Disentangling genetic and non-genetic yield trends of Dutch forage crops

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Partners in the public private partnership “Forage and soil”

Disentangling genetic and non-genetic yield trends of Dutch forage crops

- Forage production and use in the Netherlands
- Genetic and non-genetic yield trends in variety experiments
- Trends in on-farm yields

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Forage production and use in the Netherlands (2016)

Grassland
- 936,000 ha
- 11.7 t DM/ha

~51%

Dairy herd
- 1,745,000 cows

- Increase or maintain yields with reduced inputs
- Increase proportion of home grown forage

Forage maize
- 204,000 ha
- 15.2 t DM/ha

~93%

- Conserved grass	36%
- Fresh grass	10%
- Maize silage	24%
- Concentrates	30%

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100years 1918 — 2018

Statistics Netherlands (CBS), 2018

Objectives of our study

- Quantify genetic and non-genetic trends
  - yield and quality of forage maize
  - yield of perennial ryegrass
- Quantify on-farm yield trends

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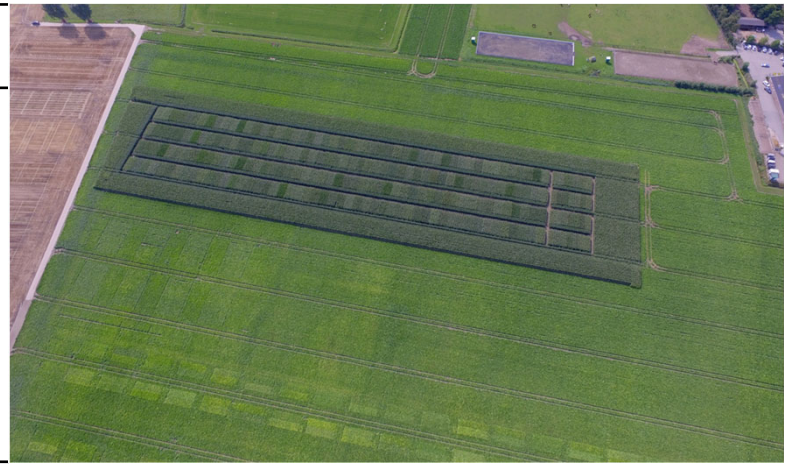
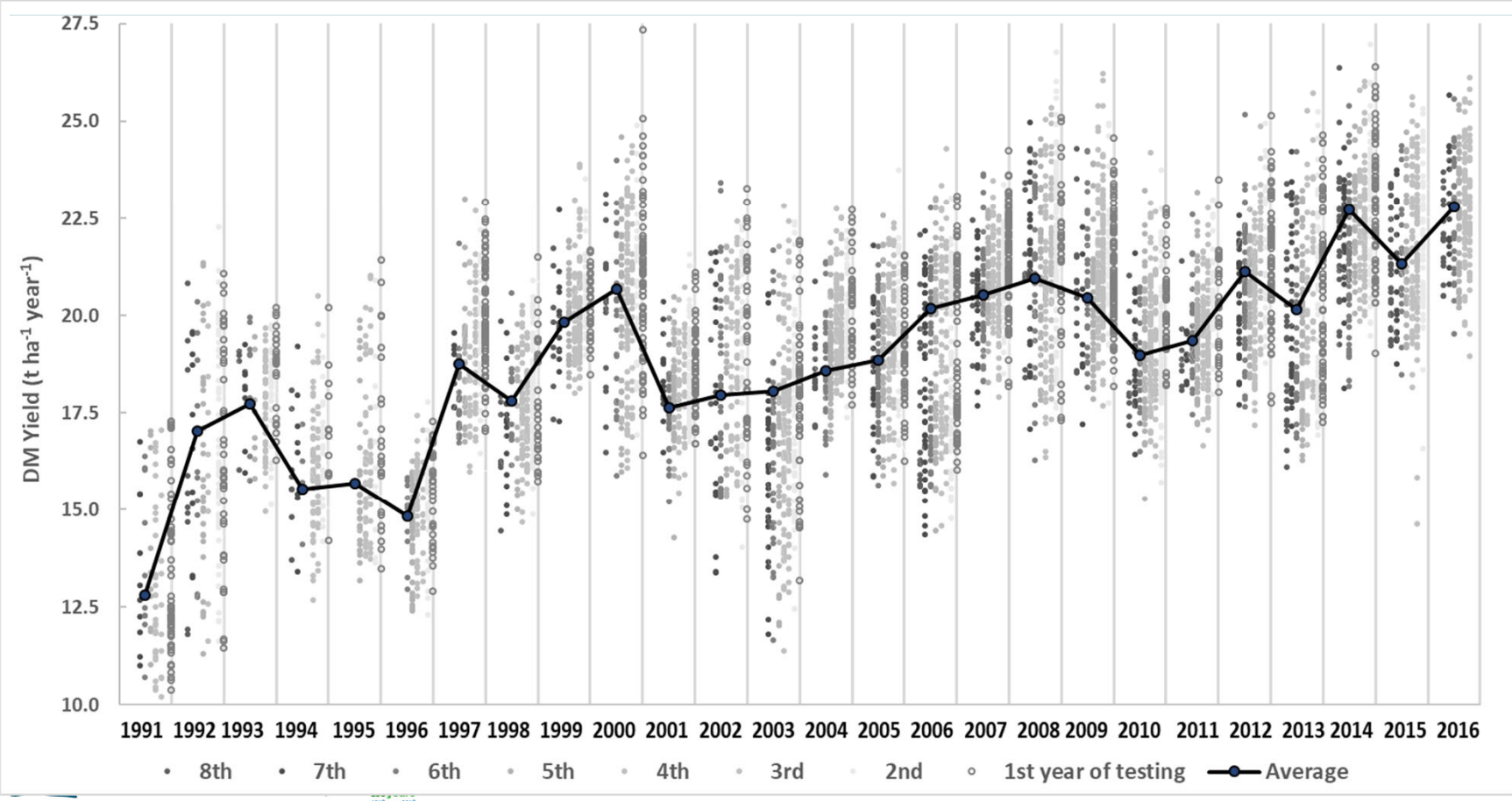
Genetic and non-genetic yield trends in Value for Cultivation and Use (VCU) experiments

	Perennial ryegrass	Forage maize
Period	1975 - 2015	1991-2016
Experiments	83	208
Harvest years	3	1
Soil types	Clay/Loam - Sand	Clay/Loam - Sand
Varieties	174	187
Maturity types	Late - Medium	Early - Late
Ploidy	Diploïd - Tetraploïd	-
Management	Cutting – Grazing	-
Traits	DM yield	DM yield, NEL



VCU experiments – Forage maize yields



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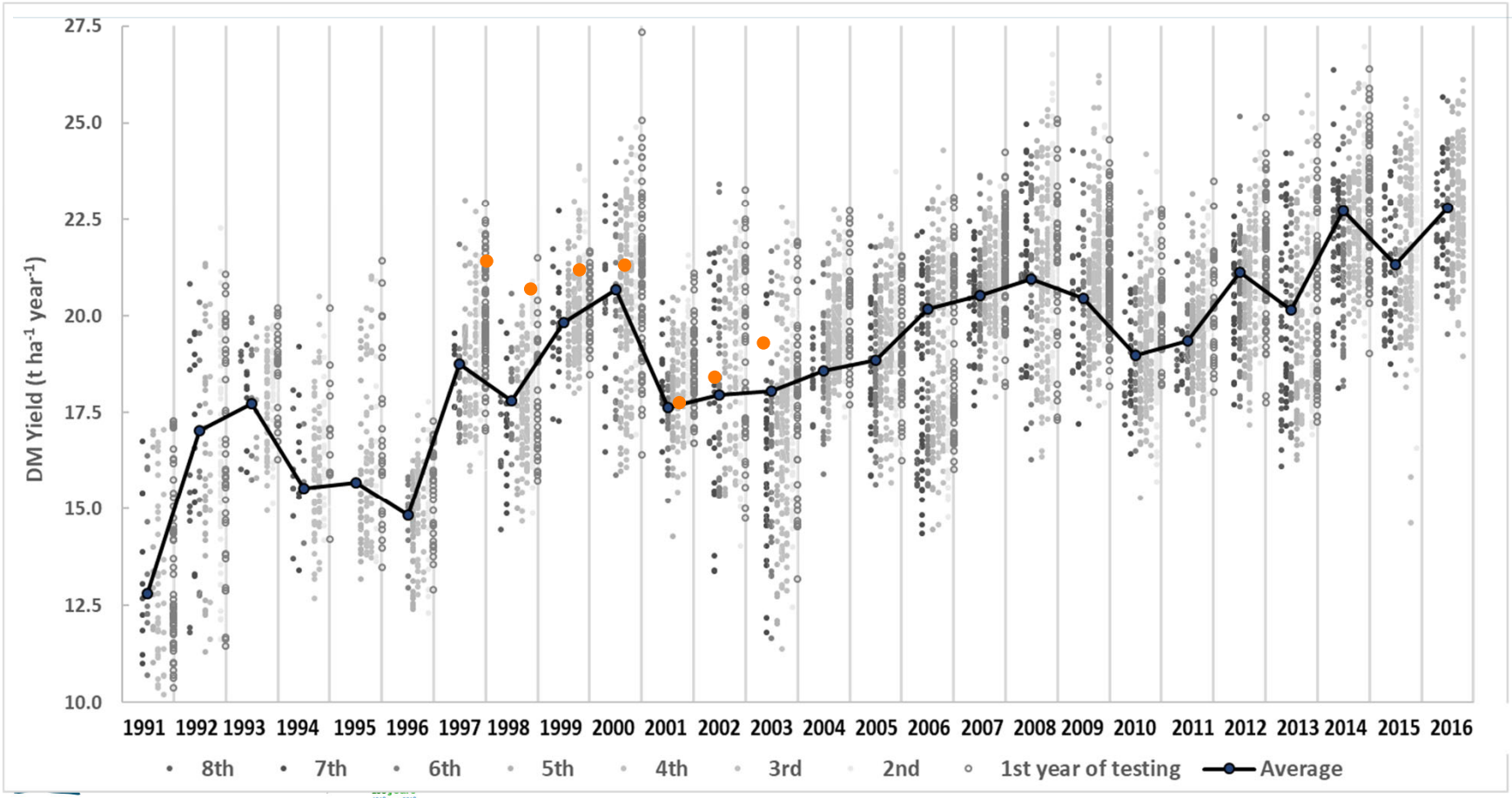
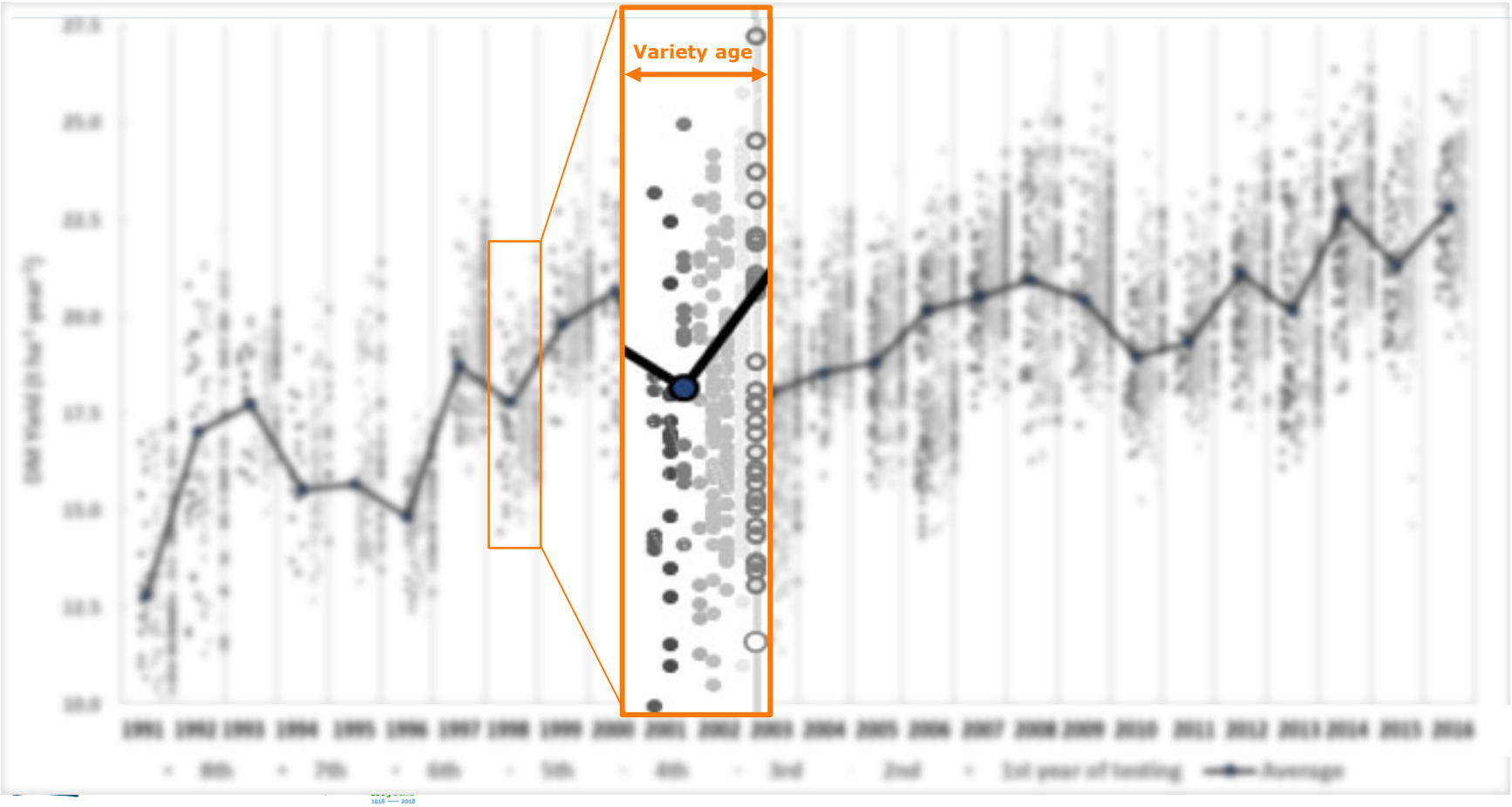


VCU experiments – Forage maize yields



Mixed model

$$y_{ijk} = \mu + TRIAL_i + GENOTYPE_j + YEAR_k + E_{ijk}$$

- $GENOTYPE_j = \beta r_j + H_j$

  Genetic trend estimated by β: regression coefficient on first year of testing of variety j

- $YEAR_k = \gamma t_k + Z_k$

  Non-genetic trend estimated by γ: regression coefficient on calendar year

Forage maize – yield trends in VCU experiments

	DM yield (t ha^{-1})	
Parameter	Estimate	SE
Constant (μ)	19.460 ***	0.251
Genetic trend (first year of testing)	0.176 ***	0.007
Non-genetic trend (Calendar year)	0.071 *	0.033

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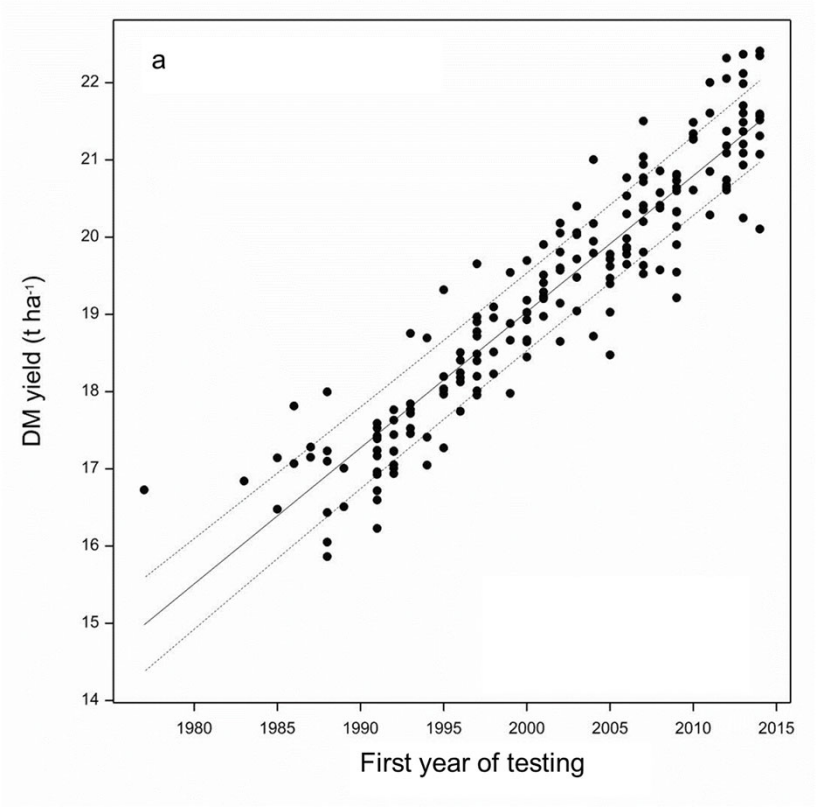
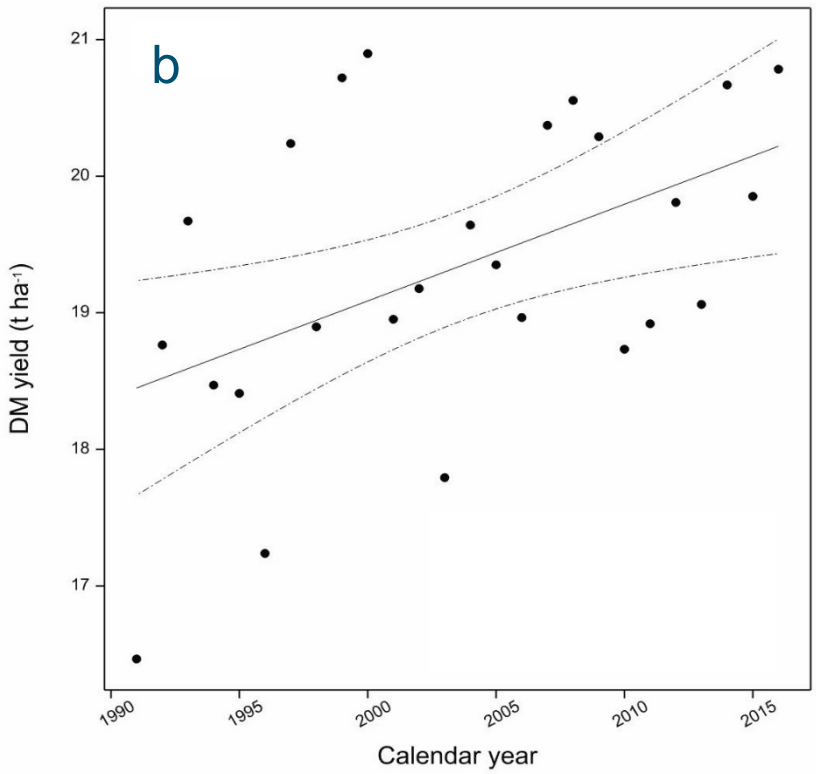
Forage maize – yield trends in VCU experiments

Predicted DM yield in relation to first year of testing



Predicted DM yield in relation to calendar year



Forage maize – quality trends in VCU experiments

	VEM (kg DM^{-1})	
Parameter	Estimate	SE
Constant (μ)	994***	4.483
Genetic trend (first year of testing)	1.778***	0.163
Non-genetic trend (Calendar year)	0.633^{ns}	0.551

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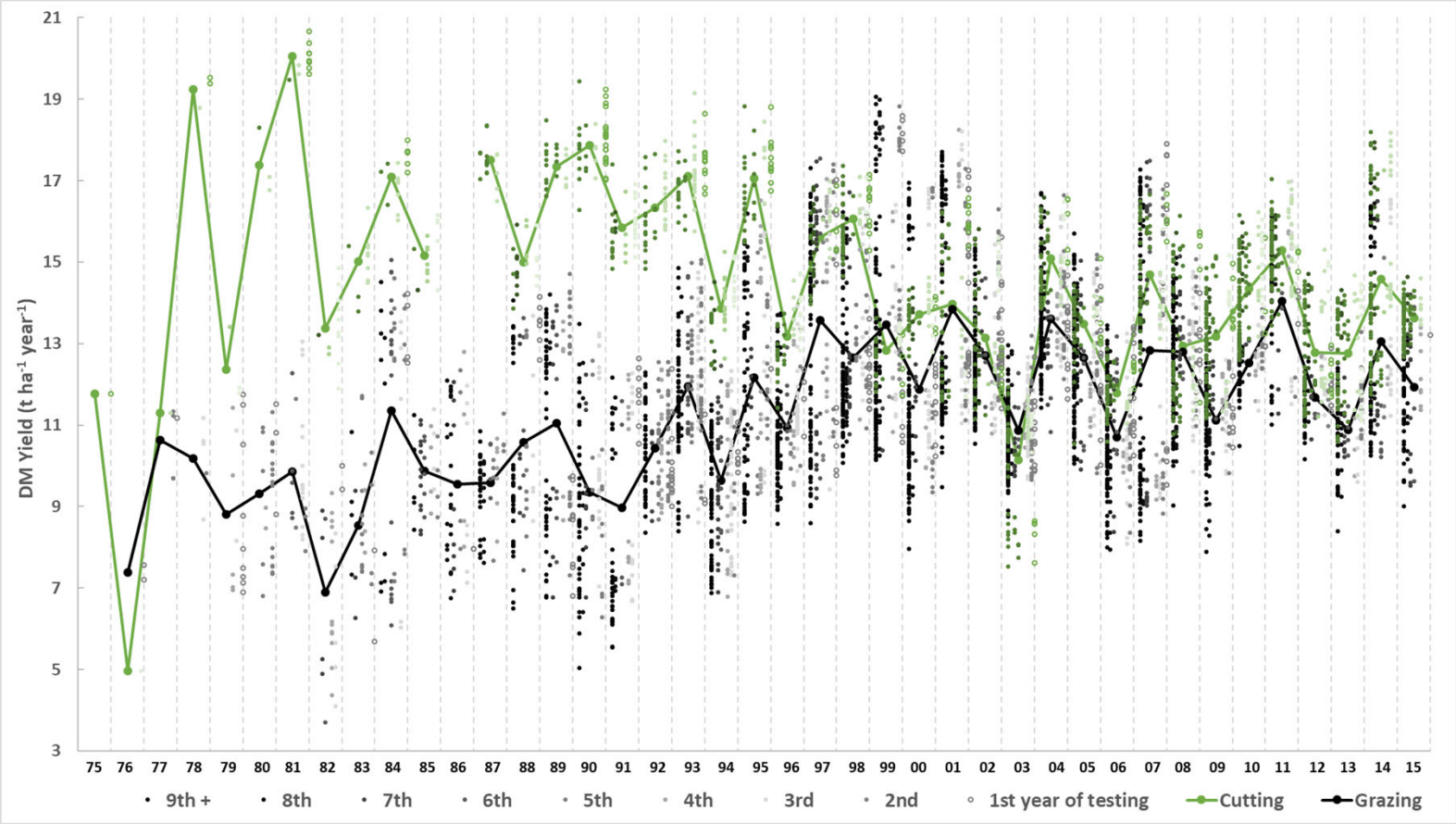
VCU experiments – Grass yields



Grass– yield trends in VCU experiments

	DM yield (t ha^{-1})	
Parameter	Estimate	SE
Constant (μ)	14.663 ***	0.409
Genetic trend (first year of testing)	0.045 ***	0.002
Non-genetic trend (Calendar year)		
- Cutting experiments	- 0.066 *	0.030
- Grazing experiments	0.058 *	0.024

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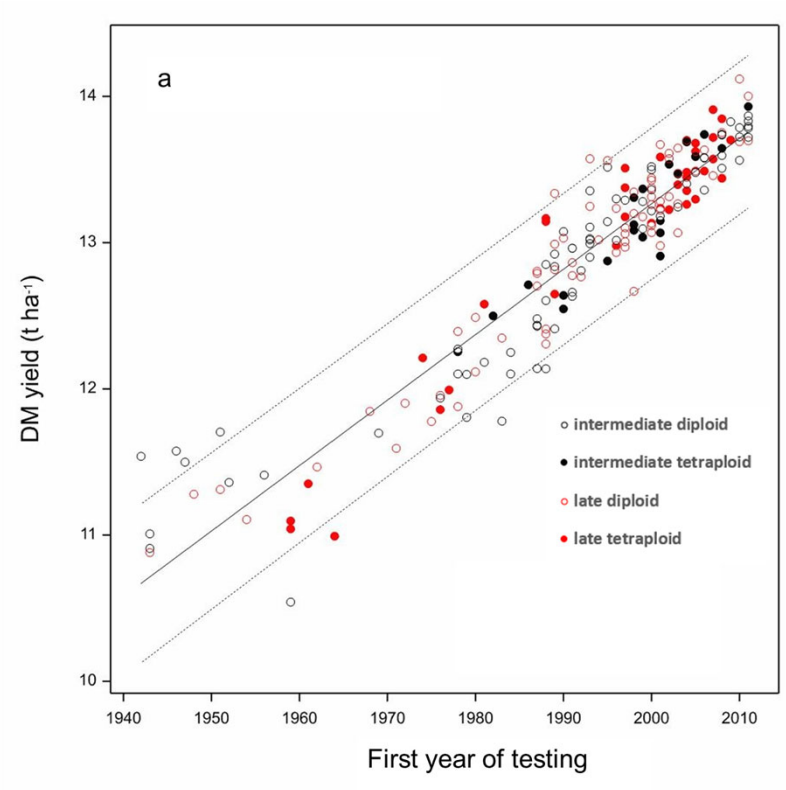
Grass– yield trends in VCU experiments

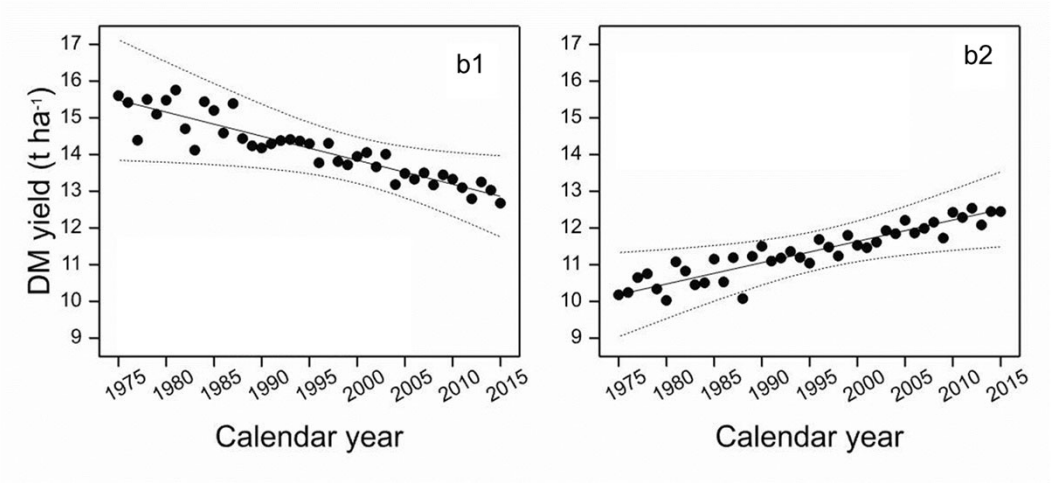
Predicted DM yield in relation to first year of testing



Predicted DM yield in relation to calendar year

Cutting

Grazing



Results of other studies

Forage maize (kg DM/ha/year)		Genetic	Non-genetic
This study	NL	176	71
Laidig et al., 2014	DE	192	-65
Mackay et al., 2011	UK	109	108
Reheul et al., 2017	BE	153	-

Perennial ryegrass (%)		Genetic	Non-genetic
This study	NL	0.36	-0.06
Laidig et al., 2014	DE	0.38	-0.28
Wilkins et al., 2000	UK	0.4	
Chaves et al., 2009	BE	0.3	
Allerit, 1986	FR	0.25	
Veronesi, 1991	IT	0.25	
McDonagh et al., 2016	IE	0.44	

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- Forage production and use in the Netherlands
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- **Trends in on-farm yields**

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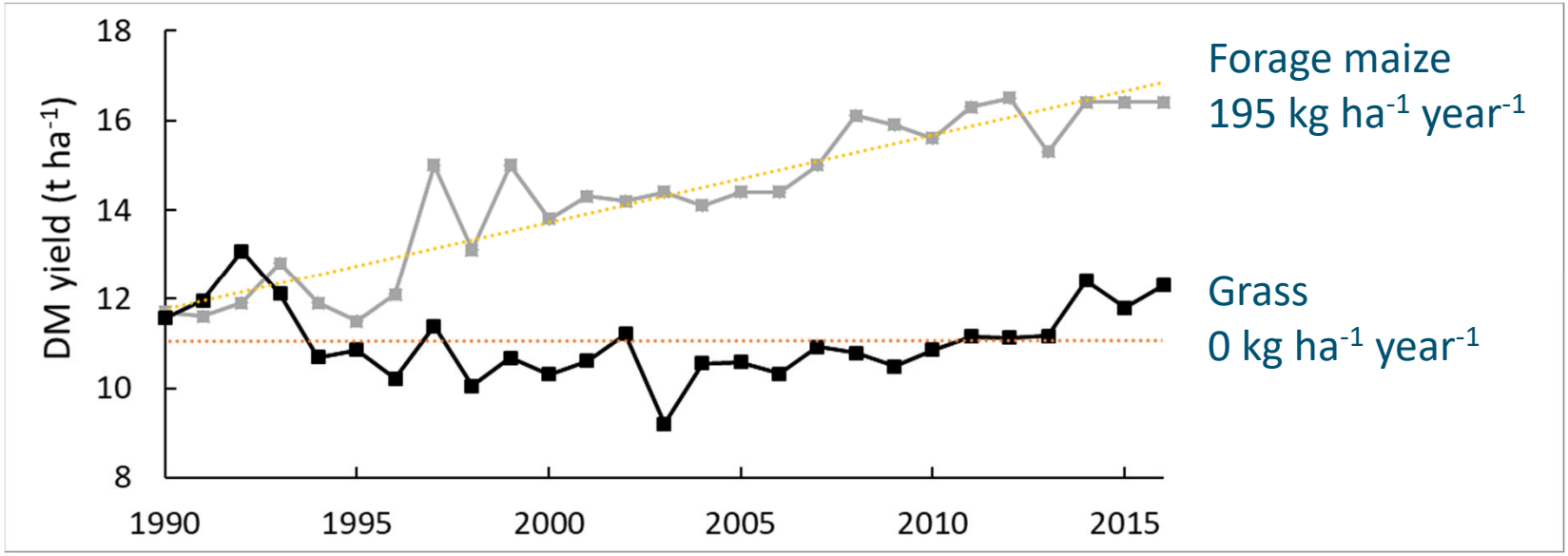
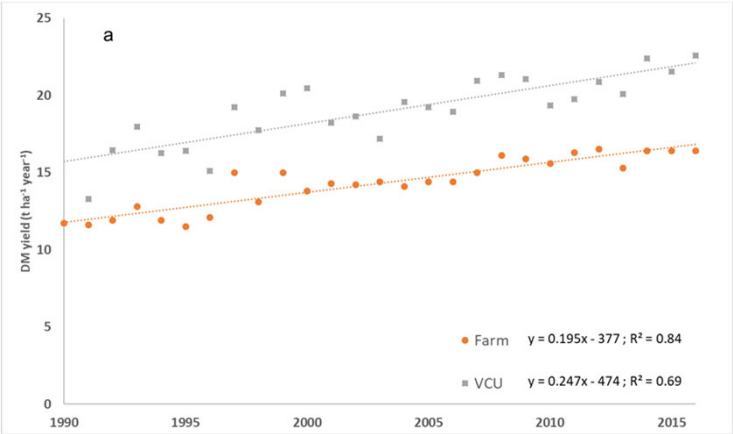
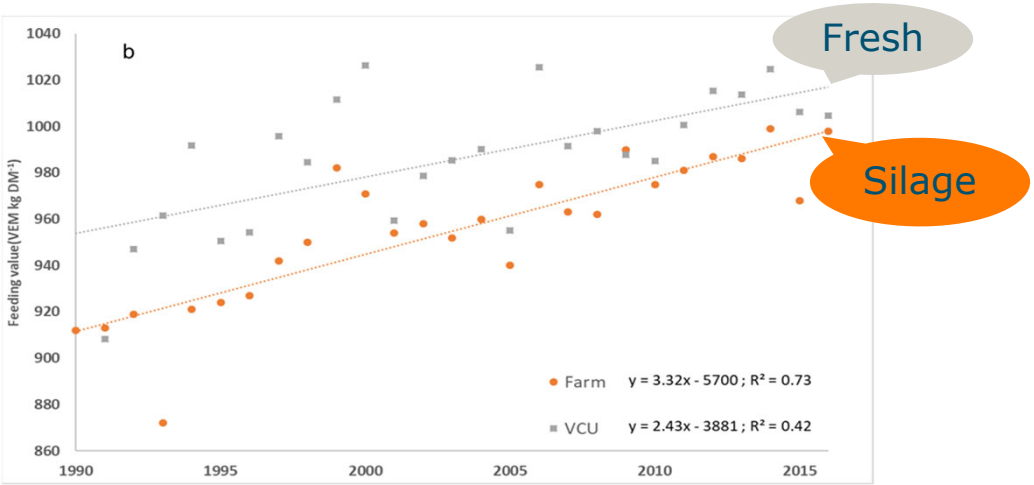
On-farm yield trends



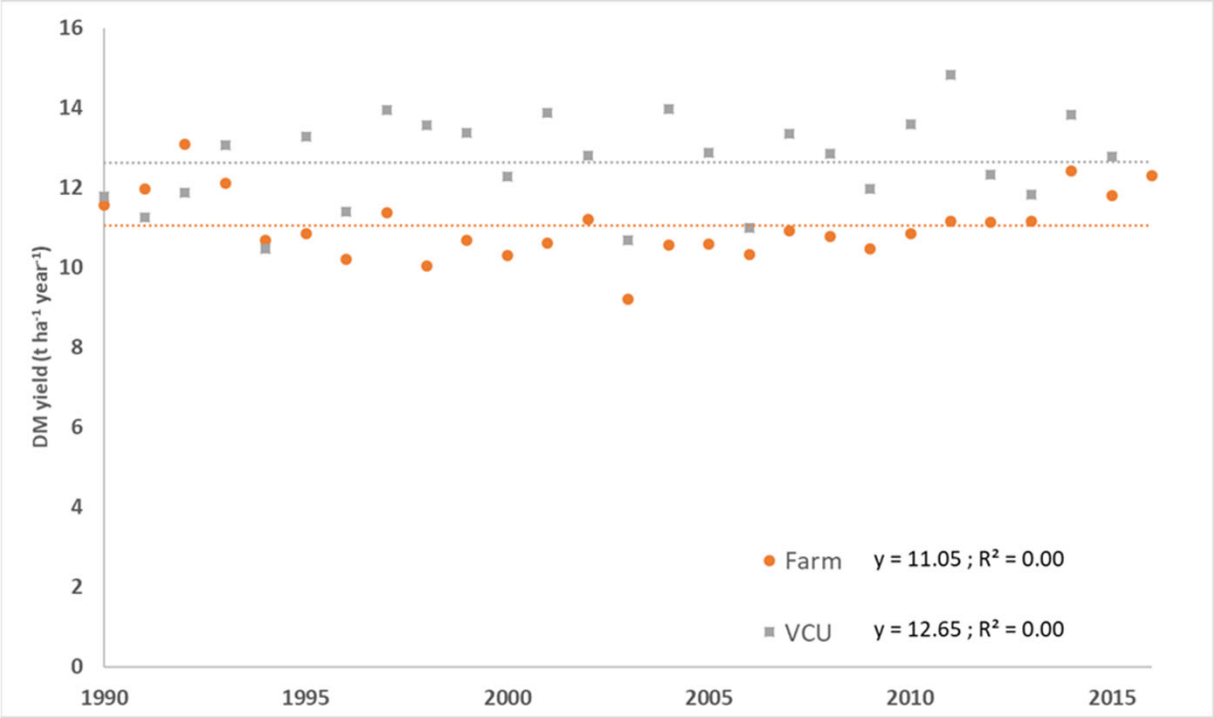
Statistics Netherlands (CBS), 2018

VCU vs. on-farm: forage maize yield and quality

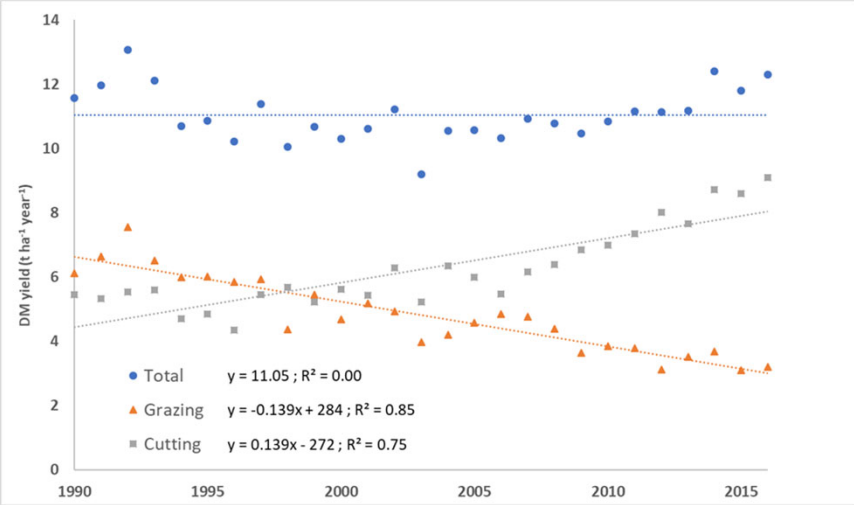




VCU vs. on-farm: grass yield



On-farm grass yields; important management trend



Grassland yields, harvested as silage/hay ("cutting") or as grazed herbage/zero-grazing ("grazing").

In conclusion

- Variety experiments revealed:
  - genetic gains in yields (and quality) of forage maize and perennial ryegrass
  - positive non-genetic trends in yields of forage maize
  - varying non-genetic trends in grass
- Analysis of on-farm data showed
  - positive trends in forage maize yields
  - no trend in grass yields

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