Sugar beet fertilization practices in Germany
- N, P, K -

4. and 5. December 2018, Paimio and Säkylä

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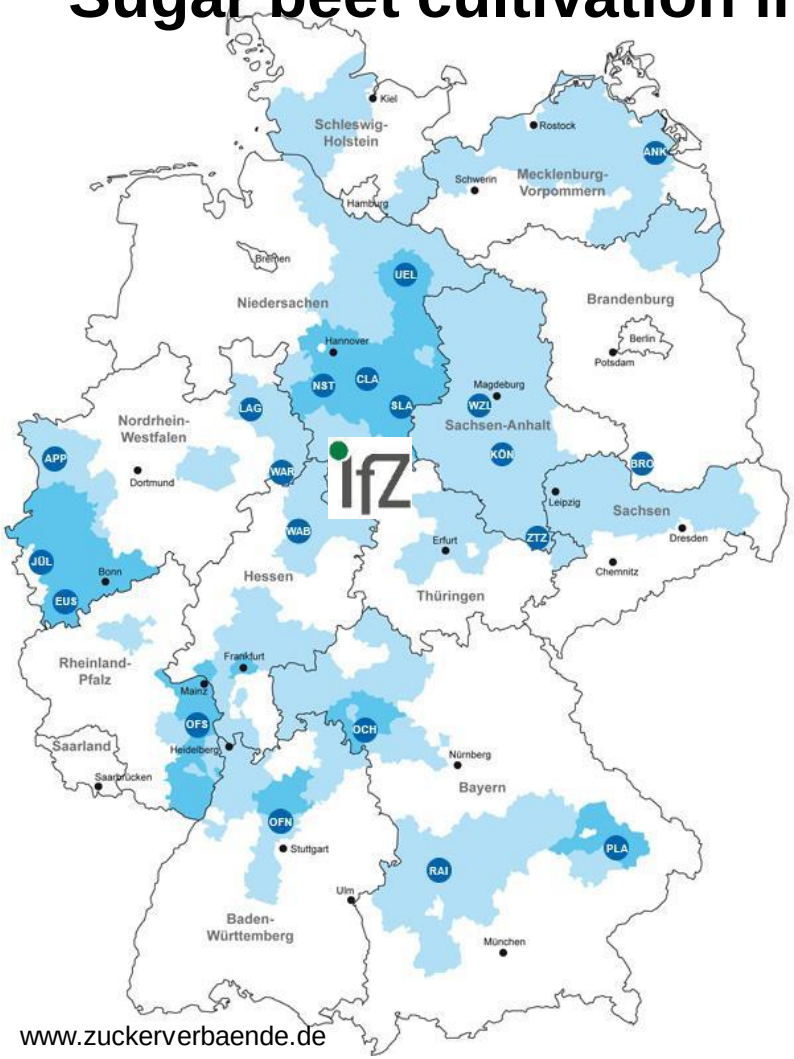
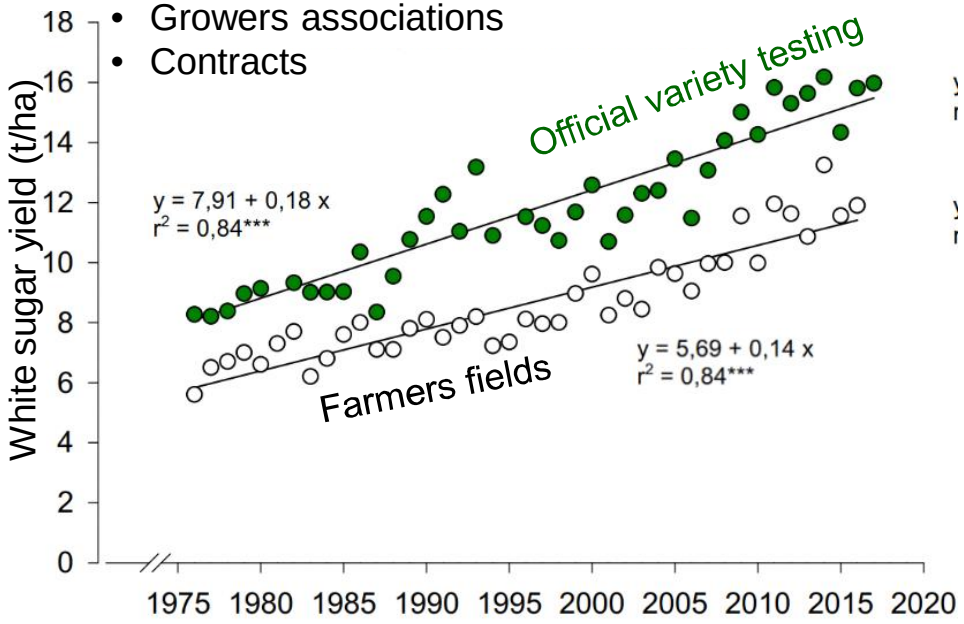
Sugar beet cultivation in Germany



www.zuckerverbaende.de

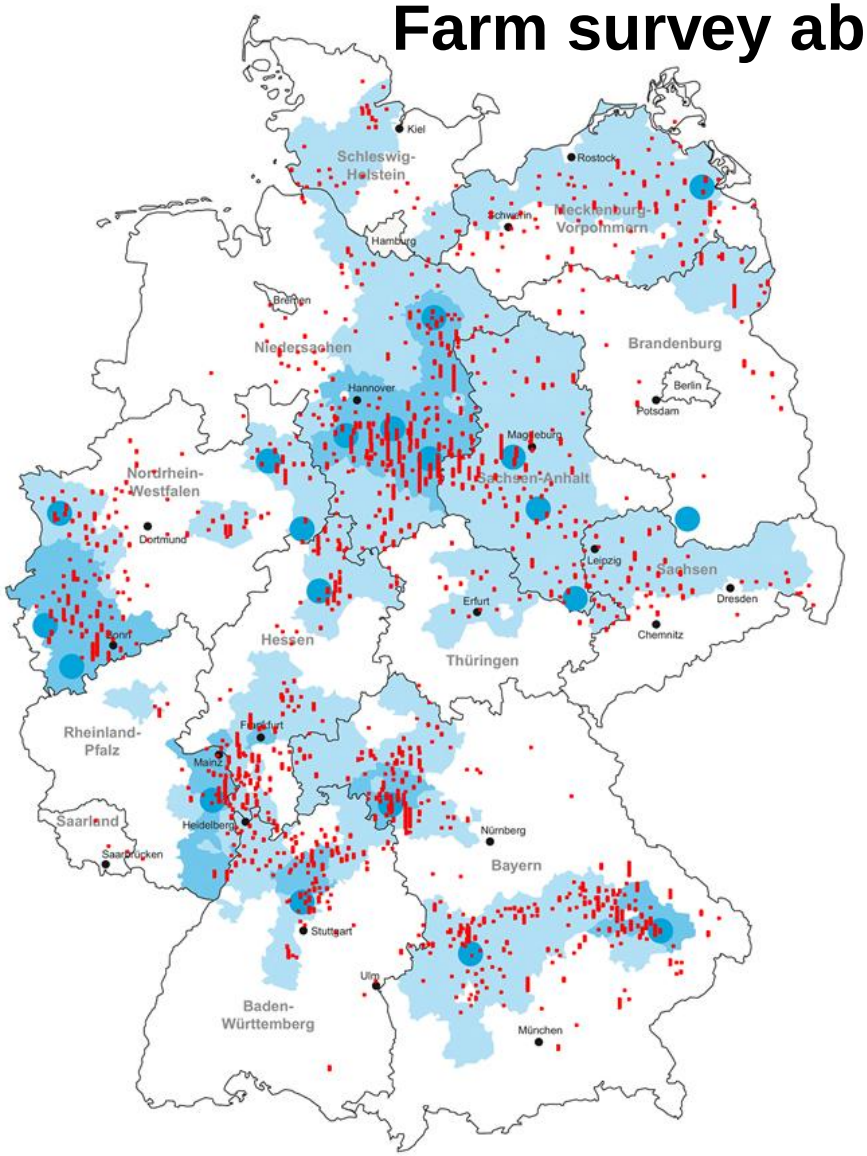
Characteristics

- ~400.000 ha p.a.
  (out of 11.7 mio ha arable land)
- ~25.000 sb growers (Ø ~12 ha/grower)
- 20 sugar factories
- 4 companies
- Growers associations
- Contracts



Jahresbericht IfZ 2016/2017

Farm survey about cropping techniques in sugar beet cultivation in Germany



2.984 farms since 2010

sugar factories

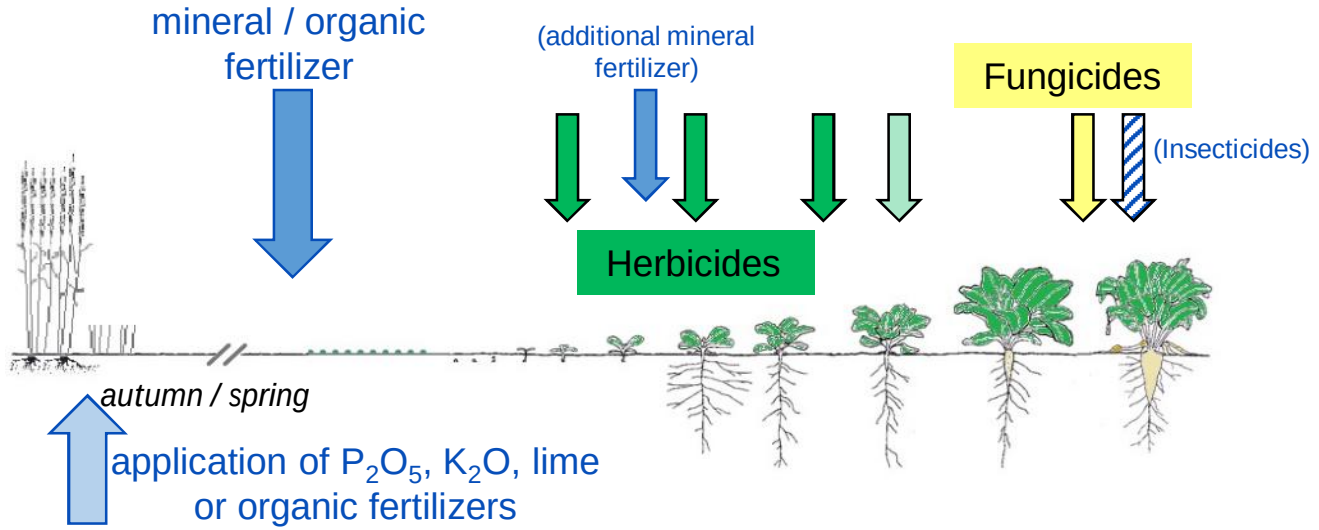
sugar beet area

Timetable

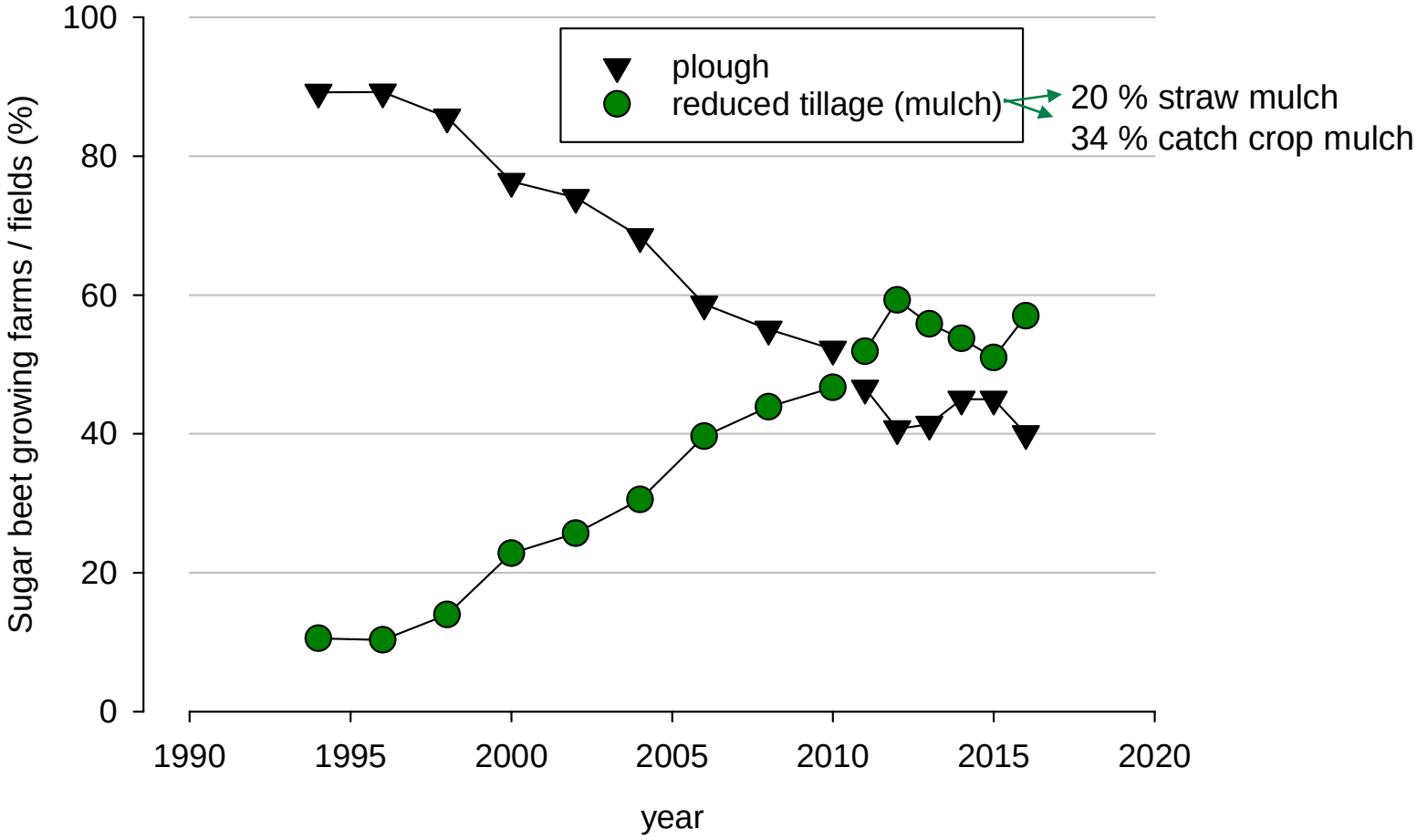
...

Pre-crop Catch crop Winter Sowing: end of march
(20.03. – 15.04.)
resowing: 1 % (main reason: erosion)

Harvest:
Sept. – Nov.

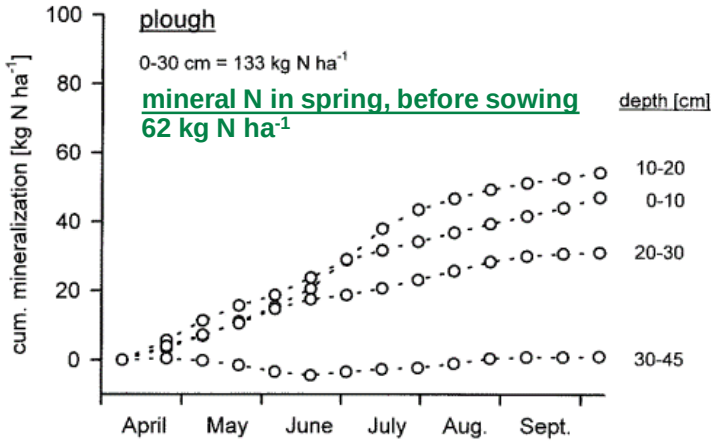


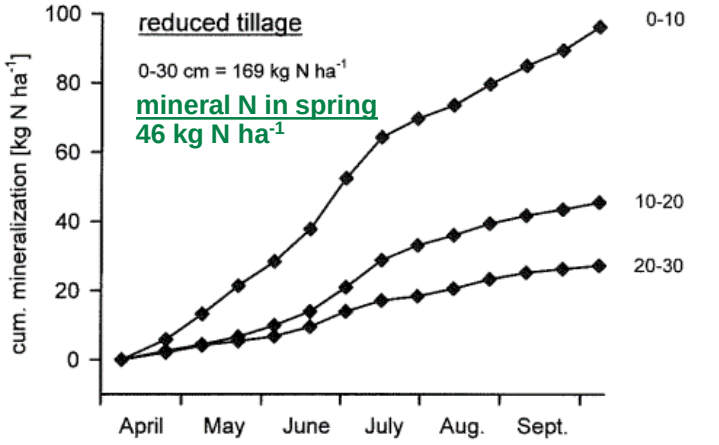
Soil tillage

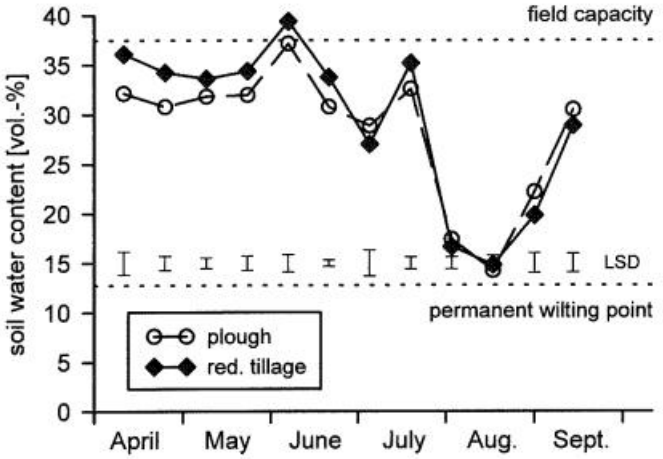


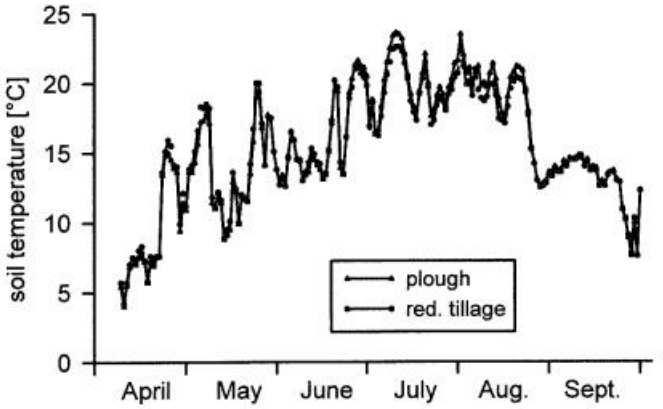
Results from a survey among experts from sugar companies (1994-2010; estimated percent of beet growing area) joint with results from a survey among farms (since 2010, more than 300 farms each year, answers given for the largest sugar beet field)

Influences of soil tillage on N mineralisation during the growing season





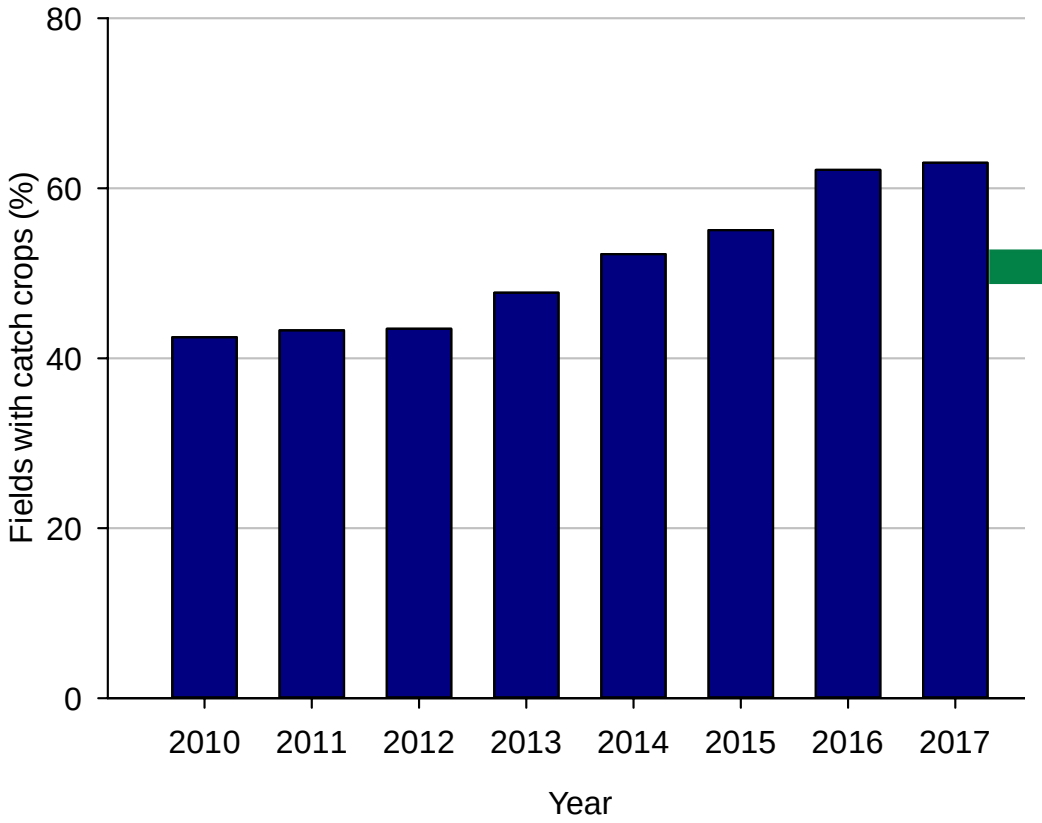


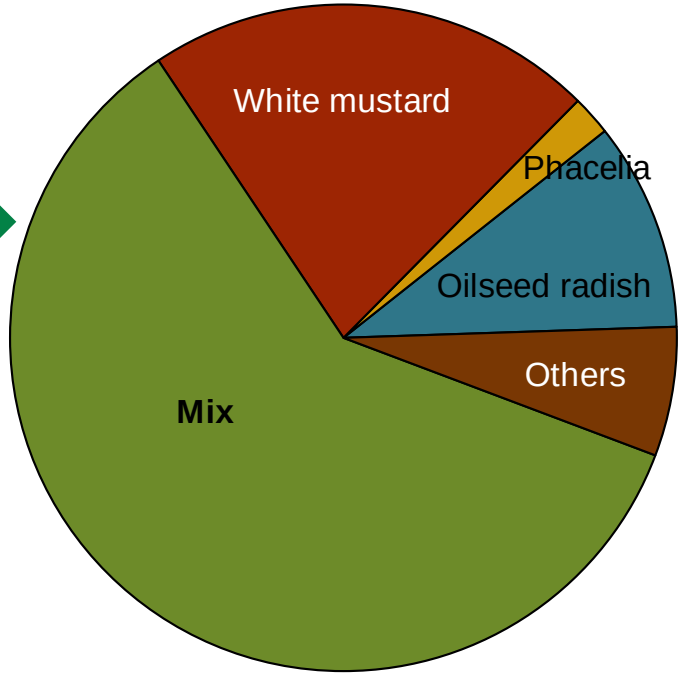


- results from unfertilized plots in a tillage trial in Göttingen 1995 after 4 years of different tillage applied, *in situ*-incubation of soil cores in the field -

Hoffmann et al., 1997

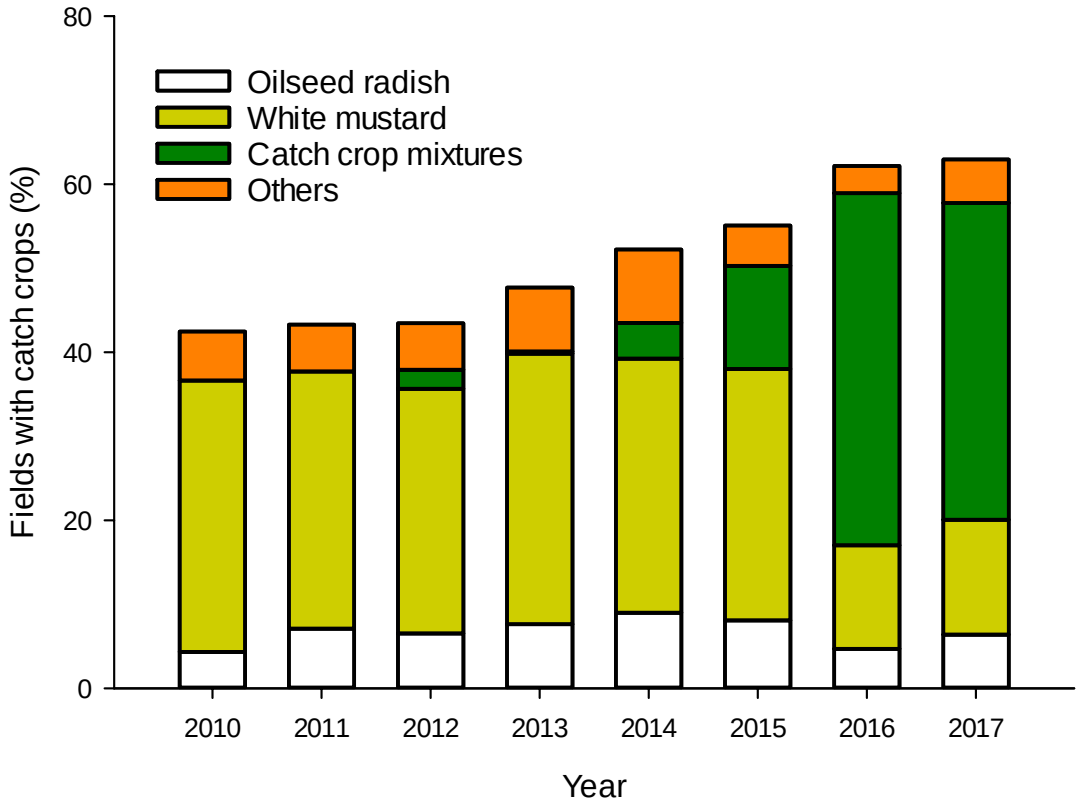
Catch crops





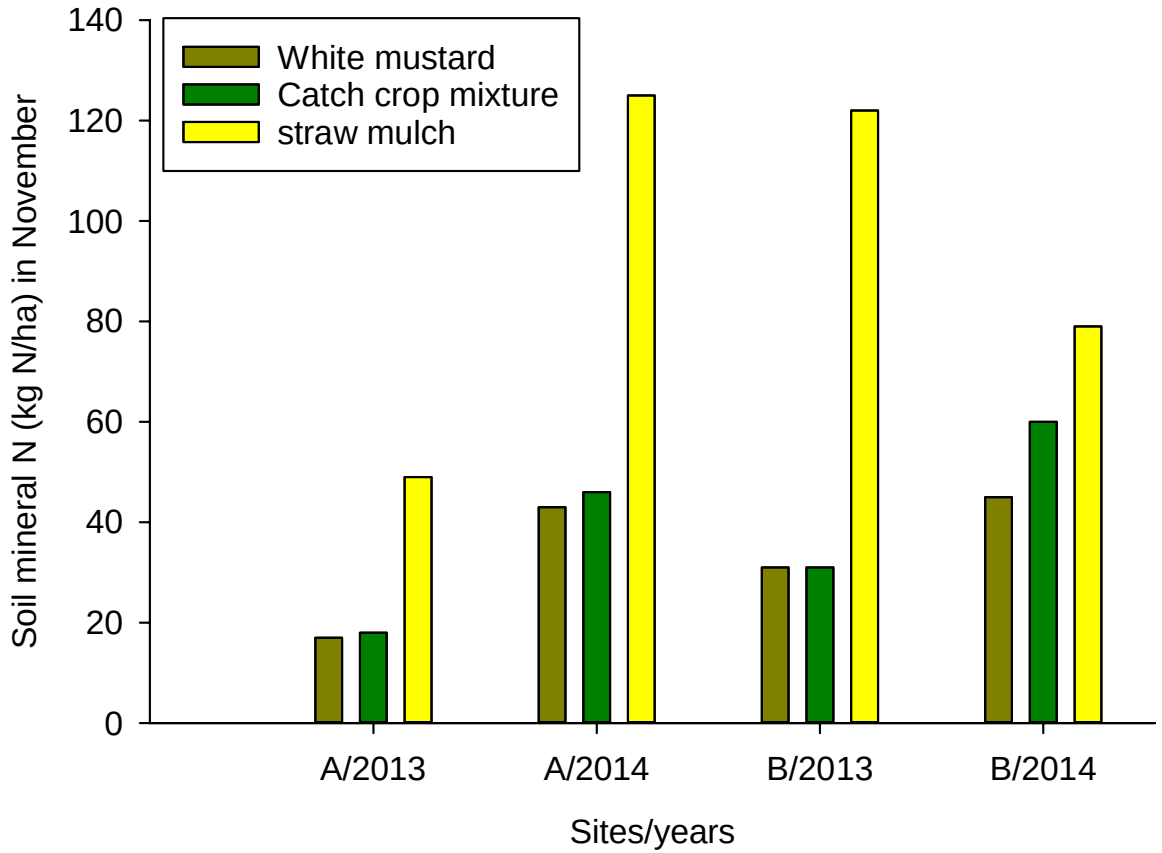
Survey about sugar beet cultivation among farms (since 2010, more than 300 farms each year, answers given for the largest sugar beet field)

Catch crops - development



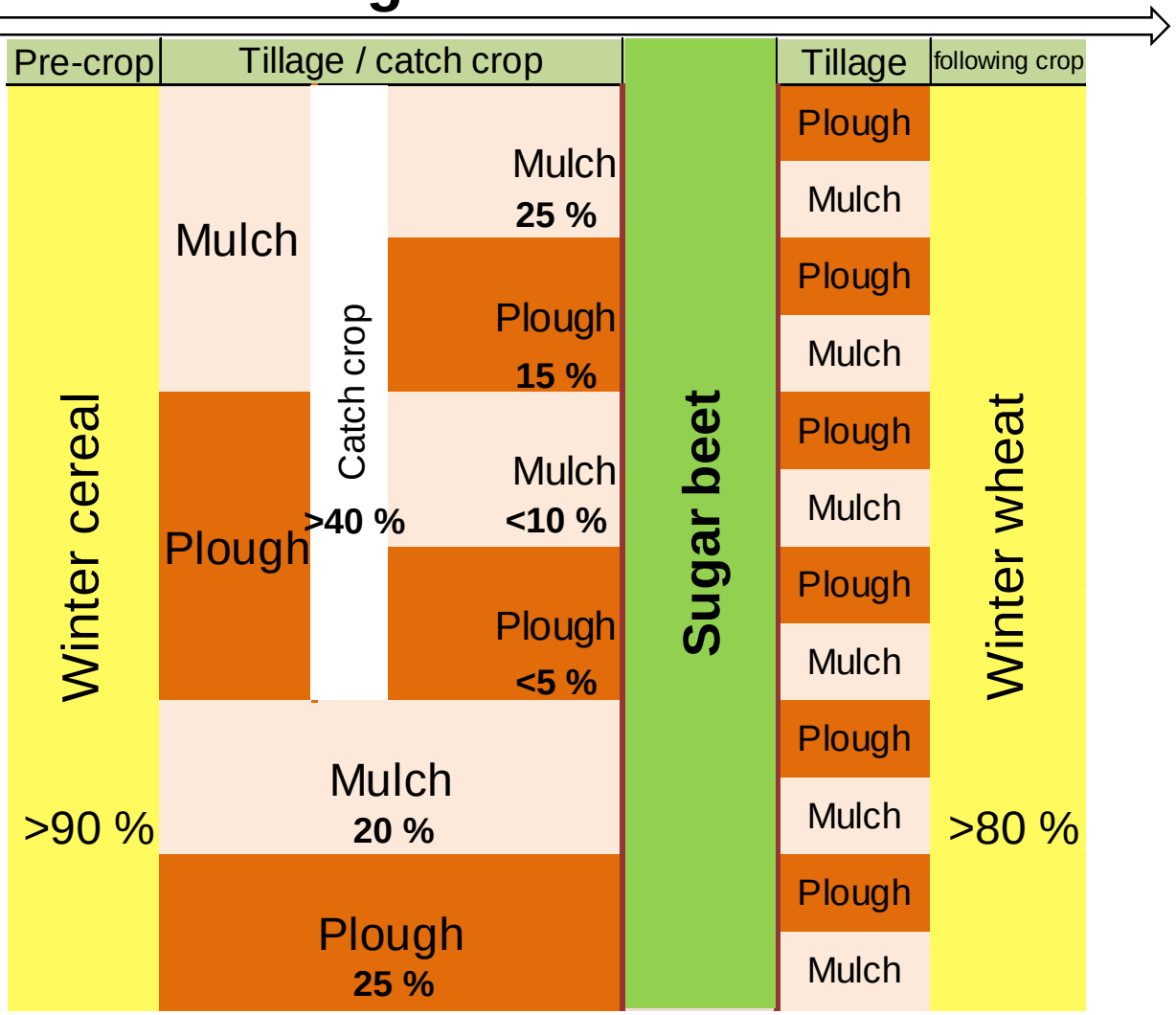
Survey about sugar beet cultivation among farms (since 2010, more than 300 farms each year, answers given for the largest sugar beet field)

Catch crops help to prevent nitrate leaching



Hauer et al. 2016

Crop rotations and tillage



Survey about sugar beet cultivation among farms (since 2010, more than 300 farms each year, answers given for the largest sugar beet field)

Background

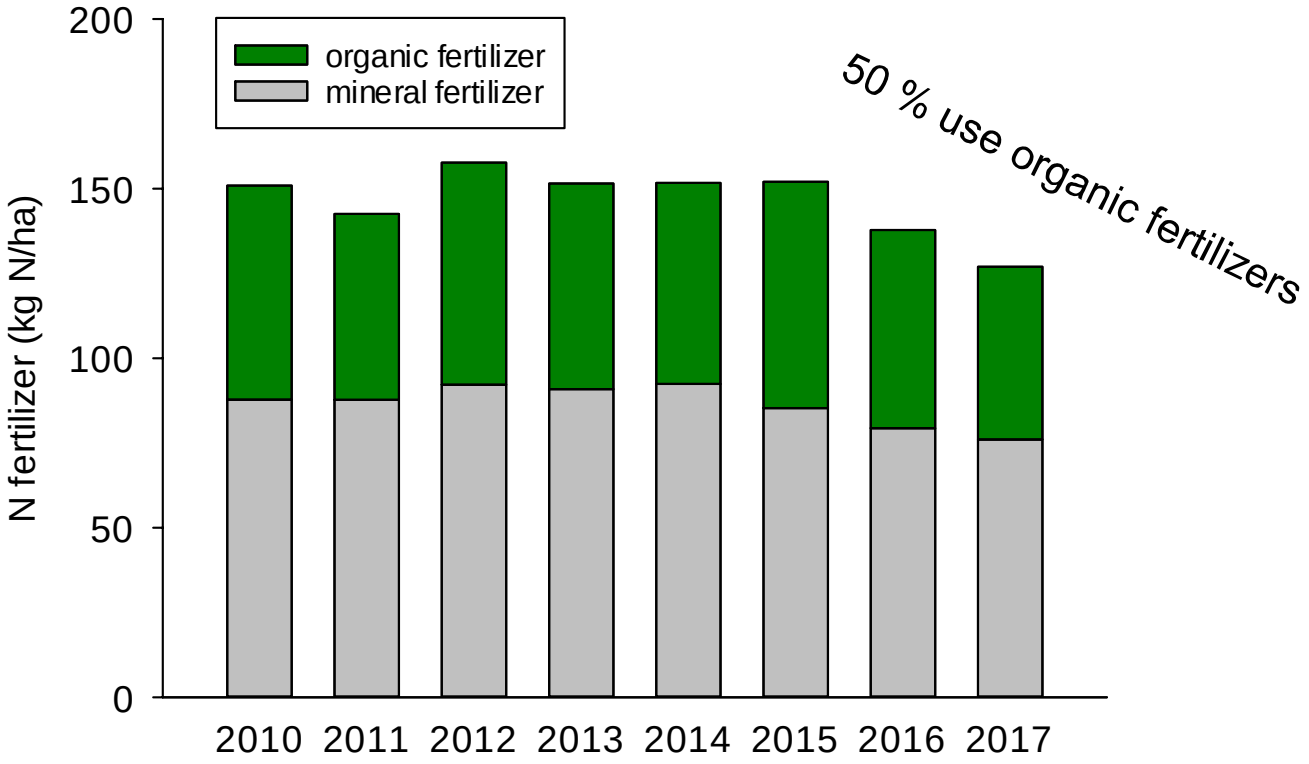
1. **Adequate nutrient supply** is fundamental for high yielding crops
2. **Fertilizer application** is essential for adequate nutrient supply,

   but can contribute to negative environmental effects

   - pollution of ground (N) and surface water (N, P)
   - N_2O and NH_4 emissions
3. **Fertilizer application** has to meet either goals:

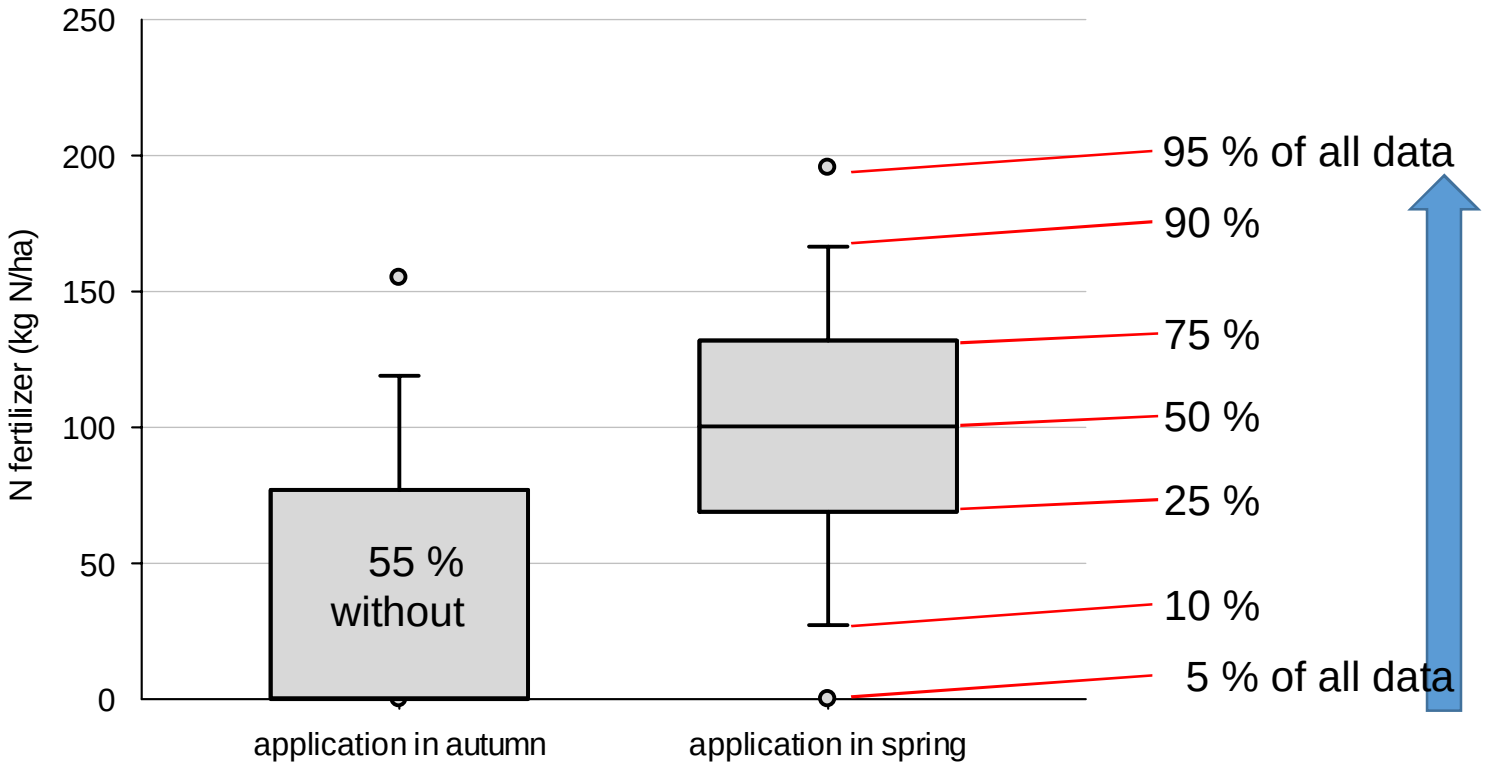
   - optimum nutrient supply of sugar beet crops
   - minimize environmental risks

Use of mineral and organic fertilizers



Survey about sugar beet cultivation among farms (since 2010, more than 300 farms each year, answers given for the largest sugar beet field)

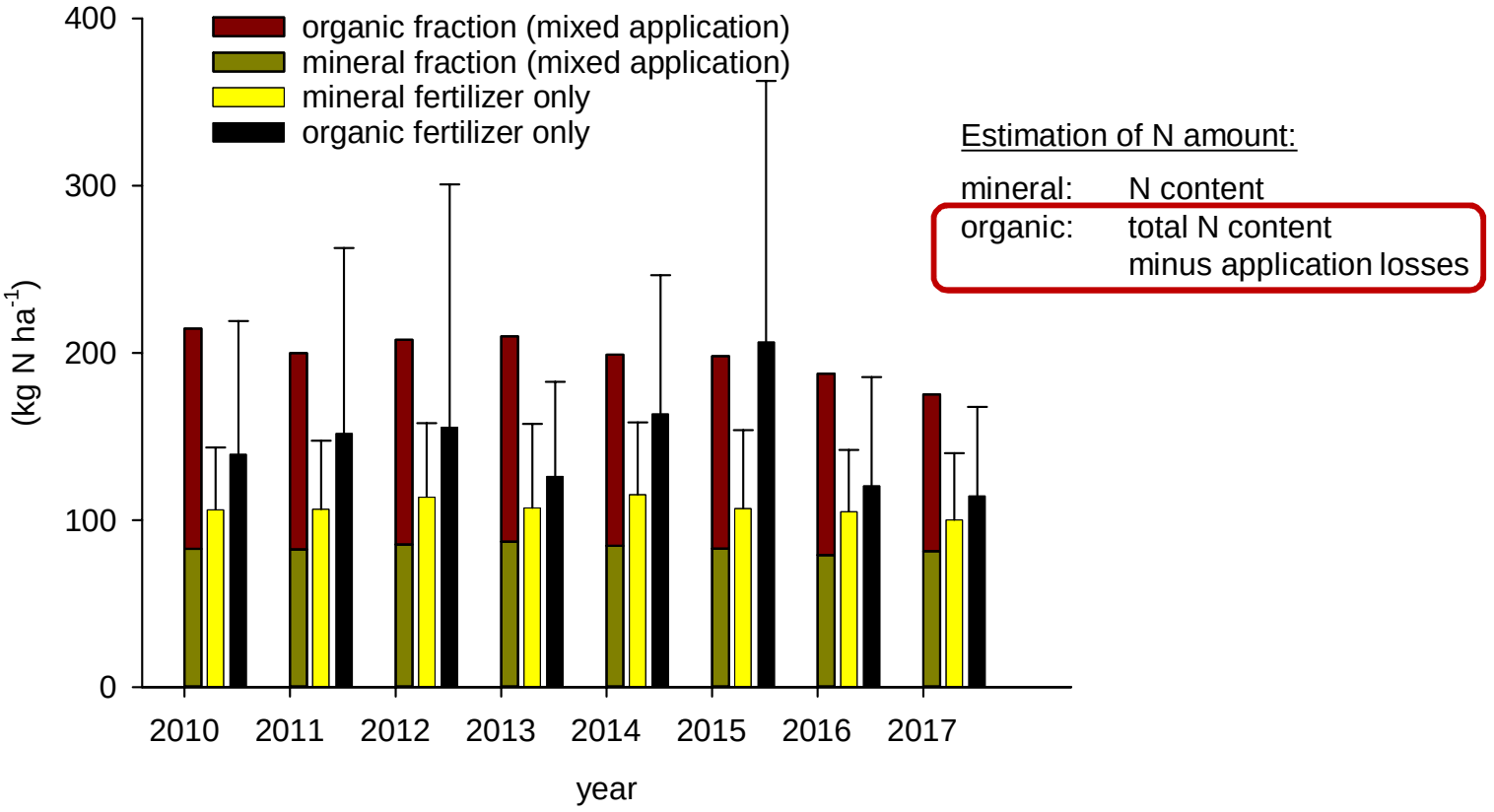
Time of fertilizer application



Survey about sugar beet cultivation among farms (since 2010, more than 300 farms each year, answers given for the largest sugar beet field)

Applied N fertilizer

- including fertilizer application to the catch crops -



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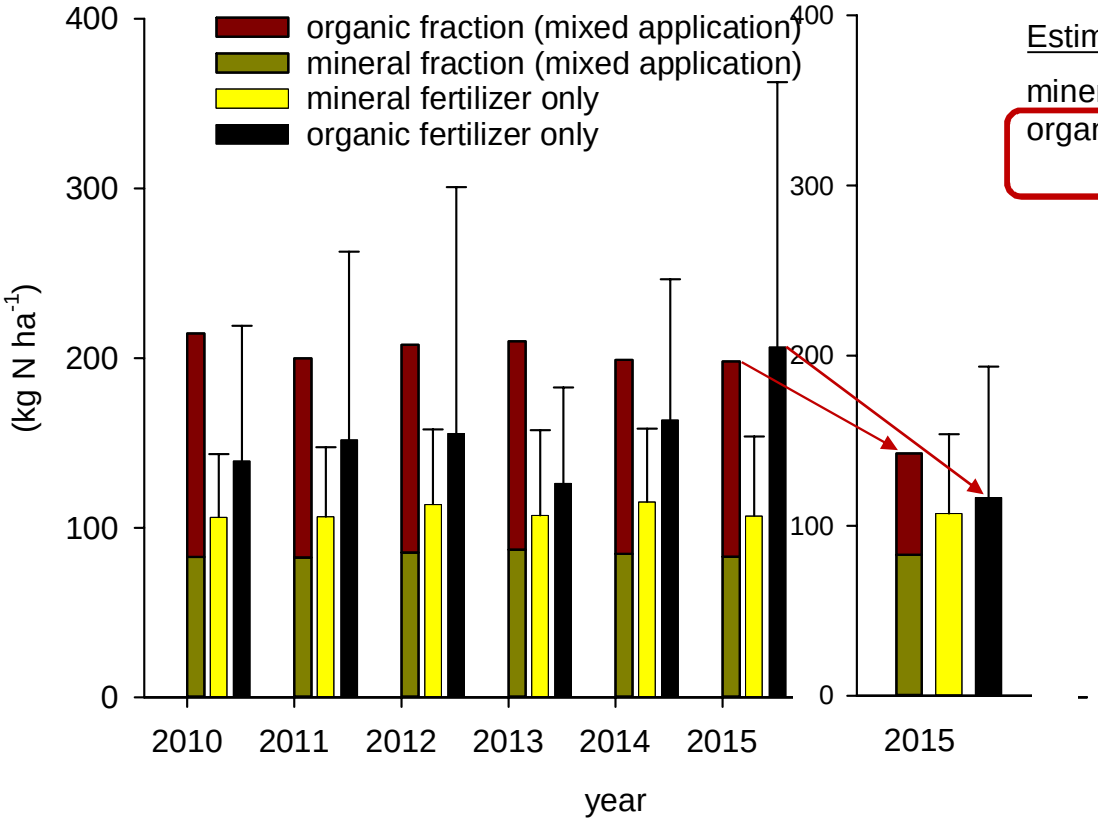


Estimation of N amount:

mineral: N content

organic: only N relevant for the sugar beet taken into account

Survey about sugar beet cultivation among farms (since 2010, more than 300 farms each year, answers given for the largest sugar beet field)

Types of N fertilizers used

mineral

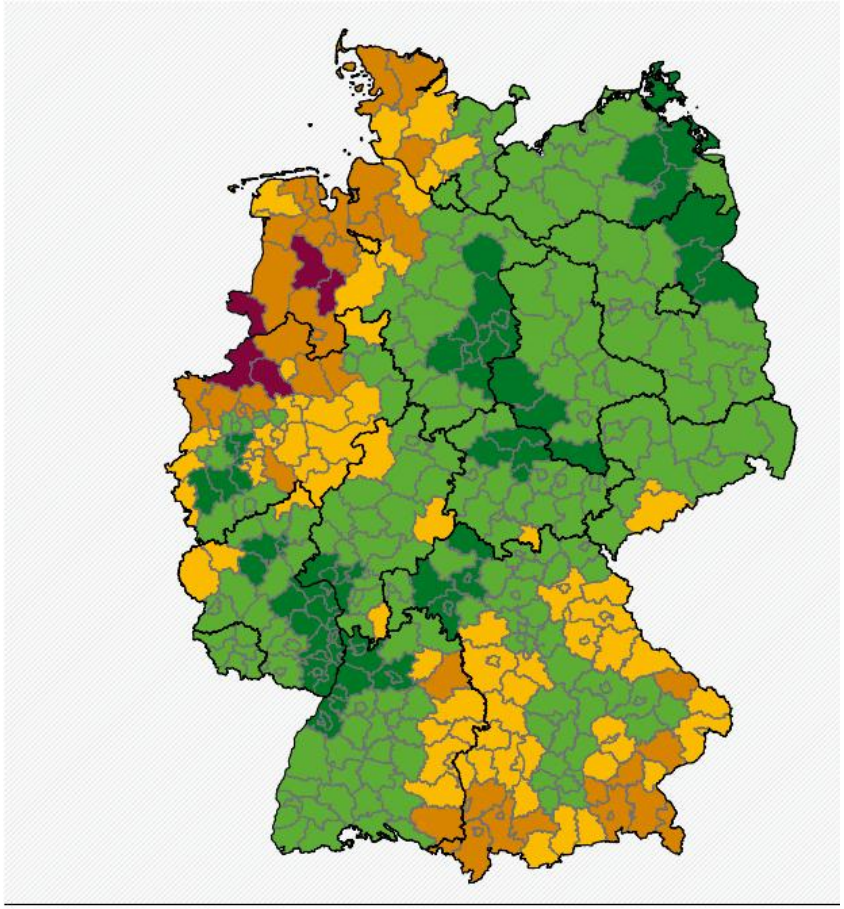
fertilizer type	number of fields
Calcium ammonium nitrate	1475
Urea	853
NP	793
Urea ammonium nitrate solution	660
Ammonium sulphate nitrate	153
Ammonium sulphate	121

organic

fertilizer type	number of fields
Biogas digestate	507
Pig slurry	369
Dairy slurry	227
Cattle manure	189
Poultry manure	139
Dried chicken faeces	121
Compost	101

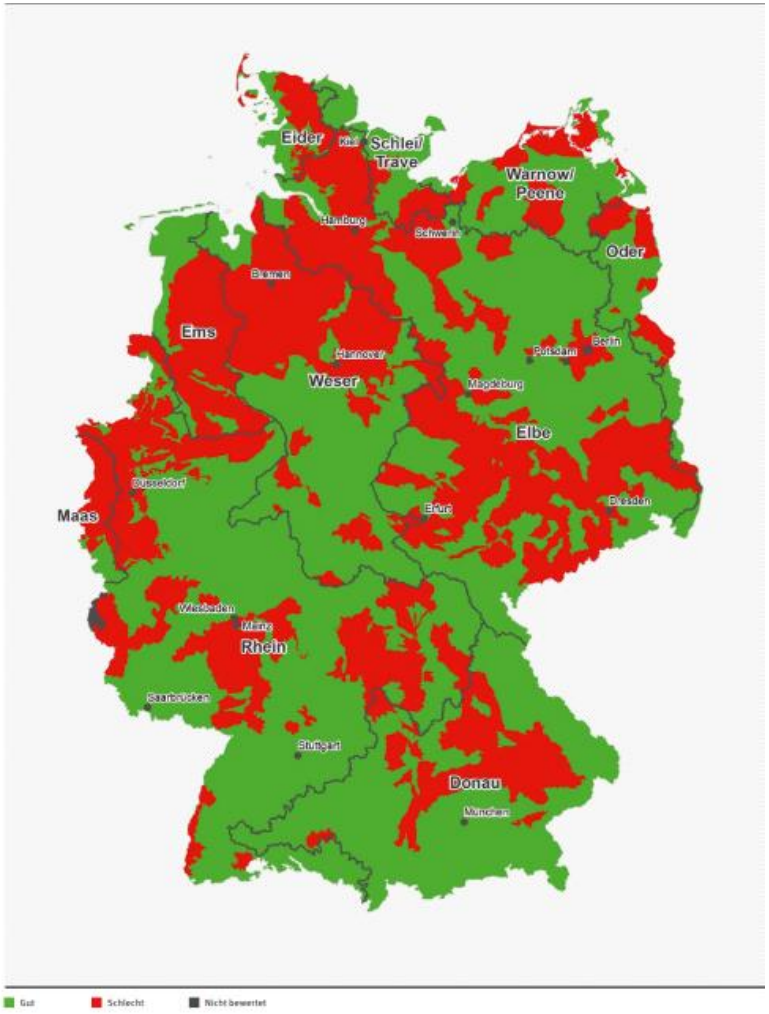
Survey about sugar beet cultivation among farms (since 2010, more than 300 farms each year, answers given for the largest sugar beet field)
total number of fields = 2984, 2010-2017, includes multiple entries

Nitrogen surpluses of field balances in Germany (Mean 2009 – 2011)



Geupel & Frommer, 2014; http:// www.umweltbundesamt.de /publikationen/reactive-nitrogen-in-germany

Chemical status of groundwater in Germany 2015



BMU/ UBA (Hrsg.), 2017; http://www.umweltbundesamt.de /publikationen

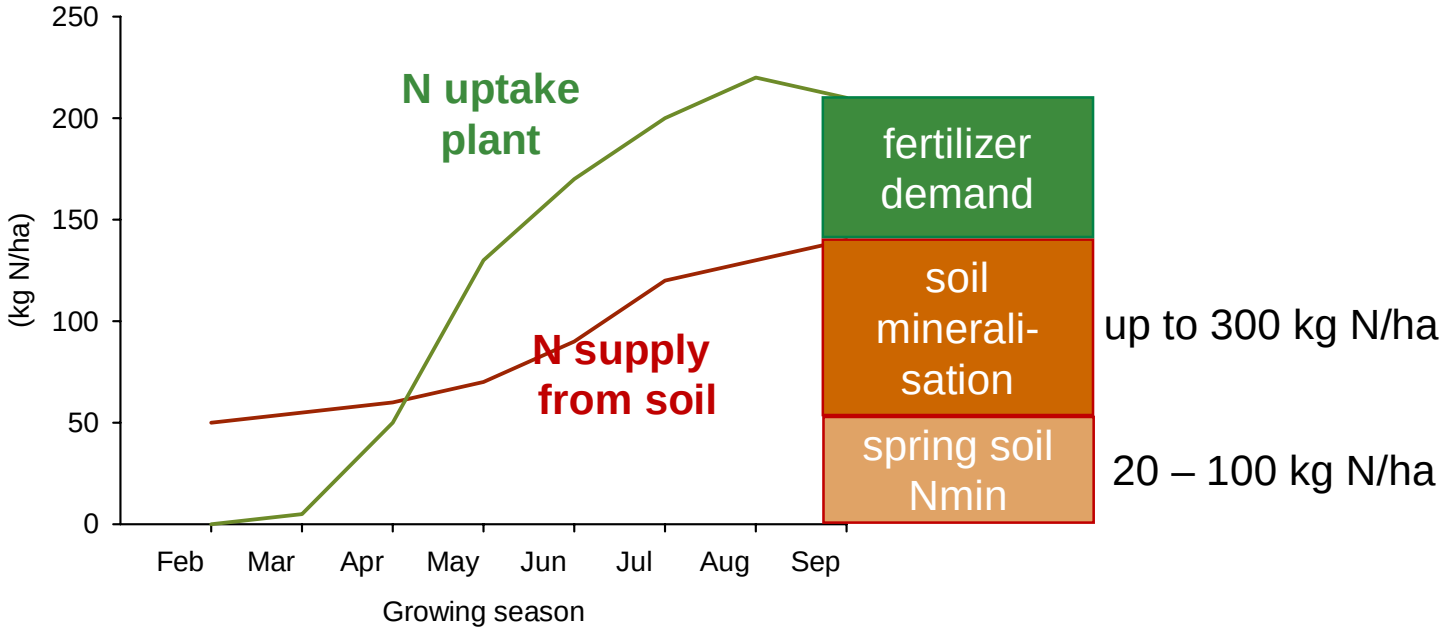
German fertilizer application ordinance (DüV), 2017

The **fertilizer N dose** is calculated by accounting for the **nutrient requirement** of the crop minus the amount of **available N** from the **soil** (Nmin; mineralization, immobilization during the season; manure; catch crops)

N-target value (adapted to yield level)
+ basic soil N mineralization

= crop N requirement (estimated from N uptake in autumn)
- spring soil Nmin - *basic soil N mineralization*
- extra N release (manure, catch crop)

= fertilizer N dose

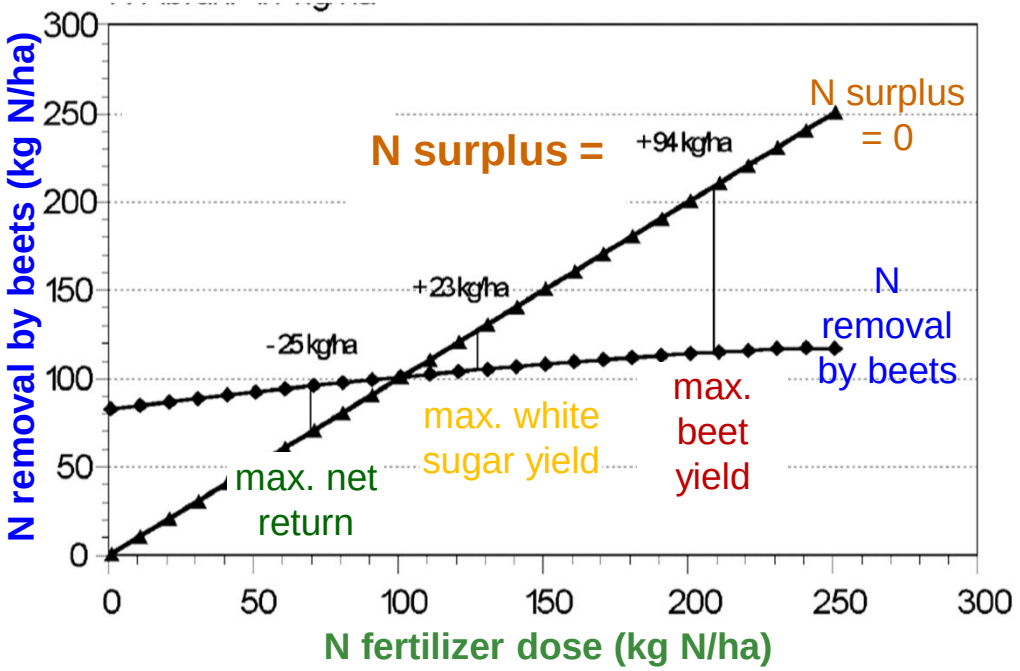


German fertilizer use ordinance (DüV), 2017
Nutrient balance for N

- Each farm has to calculate an annual nutrient balance:
  N input (fertilizers, manures) – **N removal** (crops) = **N surplus**
- Farm-scale level, 3-year moving-average
- The **maximum tolerable surplus** is: **50 kg N/ha and year**

Influence of N fertilizer dose on N removal and N surplus

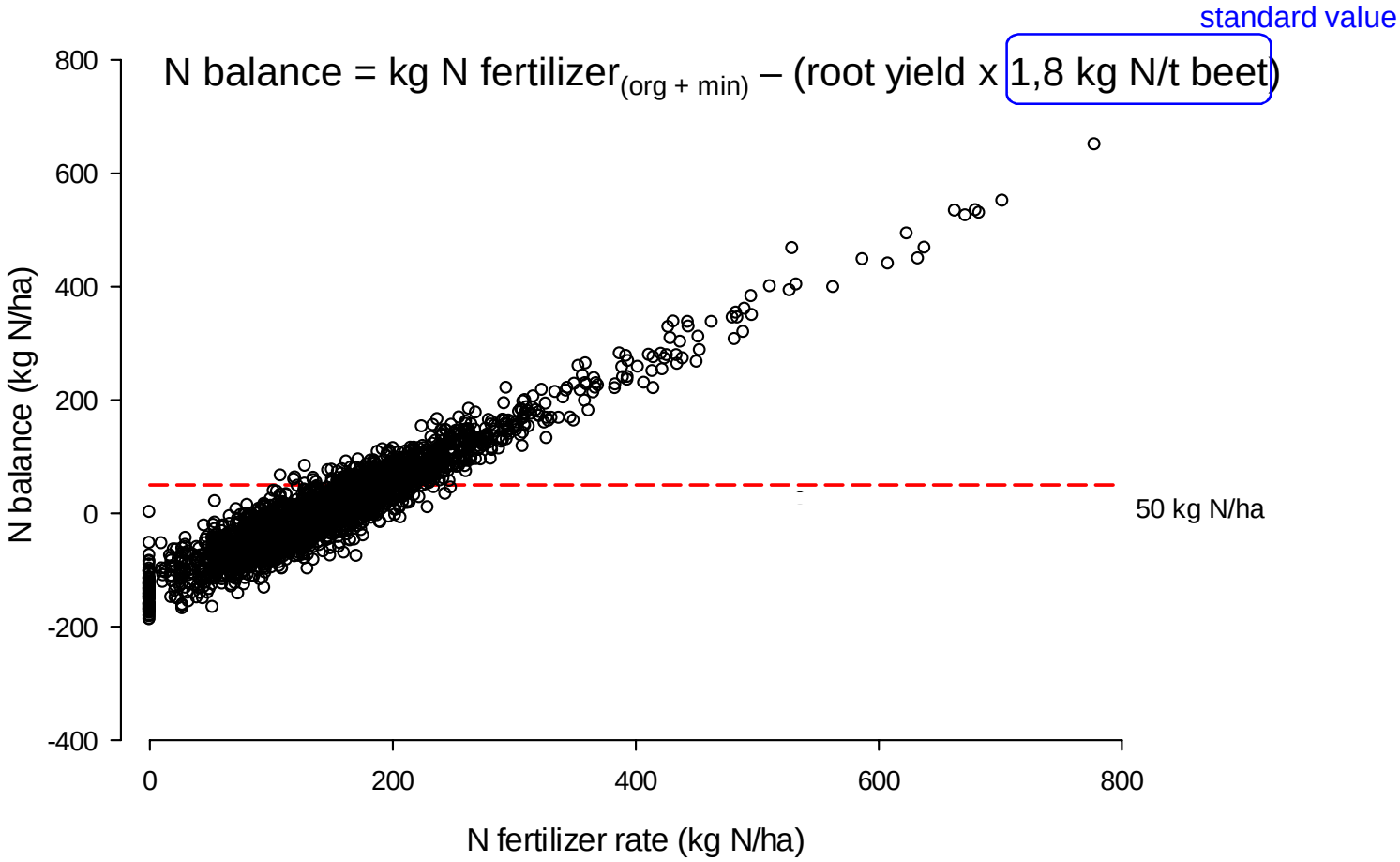
(leaves/tops left in the field)



19 trials 1996-2000

Heyn 2001

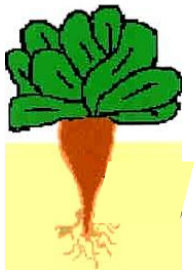
Amount of nitrogen fertilizer rules the N-surplus



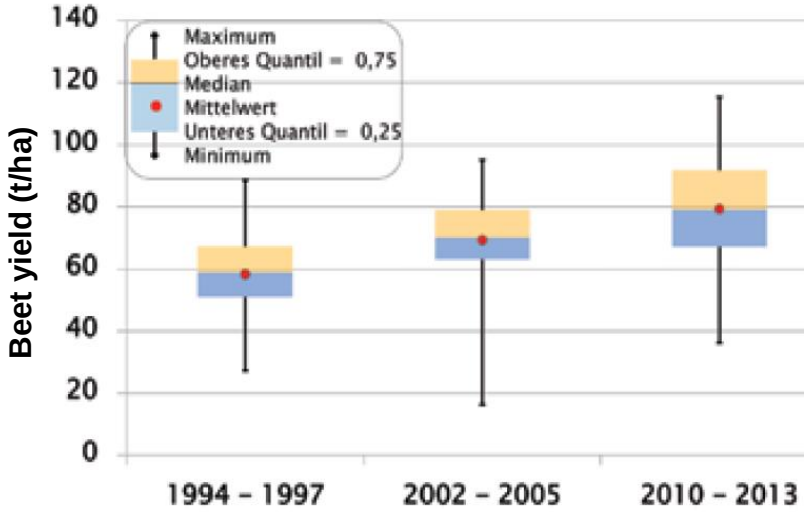
Survey about sugar beet cultivation among farms (since 2010, more than 300 farms each year, answers given for the largest sugar beet field)

Nutrient uptake of sugar beet crops in Germany

Field trial data 1994 – 2013 (N=114)



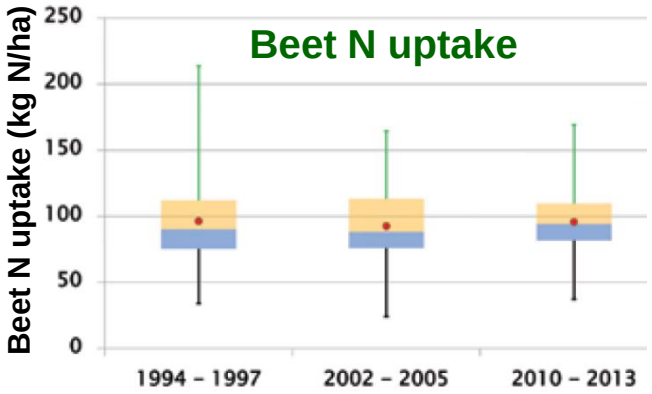
	Beet	Leaves and tops	Total plant
	Mean (min - max) in kg/ha		
Nitrogen	110 (72-169)	114 (51-199)	224 (133-328)
Phosphorus	20 (9-28)	14 (6-23)	34 (16-49)
Potassium	136 (79-214)	245 (94-439)	381 (186-617)

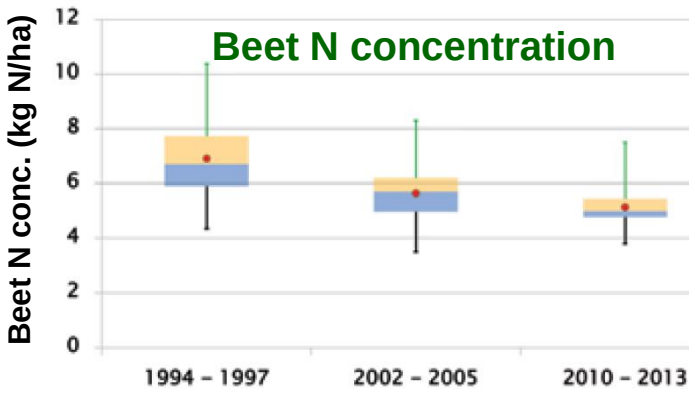


Bürcky et al. 2017 and 2018

Nutrient uptake of sugar beet crops in Germany

Field trial data 1994 – 2013 (N=114)

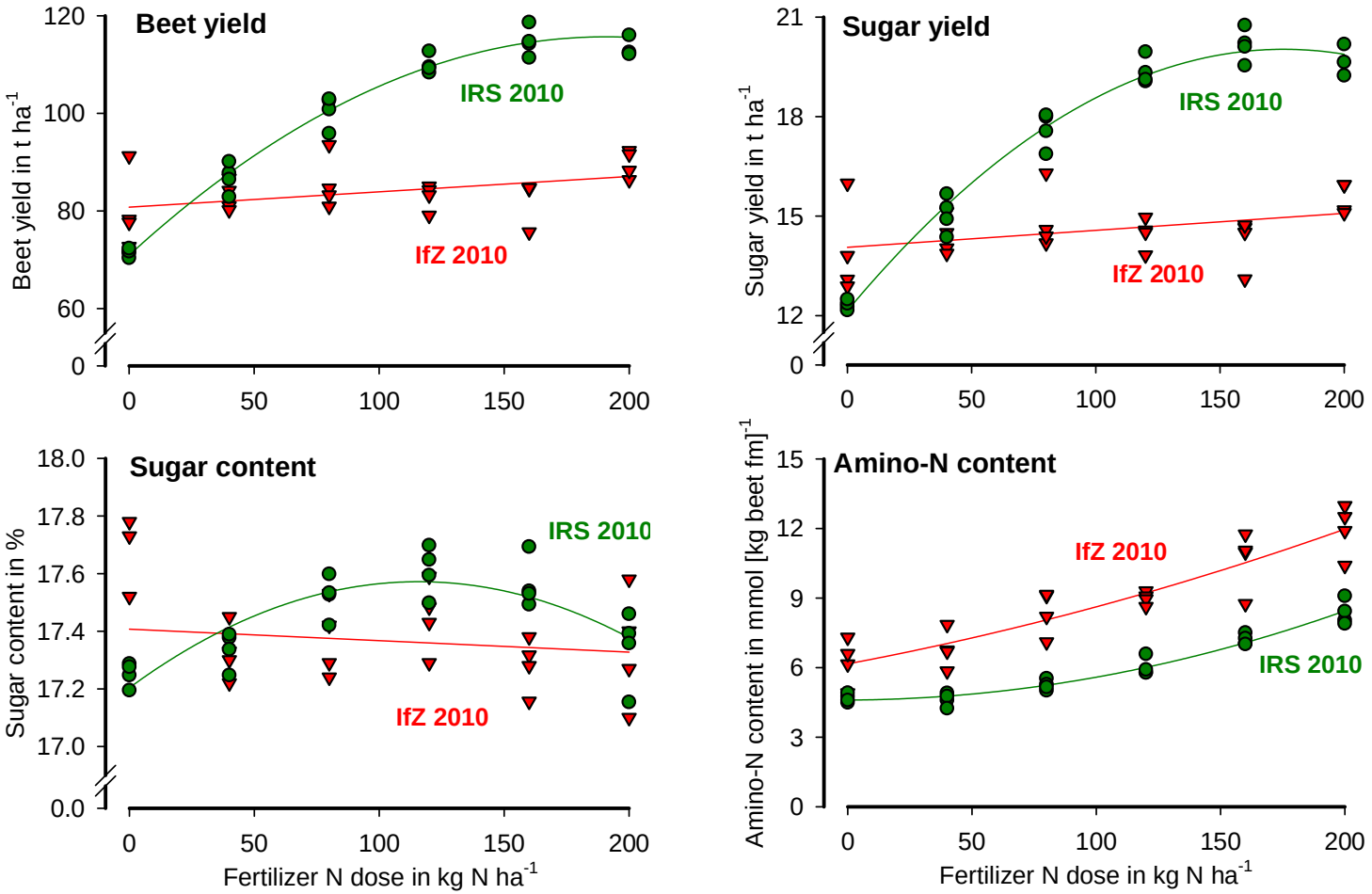




Bürcky et al. 2018

Effects of N fertilizer dose on sugar yield and beet quality

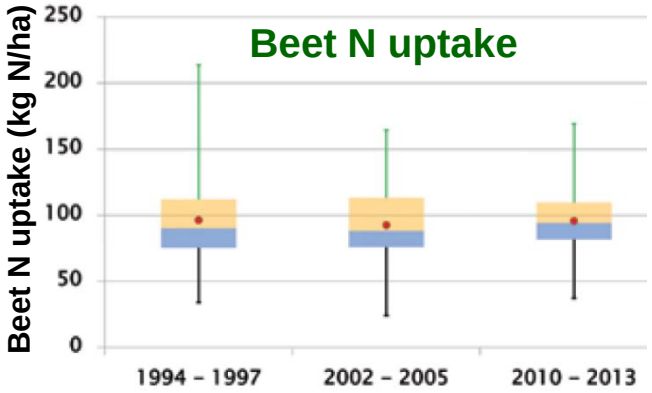
- dose-response curves from two contrasting fields -

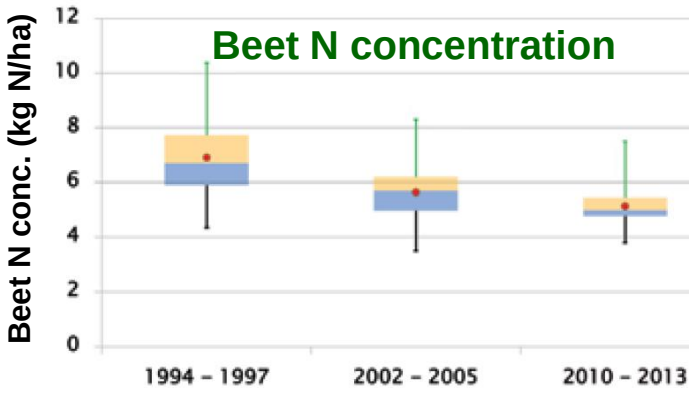


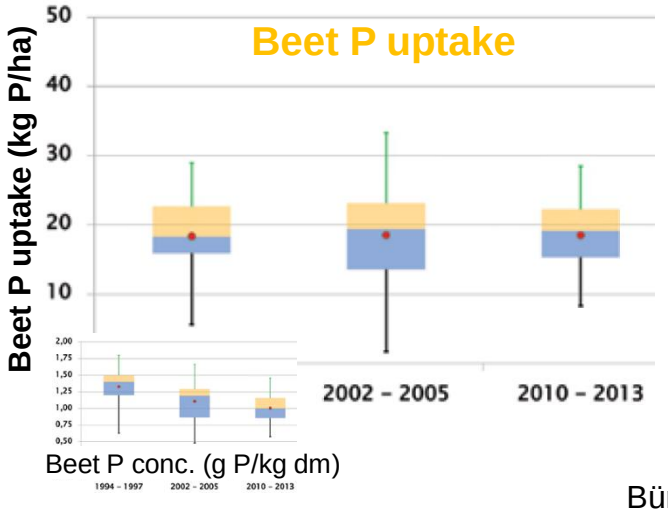
Laufer et al. 2016, adopted

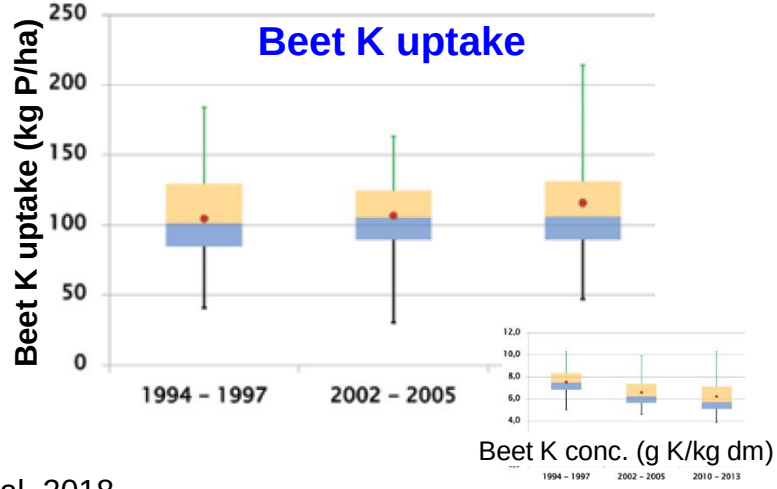
Nutrient uptake of sugar beet crops in Germany

Field trial data 1994 – 2013 (N=114)



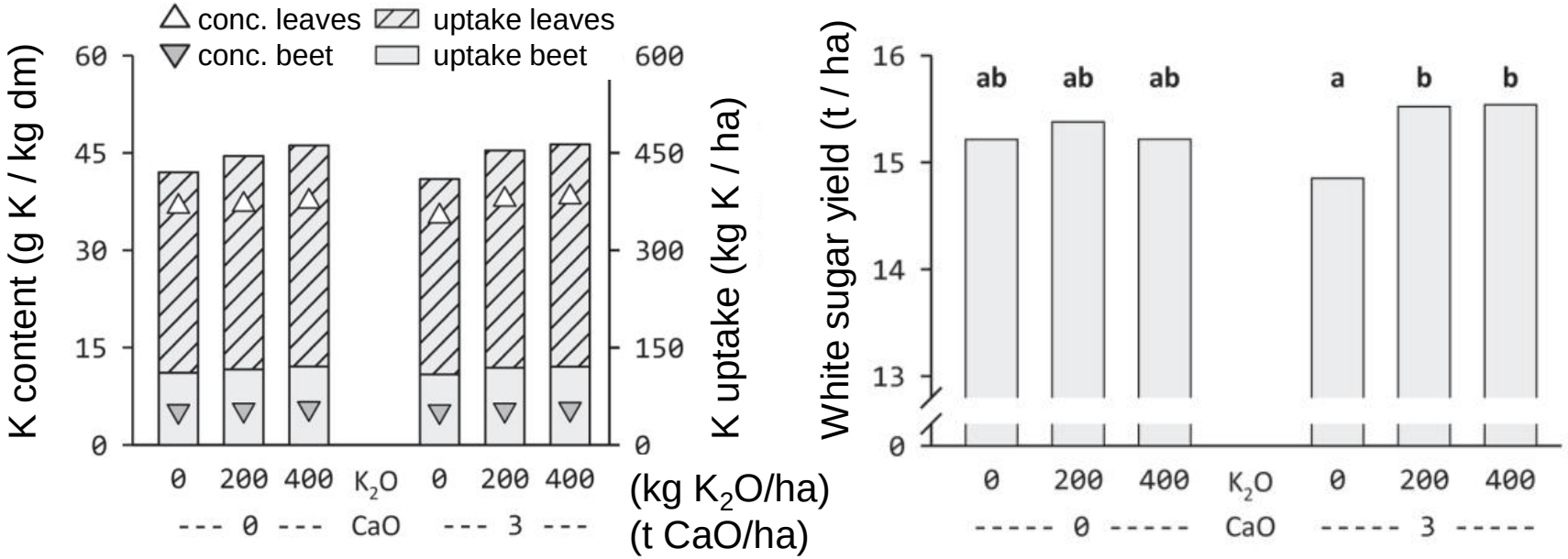






Bürcky et al. 2018

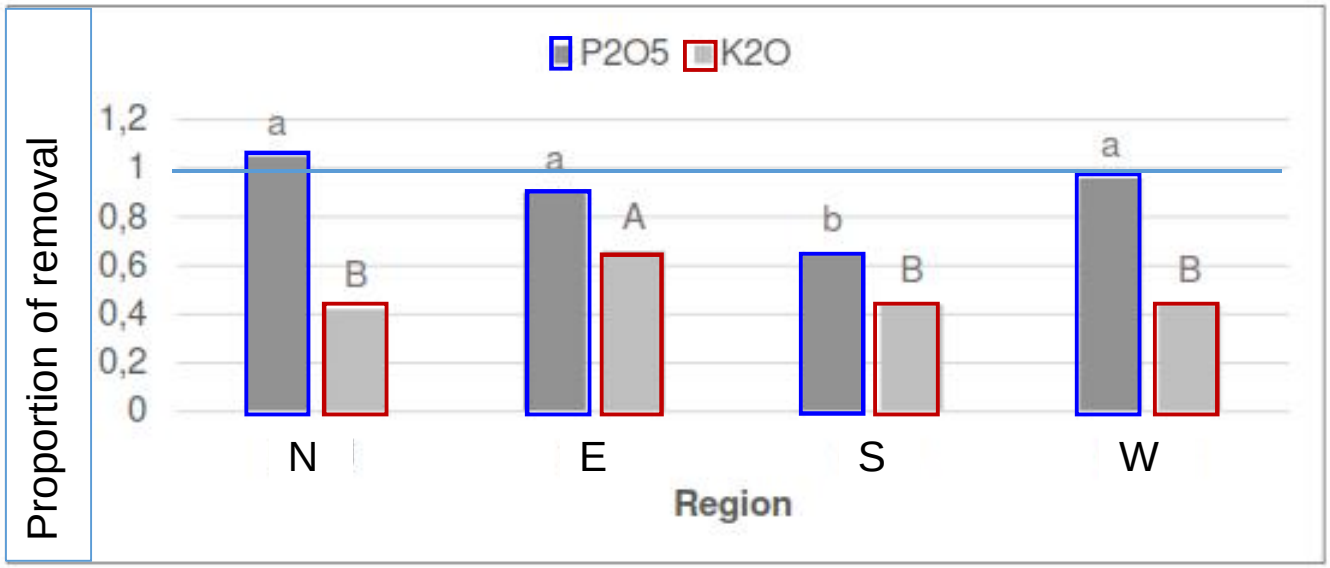
Effects of K_2O fertilizer combined with liming



10 field trials in the middle and in the south of Germany, 2011-2012 Fischer et al. 2013

Organic fertilizers: nutrient composition differs

Ratio of applied and removed nutrients;
only organic fertilizers taken into account;
2010 – 2013, n=768



...mostly P_2O_5 rules the amount

Survey about sugar beet cultivation among farms (since 2010, more than 300 farms, answers given for the largest sugar beet field)

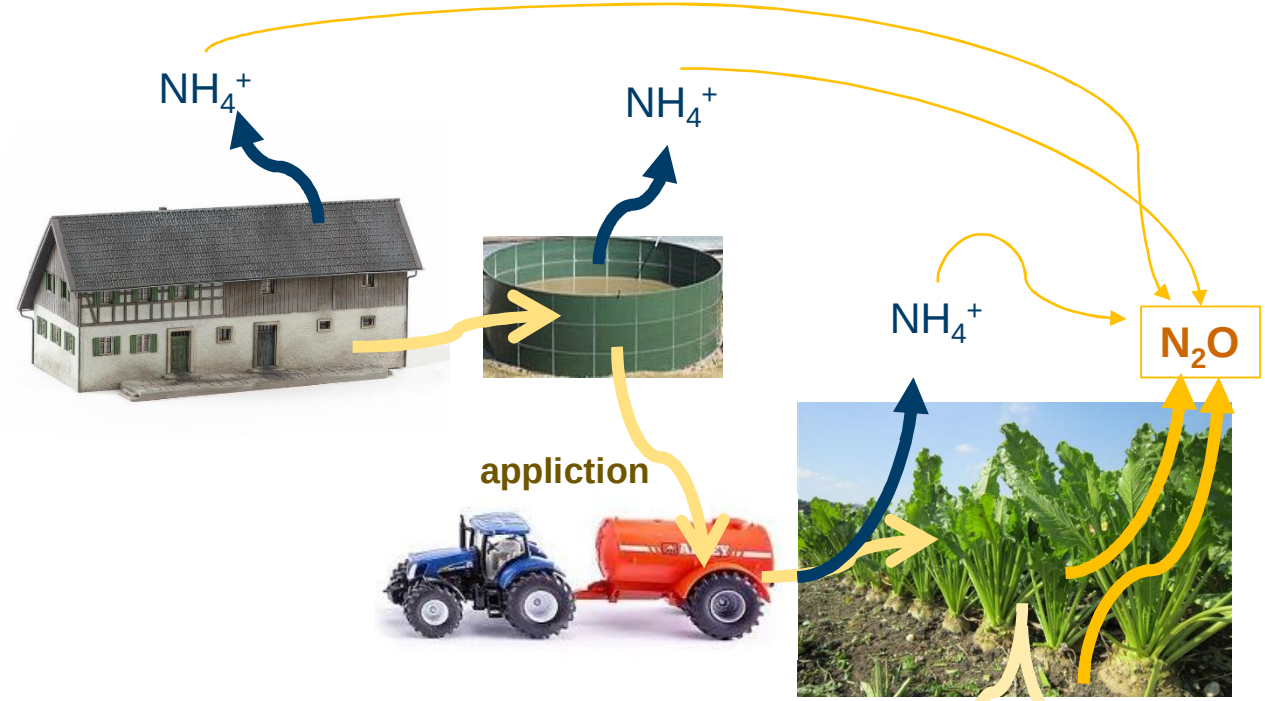
Neuschrank 2015

Fertilizer recommendation based on a crop rotation

Target: to replace the removal of P and K for the whole crop rotation with one application, mostly in fall

Crop rotation	Yield (t/ha)	Removal P (kg P_2O_5/ha)	Removal K (kg K_2O/ha)
Sugar beet	65	65	163
Winter wheat	9.0	72	54
Winter barley	8.5	68	51
Sum		**205**	**268**

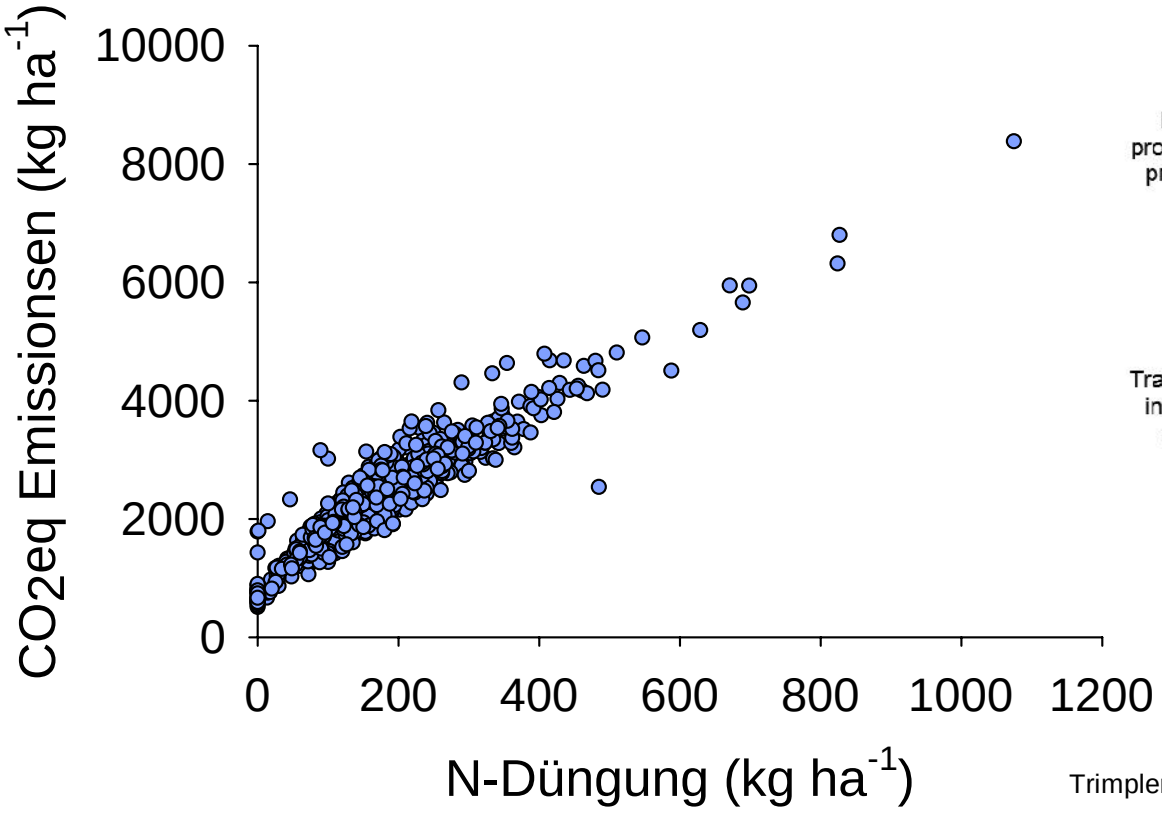
Organic fertilizers: losses along the way



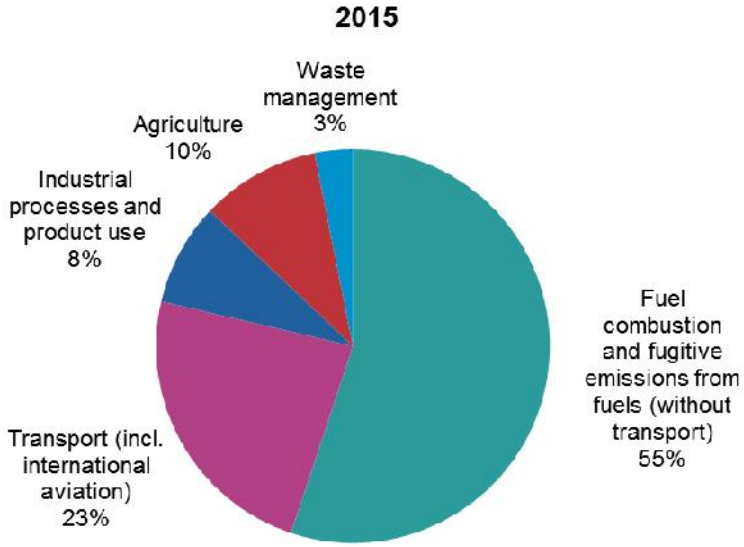
= total N input

Influence of N fertilizer on GHG emissions

N fertilizer: mineral and organic including applications to the catch crop, 2010 – 2013 (n = 1181)
mean N amount was 141 kg N ha^{-1} for all 3 years



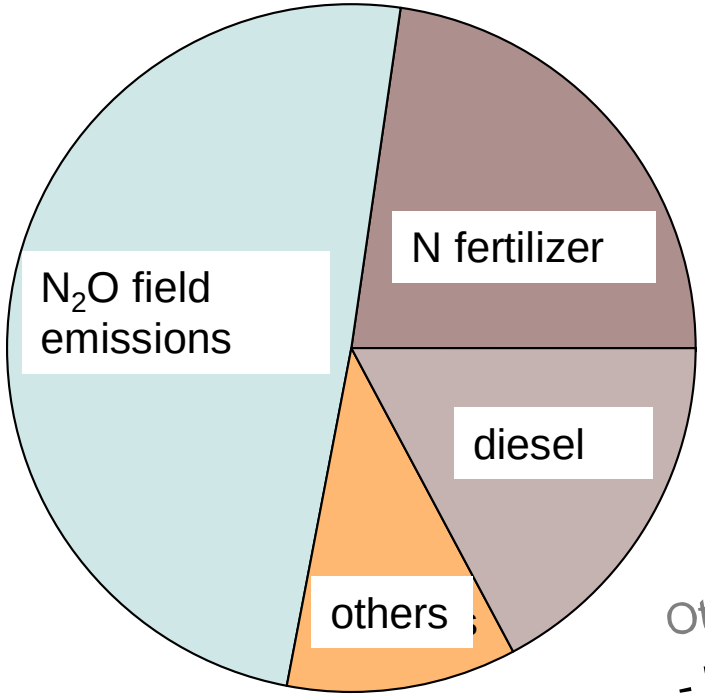
Trimpler et al. 2016



Greenhouse gas emissions, analysis by source sector, EU-28, 1990 and 2015

http://ec.europa.eu/eurostat/statistics-explained

GHG emissions from sugar beet cultivation

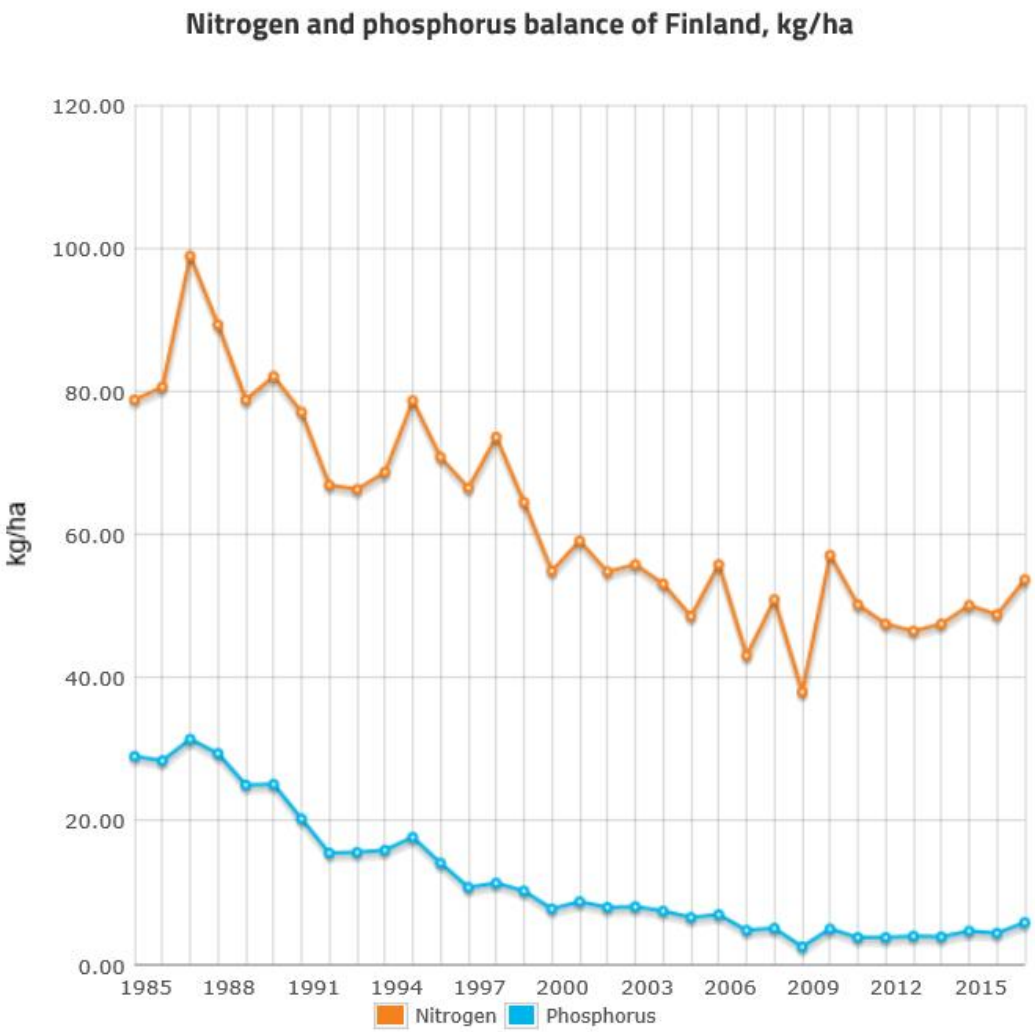


Other production factors:

- P_2O_5
- K_2O
- Pesticides
- Seeds

Results from a survey among farms
(2010 - 2012, more than 350 farms each year)

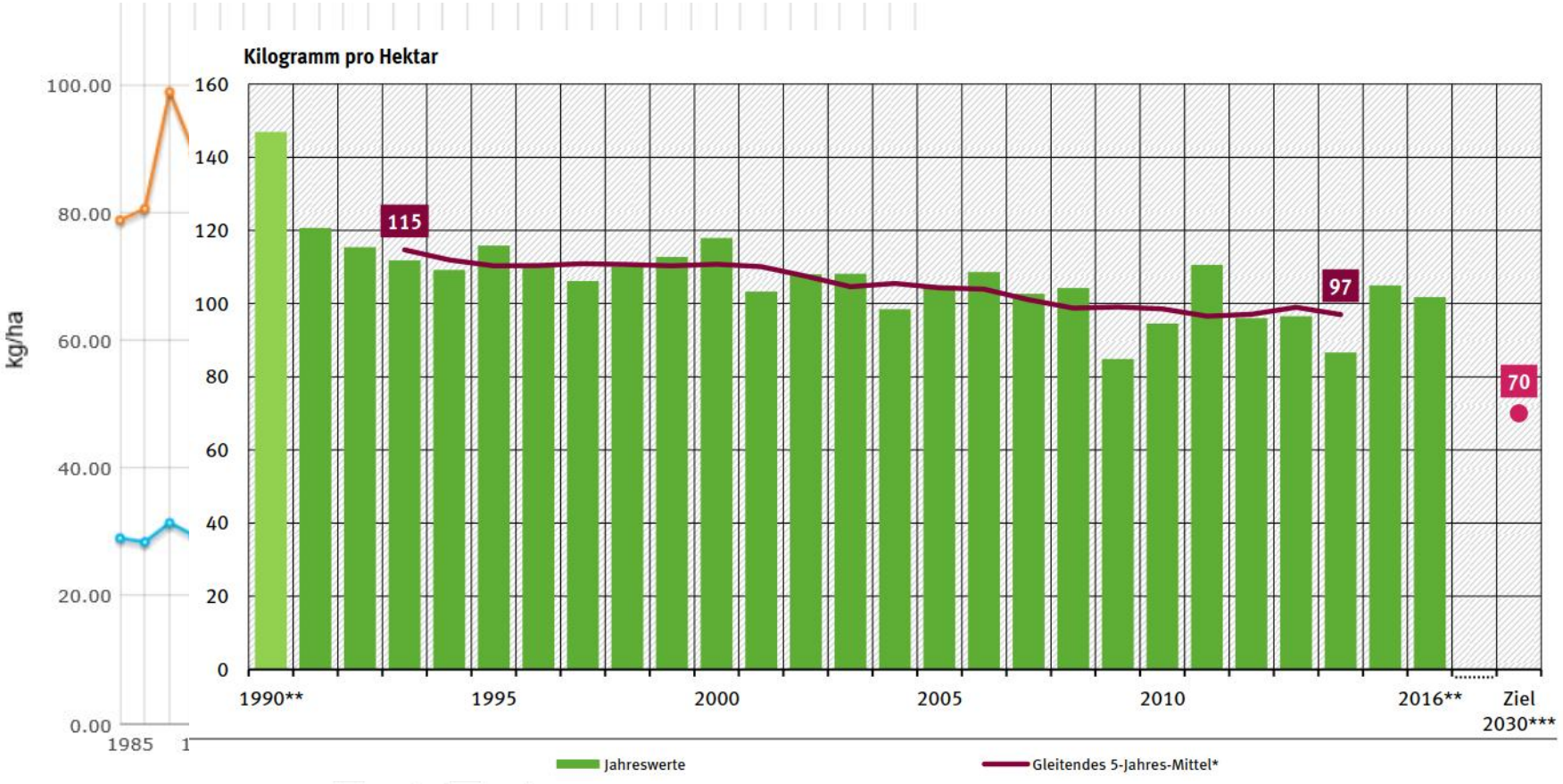
according to Trimpler et al., 2016; adopted



Source: Natural Resources Institute Finland.

https://www.luke.fi/ruokafakta/en/field-crops/nitrogen-and-phosphorus-balance/

Nitrogen balance of Germany, kg/ha



Source: Natural Resources Institute Finland.

https://www.umweltbundesamt.de

Thank you!