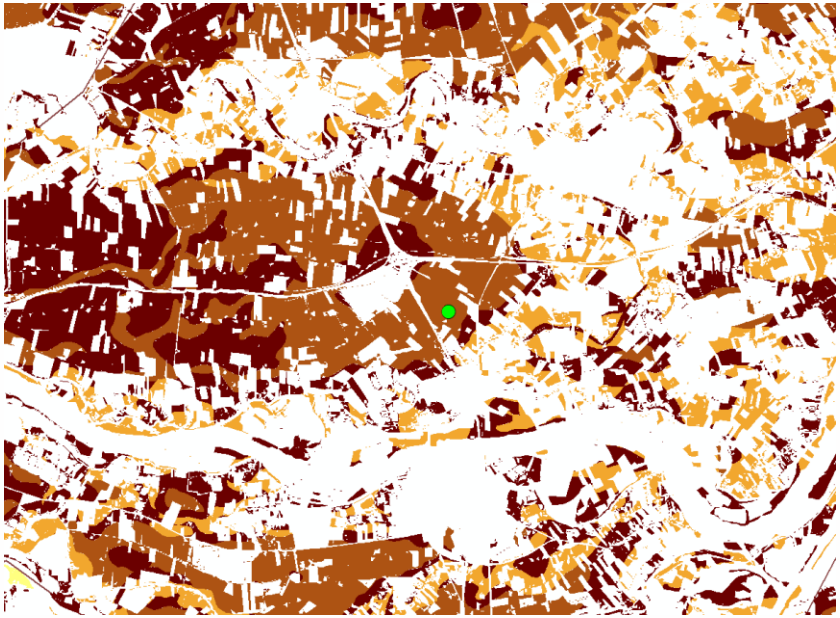


Maize (Y_W)
10 -> 24

Linking to farms

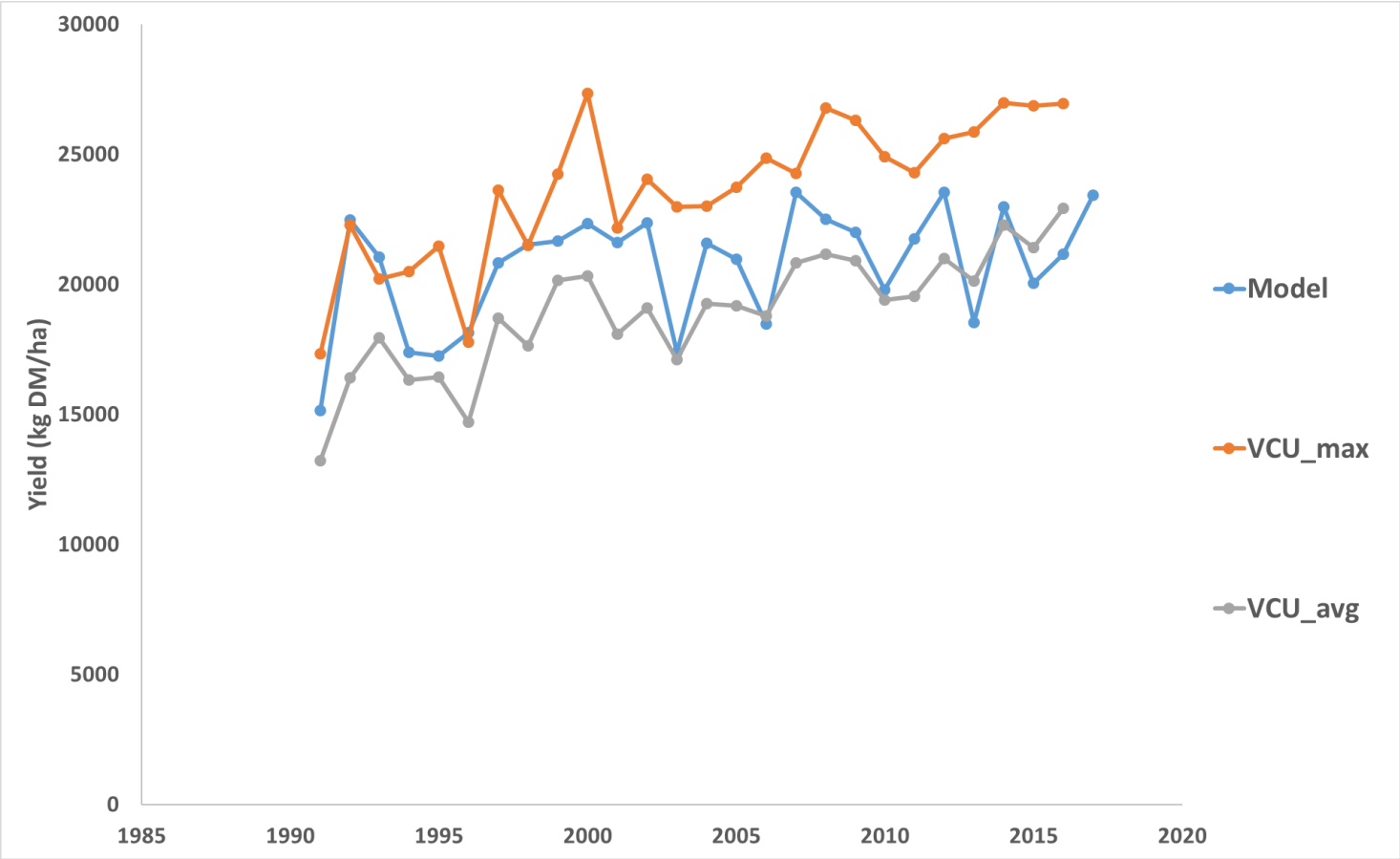


Grass (YWN)



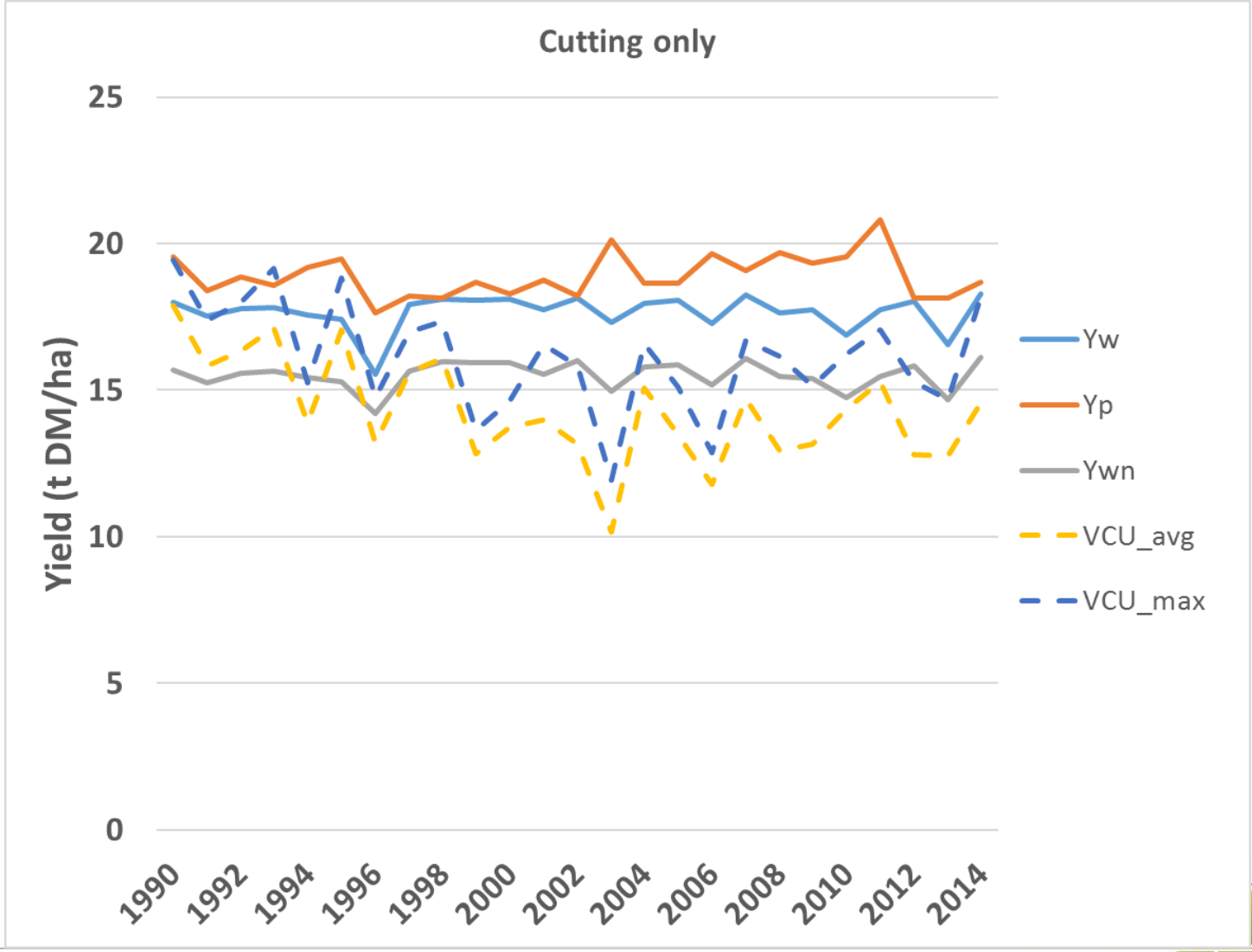
KK_Wijk

Maize: Wofost - VCU



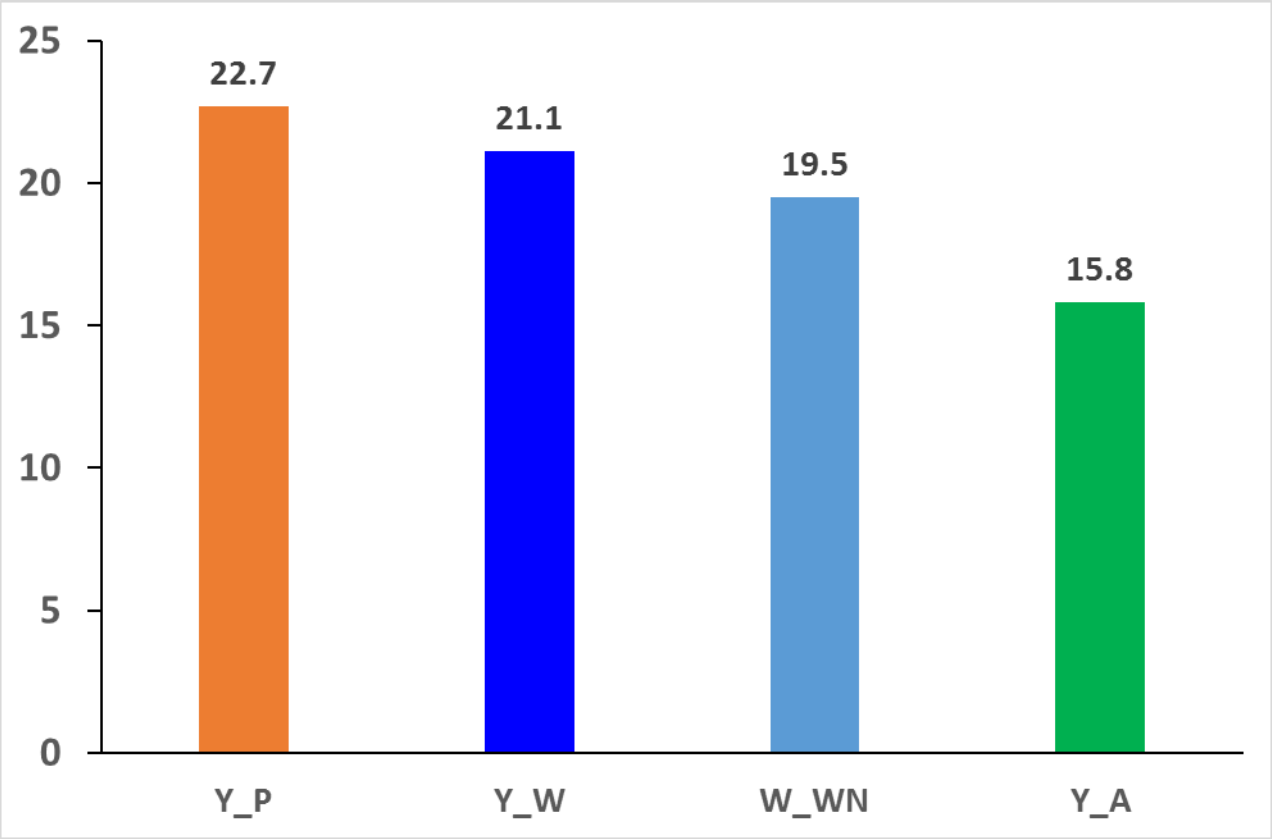
Ruwvoer & Bodem

Grass: GRAS2007 - VCU



Forage maize

(gross; t DM per ha)



Ruwvoer & Bodem

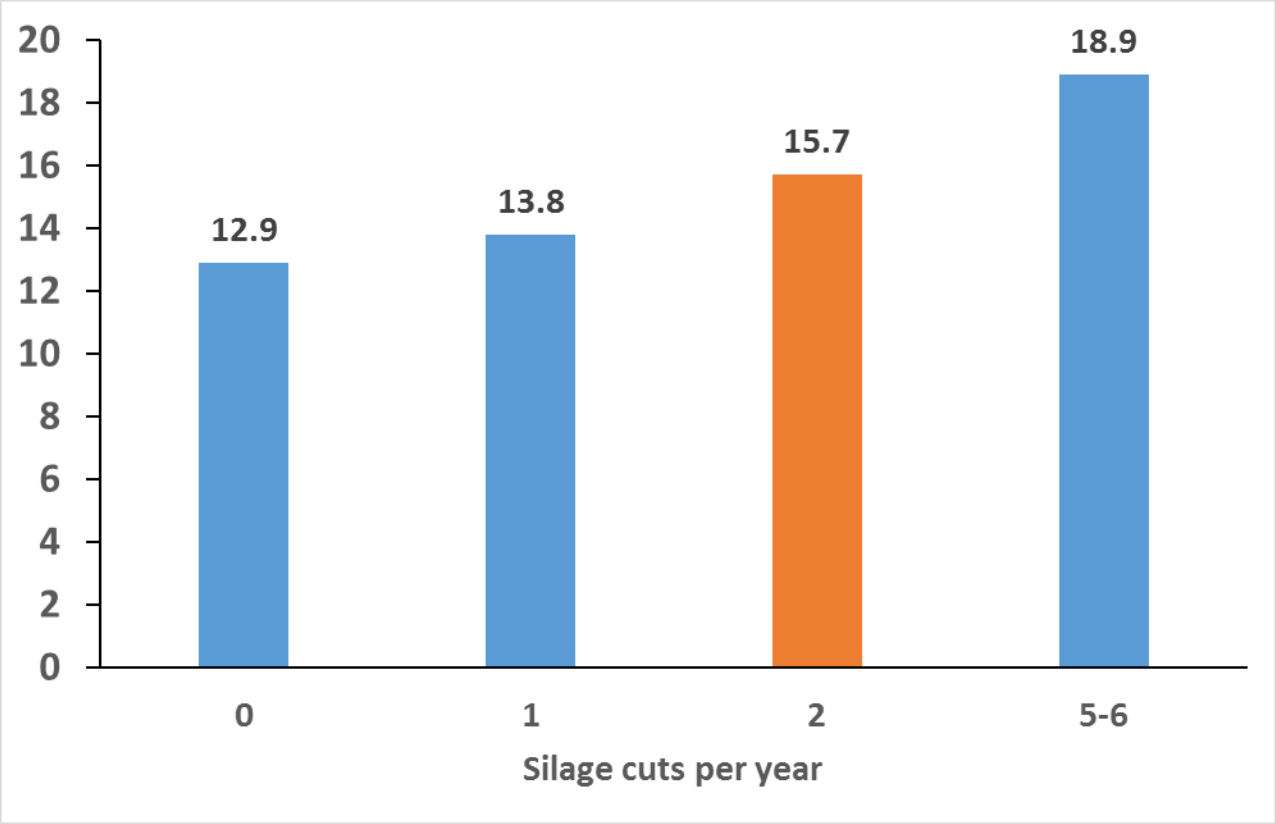
Maize yield – soil type

(t DM/ha)

Soil type	Y_P	Y_W
Clay/Loam	22.8	20.9
Peat	22.3	22.2
Sand	22.6	19.9

Grass – potential yield (Y_P)

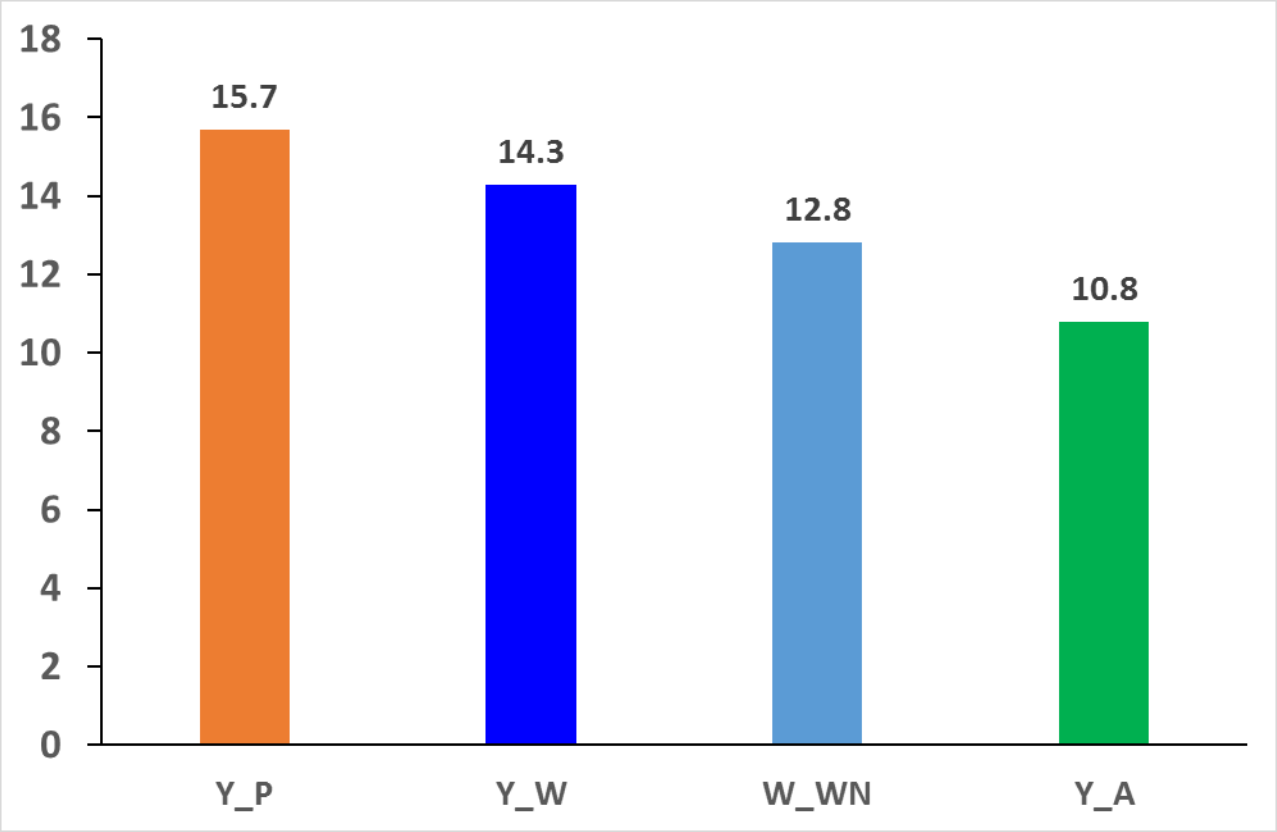
(gross; t DM per ha)



Ruwvoer & Bodem

Grasland: cutting (2) and grazing

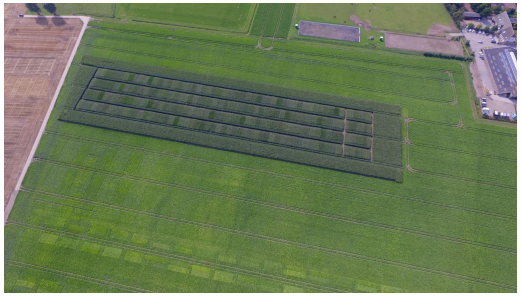
(gross; t DM per ha)



Grass – soil type

Soil	Y_P (5-6 cuts)	Y_P (2 cuts)	Y_W (2 cuts)	Y_{WN} (2 cuts)
Sand	19.2	16.4	14.1	12.1
Clay	18.6	15.4	14.5	13.4
Peat	17.8	15.0	14.4	13.1

Summary



- Genetic progress
  - Maize: 185 kg DM/ha
  - Grass: 52 kg DM/ha

- Yield Gap ($Y_W - Y_A$)
  - Maize: 5.3 t DM/ha
  - Grass: 3.5 t DM/ha

- *Yield Gap ($Y_{WN} - Y_A$)*
  - *Maize: 3.7 t DM/ha*
  - *Grass: 2.0 t DM/ha*

Ruwvoer & Bodem