Topics

- Comparison Organic vs. Conventional systems
- Grain legumes as preceding crops
- Assessment of crop diversification strategies
- Ranking of bioenergy species
- Assessment of yield loss due to climate change in France

People

- D. Makowski (INRA)
- E. Pelzer (INRA)
- T. Ben-Ari (INRA)
- C. Lesur (INRA)
- E. Malezieux (CIRAD)

- C. Cernay (PhD student)
- D. Beillouin (post-doc)
- W. Ouaret (MSc)
- J. Hebbrecht (MSc)

Topics

- **Comparison Organic vs. Conventional systems**

  in collaboration with AgriBio4

  MSc student: Walid Ouaret
- **Grain legumes as preceding crops**

  PhD student (C. Cernay)
- **Assessment of crop diversification strategies**

  in collaboration with DiversImpact (EU)

  Post-doc: Damien Beillouin
- **Ranking of bioenergy species**
- **Assessment of yield loss due to climate change in France**

  in collaboration with CLAND

  MSc student: Julia Hebbrecht

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Agron. Sustain. Dev. (2017) 37:45
DOI 10.1007/s13593-017-0455-5

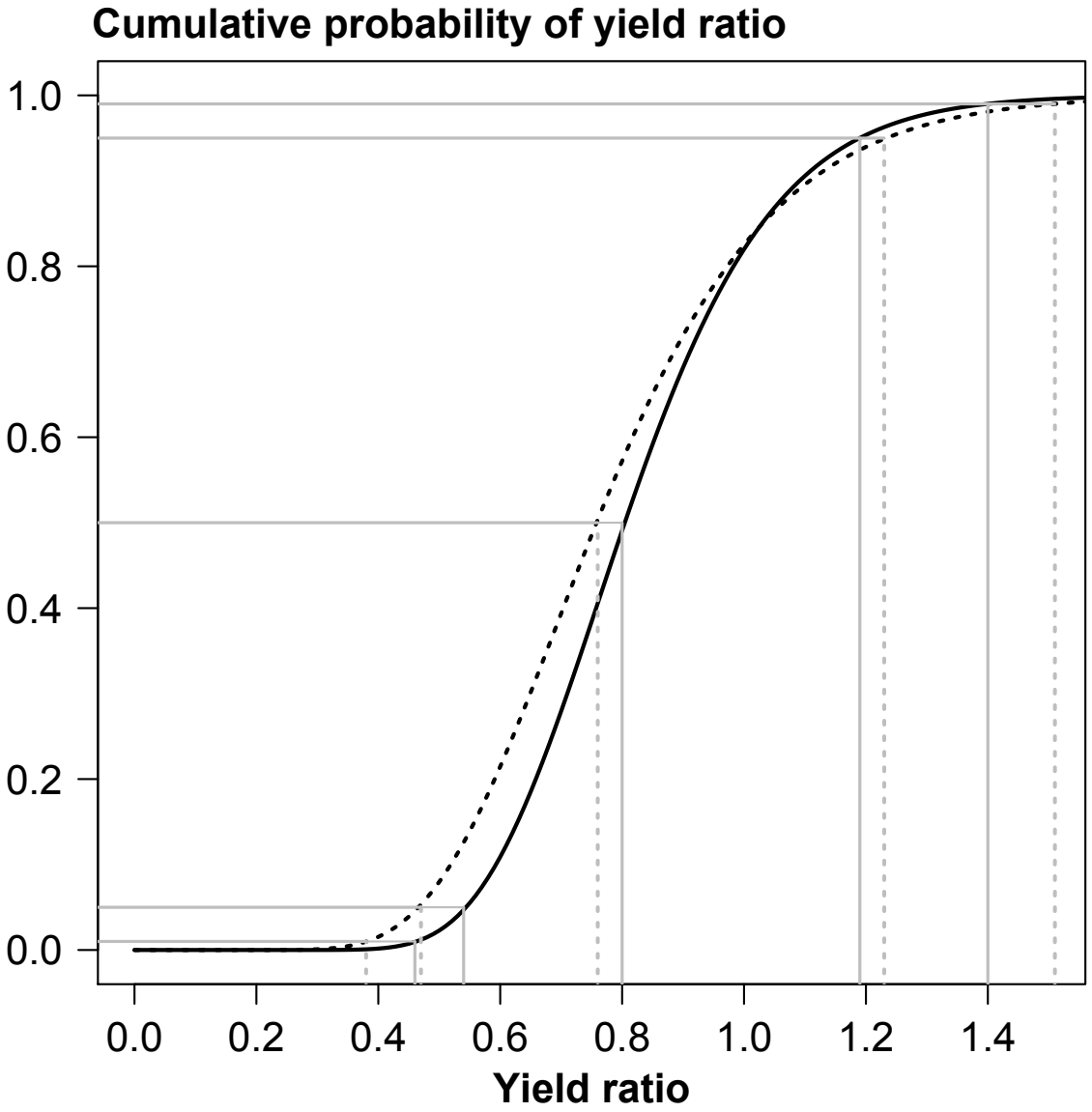
REVIEW ARTICLE

Lower average yields but similar yield variability in organic versus conventional horticulture. A meta-analysis

Claire Lesur-Dumoulin[1] · Eric Malézieux[2] · Tamara Ben-Ari[3] · Christian Langlais[2] · David Makowski[3]

Objective

Compare yields of organic and conventional crops, and analysed their variability across experiments and years.


Cumulative probability of yield ratio
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Yield ratio

Yield mean – Yield variance relationship

Taylor's law: $\sigma^2 = a\mu^b$

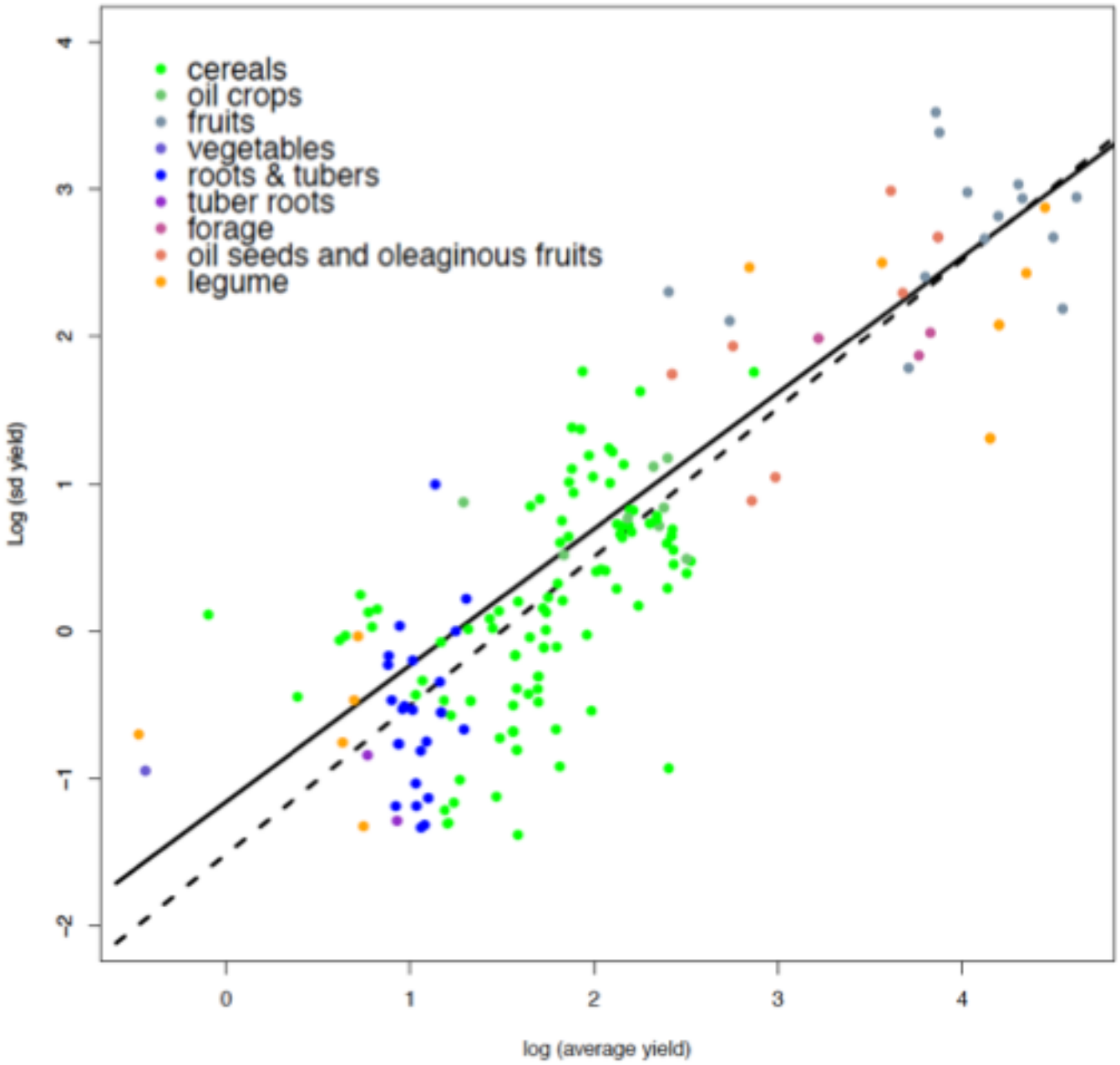
- Does such a relationship exist for inter-annual crop yield variance?
- Does it depend on cropping systems?

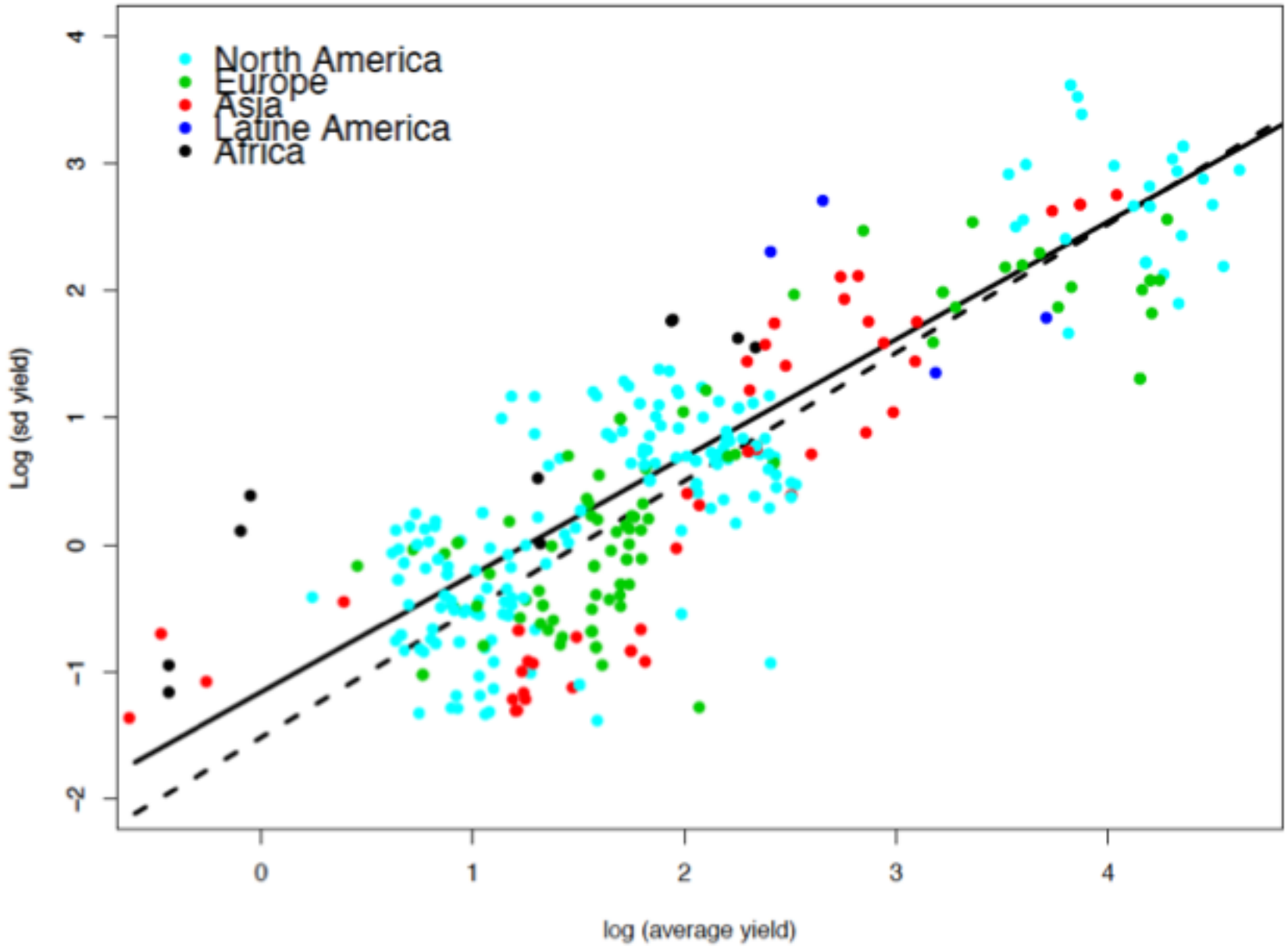
Trial random effect

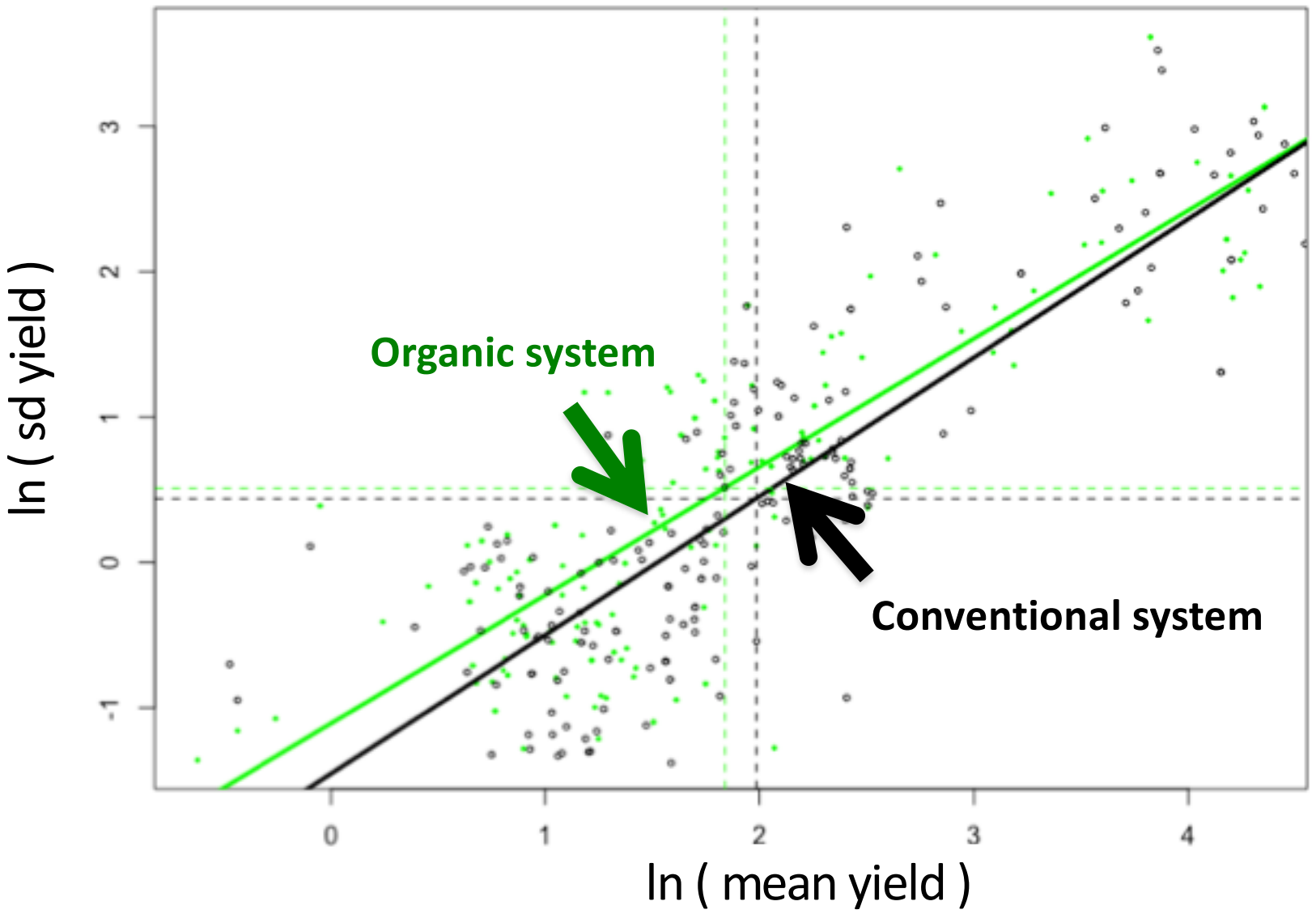
$$\ln(\sigma) = \beta_0 + \beta_1 X + (\beta_2 + \beta_3 X)\ln(\mu) + u + \varepsilon$$

Dummy variable (0,1)
related to cropping system

Within-trial residual


cereals
oil crops
fruits
vegetables
roots & tubers
tuber roots
forage
oil seeds and oleaginous fruits
legume
Log (sd yield)
log (average yield)
4
3
2
1
0
−1
−2
0
1
2
3
4


North America
Europe
Asia
Latine America
Africa
Log (sd yield)
log (average yield)
−2
−1
0
1
2
3
4
0
1
2
3
4


ln (sd yield)
ln (mean yield)
Organic system
Conventional system
-1
0
1
2
3
0
1
2
3
4

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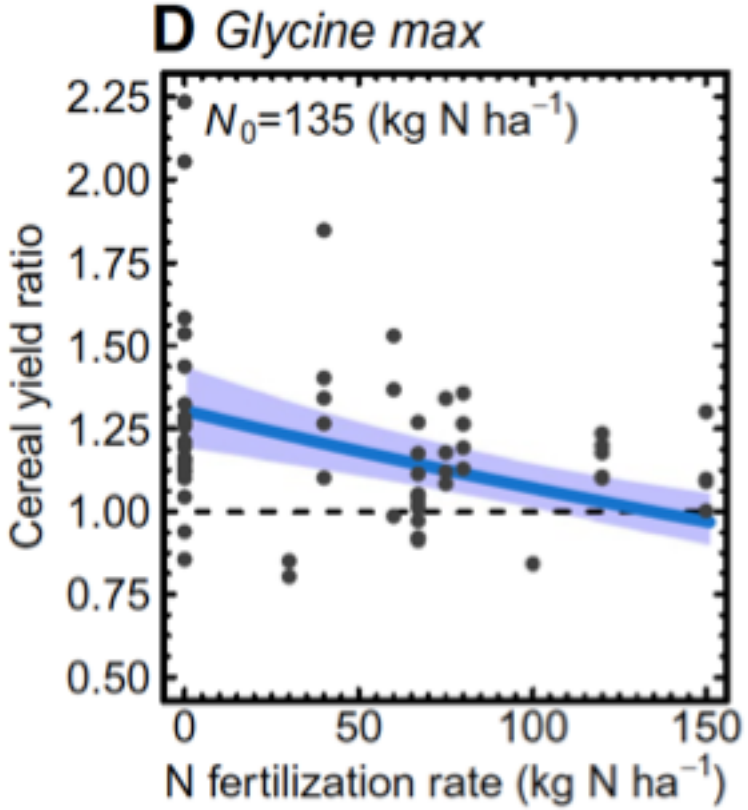
Environmental Chemistry Letters
https://doi.org/10.1007/s10311-017-0698-z

ORIGINAL PAPER

Preceding cultivation of grain legumes increases cereal yields under low nitrogen input conditions

Charles Cernay[1] · David Makowski[1] · Elise Pelzer[1]



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Why synthethizing results on crop diversification ?

- Numerous strategies of crop diversification are proposed

Inter-cropping

cultivar mixture

Agroforestry

Photos:

Agroforestry World - World Agroforestry Centre

Agronomic Crops Network - The Ohio State University

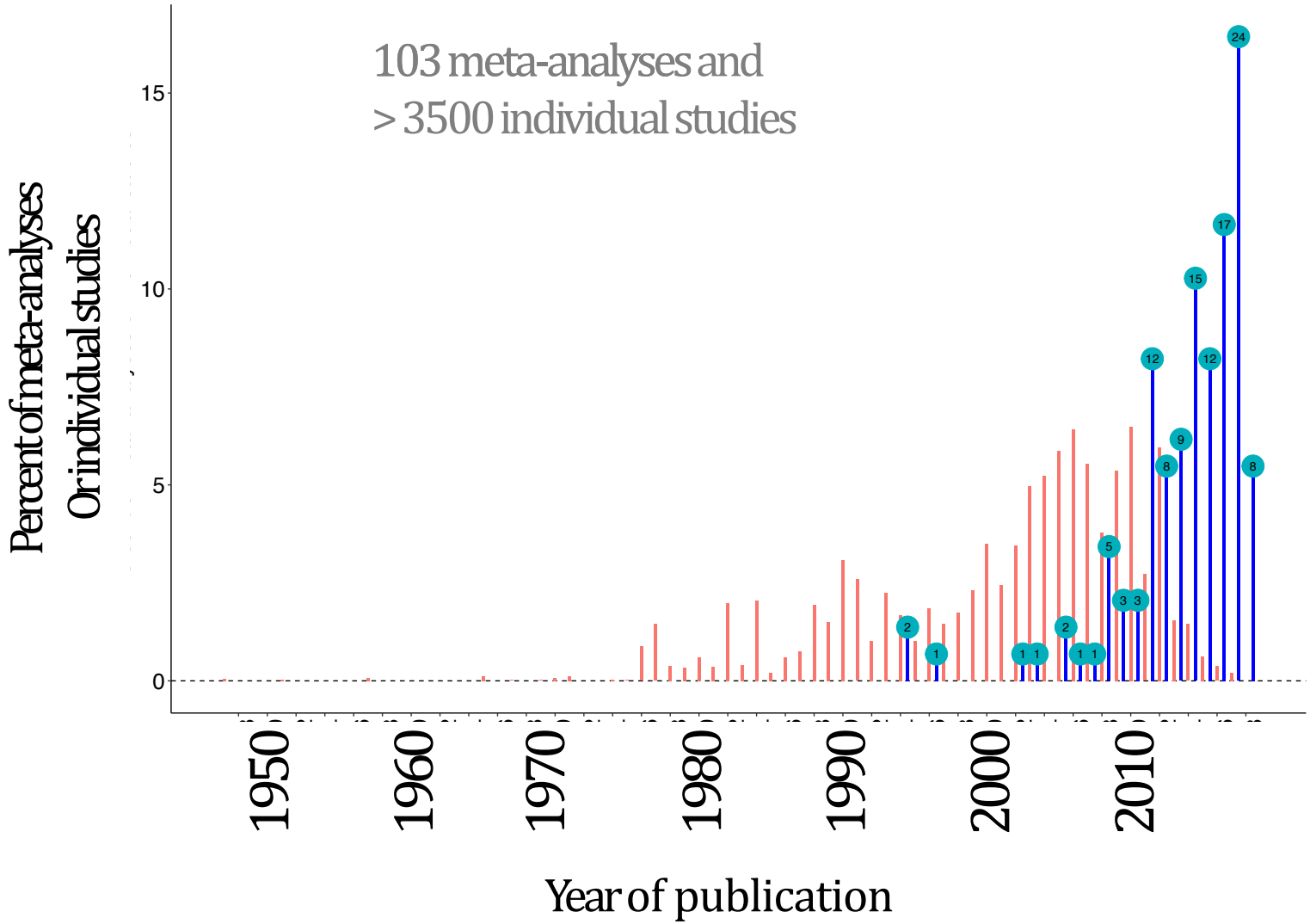
American Phytopathological Society

Why synthethizing results on crop diversification ?

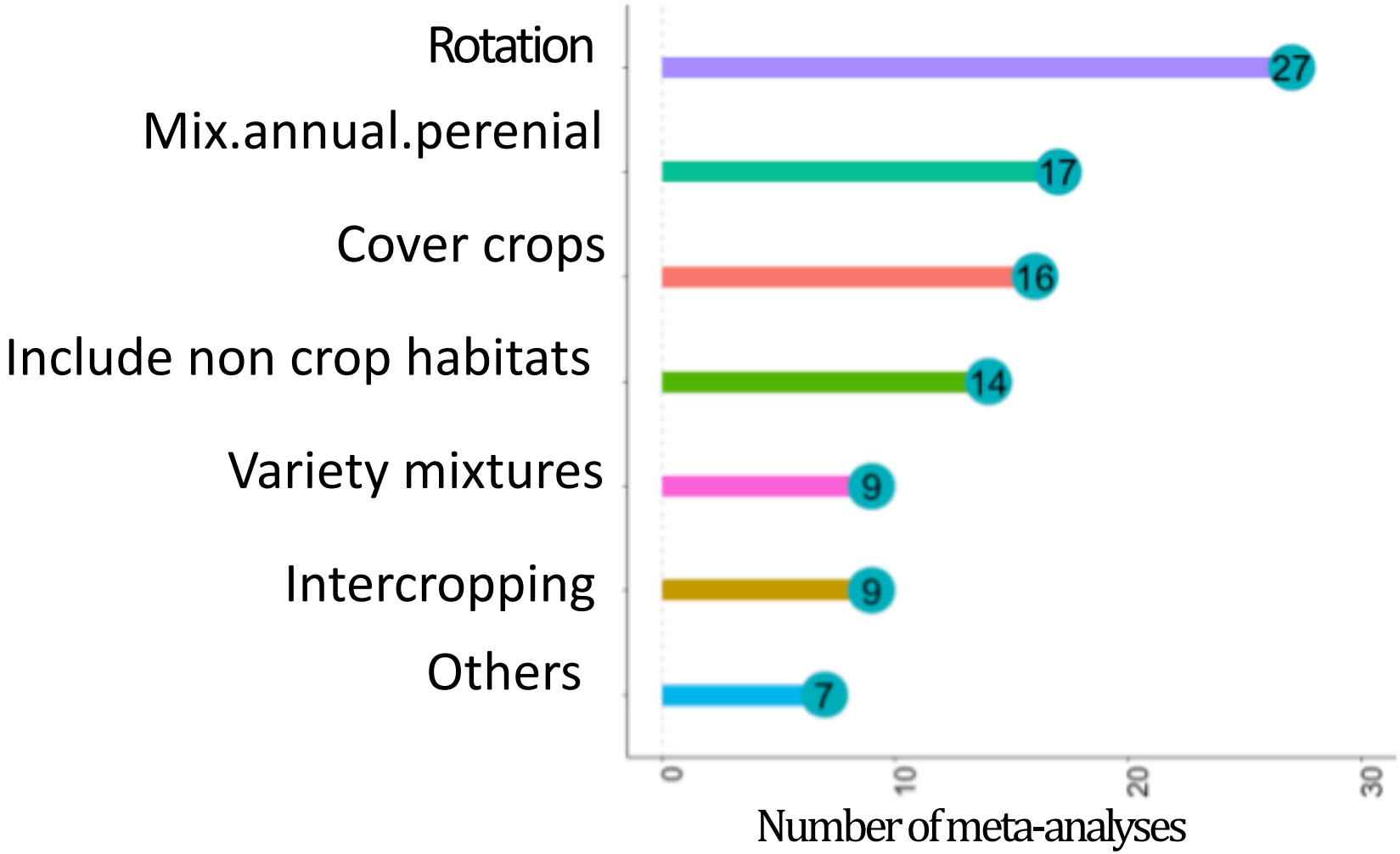
- Numerous strategies of crop diversification are proposed
- Many experiments has been performed in different countries

Experimental sites that have conducted experiments on crop diversification

Meta-analyses published on crop diversification



Strategies of diversification explored:



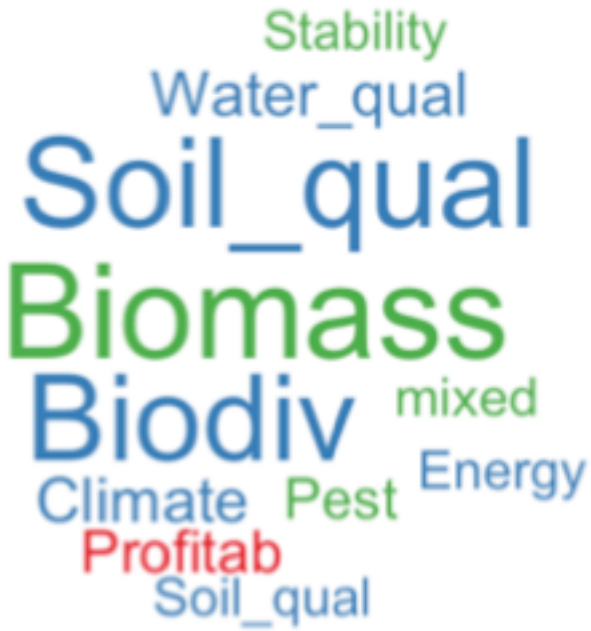
Type of output analysed:

Environment:
50 MA

Production:
43 MA

Economy:
6 MA

Subcategories of output :



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One experiment comparing two species

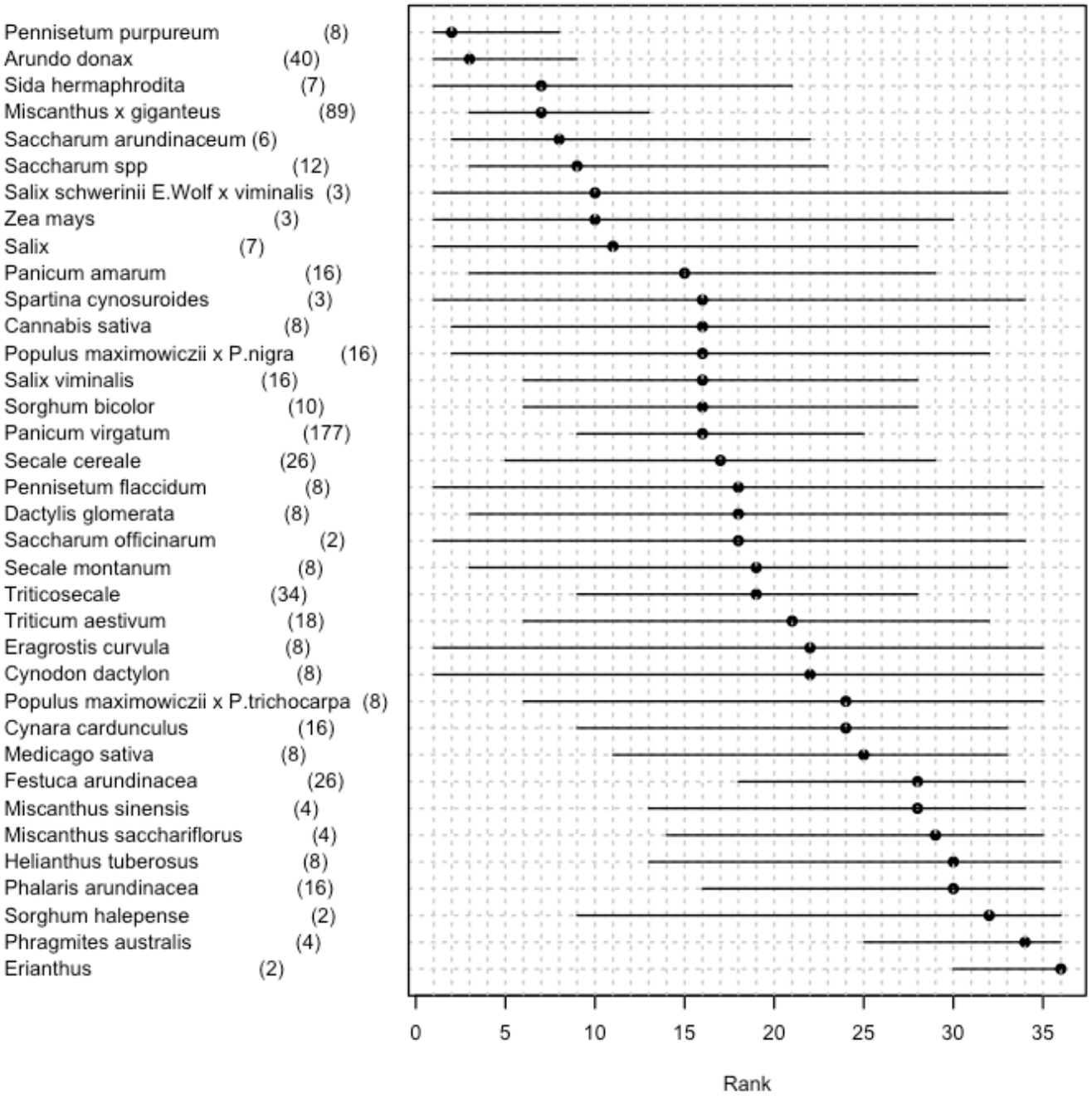
Yield of species 1

Yield of species 2

Dataset including *N* experiments comparing *P* species

How could we rank the *P* species according to their productivity from such dataset?

Network of experimental data



639 yield data

1: Miscanthus x giganteus
2: Panicum virgatum
3: Salix
4: Triticosecale
5: Erianthus
6: Sorghum halepense
7: Saccharum officinarum
8: Zea mays
9: Sorghum bicolor
10: Pennisetum purpureum
11: Phalaris arundinacea
12: Miscanthus sinensis
13: Phragmites australis
14: Arundo donax
15: Cynara cardunculus
16: Miscanthus sacchariflorus
17: Sida hermaphrodita
18: Salix viminalis
19: Triticum aestivum
20: Secale cereale

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Stage de Julia Hebbrecht

$$Ln(Y_{i,t}) = a_i + b_i t + c_i t^2 + dT_{i,t} + eT^2_{i,t} + fP_{i,t} + gP^2_{i,t} + \varepsilon_{i,t}$$

Predicted Yield

t: year of yarvest

a_i, b_i, c_i: parameters

T: mean temperature

P: precipitation

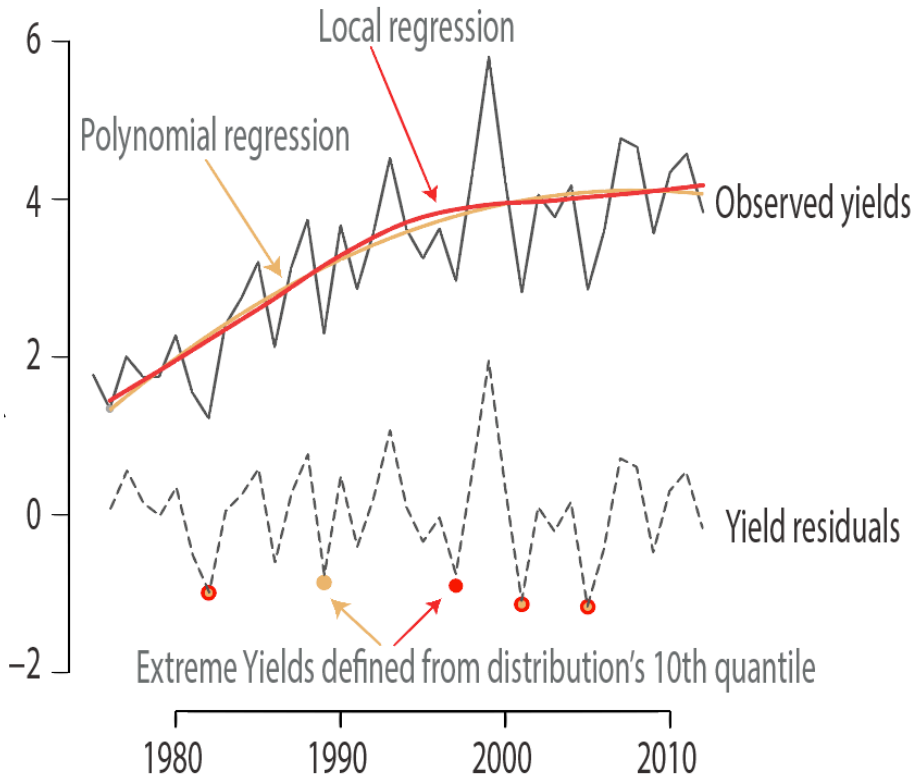
d, e, f, g: parameters

Residual

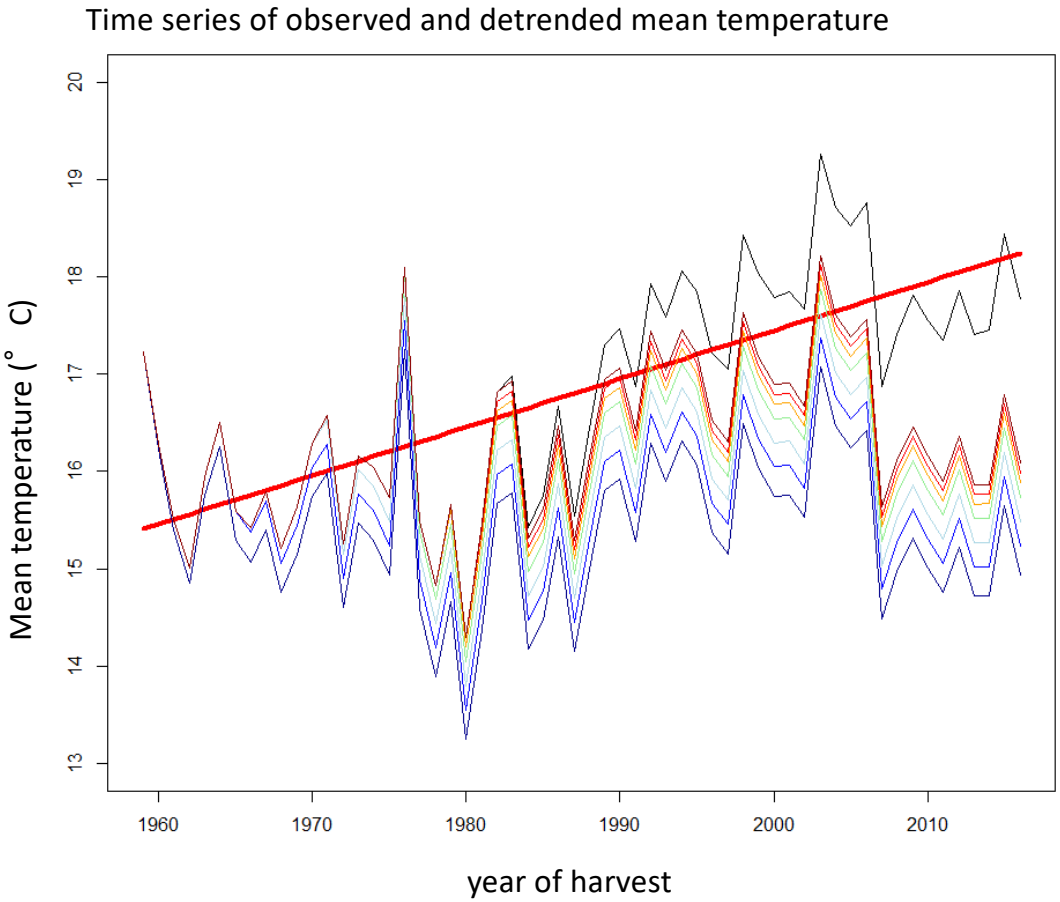
i: departement

t: year of harvest

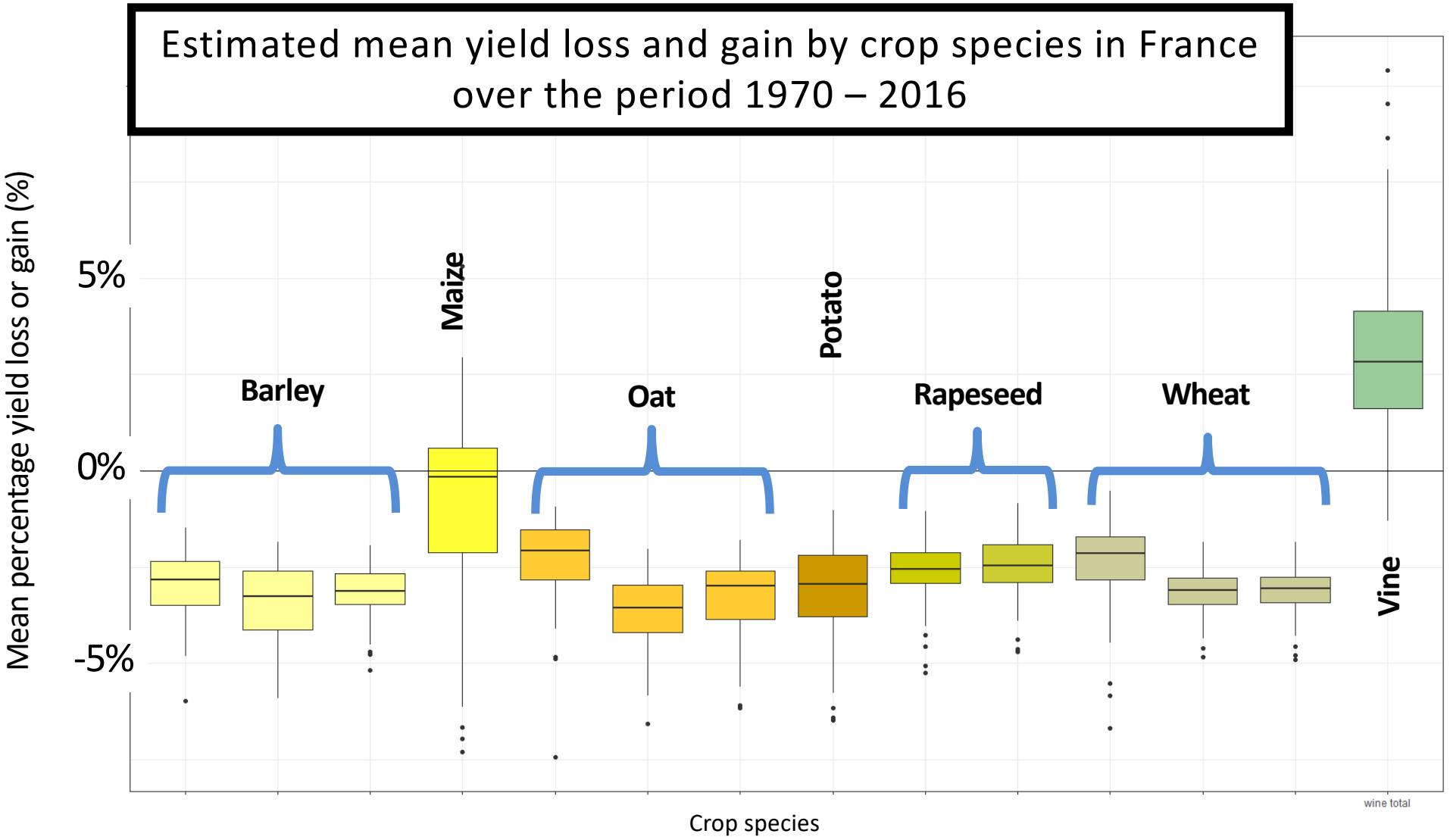
All temperature and precipitation values are **means** over the **last four months of the growing season** and are **centered** and **reduced.**


Local regression
Polynomial regression
Observed yields
Yield residuals
Extreme Yields defined from distribution's 10th quantile
6
4
2
0
−2
1980
1990
2000
2010

Lobell's detrending method to « remove climate change »

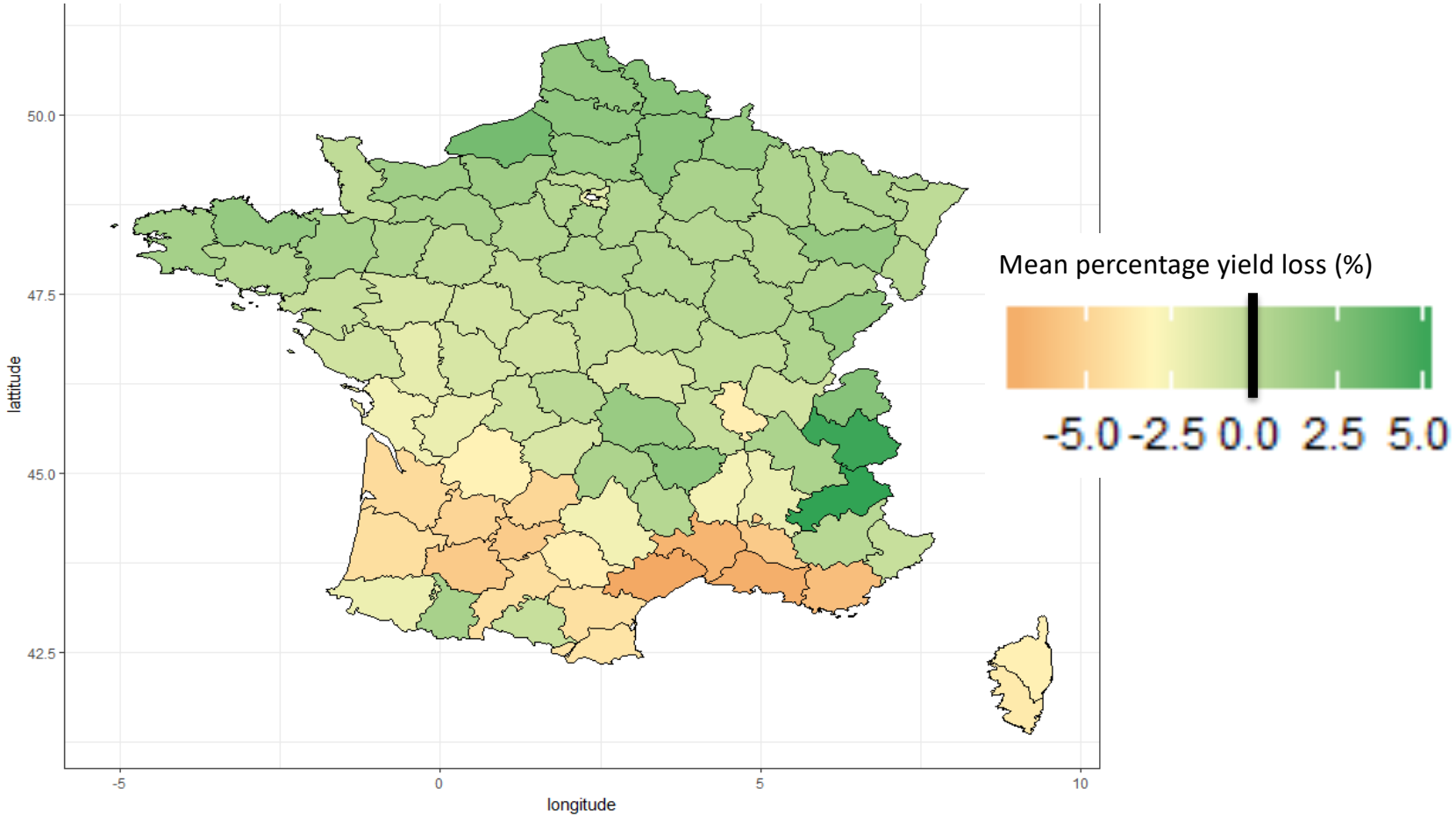


- Climate variable: **Tmean**
- Crop:
  Winter wheat
- Departement:
  Allier
- Start year
  of detrending:
  1958, 1960, 1965,
  1970, 1975, 1980


Estimated mean yield loss and gain by crop species in France over the period 1970 – 2016
Mean percentage yield loss or gain (%)
5%
0%
-5%
Barley
Maize
Oat
Potato
Rapeseed
Wheat
Vine
wine total
Crop species

Maize

Average yield loss and gain over the period 1970 - 2016



Bonus

Global Change Biology

Global Change Biology (2016) 22, 3383–3394, doi: 10.1111/gcb.13341

Spatially explicit estimates of N_2O emissions from croplands suggest climate mitigation opportunities from improved fertilizer management

JAMES S. GERBER[1], KIMBERLY M. CARLSON[1,2], DAVID MAKOWSKI[3], NATHANIEL D. MUELLER[4,5], IÑAKI GARCIA DE CORTAZAR-ATAURI[6], PETR HAVLÍK[7], MARIO HERRERO[8], MARIE LAUNAY[6], CHRISTINE S. O'CONNELL[1†], PETE SMITH[9] and PAUL C. WEST[1]