

Nutrient bookkeeping in Germany

On farm and national level

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Outline



- Legal background
- Parties involved
- Implementation
- Methodology
- Uncertainties
- Assessment of effectiveness

Legal background

German Fertilising legislation



EU legislation as a framework for national legislation:

e.g. Nitrates Directives (91/676/EEC), NEC Directive (2001/81/EC), Water Framework Directive (2000/60/EC)



German legislations with Codes of Good Agricultural Practice:

- Fertilisation Act (Düngegesetz)
 - Ordinance on Fertiliser Application (Düngeverordnung)
 - Ordinance on Fertiliser Quality (Düngemittelverordnung)
 - Ordinance on Marketing and Transport of Manure (Wirtschaftsdüngerverbringungsverordnung)
- Federal Soil Conservation Act (Bundesbodenschutzgesetz)
- Federal Nature Conservation Act (Bundesnaturschutzgesetz)

Parties involved



Federal Ministry of Food and Agriculture
Federal Environment Ministry

**Ministries of Agriculture and Environment
of the 16 Federal States**



Federal Environment Agency (UBA)
Federal Research Institutions



State Research Centers for Agriculture



German Agricultural Society (DLG)
German Farmers' Association
Nature And Biodiversity Conservation Union (NABU)
Association of German Agricultural Analytic and Research Institutes



Chambers of Agriculture



Fertiliser Application Ordinance

Background and scope



Background

- Implementation of Nitrates Directive (Action programme)
- Nation-wide with a revision every 4 year
- Last comprehensive revision from 2007 – Amendment in progress since 2012

Scope of the Fertiliser Ordinance

- Application technique and incorporation
- Site specific rules to control the spread of nutrients
- Prohibition periods, storage capacity, application after harvest of main crop
- Fertiliser requirements (fertiliser planning)
- Nutrient management plan (N- and P-balances)
- Limit for the application of animal manure

Fertiliser requirements

Fertiliser planning (DüV 2007)



Basic principles for application

- Assessment of fertiliser requirement **before** application:
 - Maintenance of site-related soil fertility
 - Balance between demand and supply
- Several **parameters** have to be considered for each field/management unit:
 - expected yield and quality; availability of soil nutrients; soil pH and C; other nutrient sources; other cultivation conditions like previous crop; soil tillage; irrigation
- Calculation of fertiliser demand based on **available soil nutrients**:
 - For N: Annually calculation for each field/management unit (N_{\min} , recommendations)
 - For P: Soil analyses at least every 6 years.
- Time and amount of nutrient application **close to plant uptake**

Fertiliser requirements

Amendment of Fertiliser Ordinance (DüV 201x)



Uniform and mandatory fertiliser planning for all crops and farms

- Crop N demand at a specific yield level **e.g. Winter wheat (C), 9 t/ha
210 kg N**
- Increases and reductions for:

Mineral-N in the soil (N_{\min})	- 40 kg N
Yield difference to 3-yrs-average (10/15 kg N per 1 t/ha)	+ 10 kg N
Humus content of soil (> 4.5% → -20 kg N)	0 kg N
Application of organic fertilisers (10% of N_{tot})	- 12 kg N
Effect of preceeding crop (e.g. winter rape)	- 10 kg N
- Calculated crop N demand **158 kg N**
- Minimum N-indices for the application of organic fertilisers
- Increases for crop development and weather events

Nutrient management plan

N- and P-Balances (DüV 2007)



Nutrient balance

- Annual nutrient balances for N and P by 31.03. for **previous** fertiliser year
 - Surface balance or aggregated land parcel plan
 - Updated annually to a multi-year nutrient management plan
- Minimum N-indices for organic manure application after deduction of shed, storage and application losses
- Unavoidable losses can be considered according to Federal State legislation
- Exceptions for:
 - Land with only ornamental plants, nurseries, vineyard or fruit orchard
 - Land used solely for grazing (≤ 100 kg N/ha from organic manure), no additional N
 - ≤ 10 ha managed fields
 - ≤ 1 ha vegetables, hops or strawberries
 - ≤ 500 kg N yr⁻¹ from organic manure

Nutrient management plan

Evaluation of N- and P-Balances (DüV 2007)



Evaluation of nutrient balances

- The balance need to be presented on demand (Federal State)
- Threshold for 3-yrs average of acceptable N balance surplus:
 - 2006-2008 : $\leq 90 \text{ kg N/ha*yr}$
 - 2007-2009 : $\leq 80 \text{ kg N/ha*yr}$
 - 2008-2010 : $\leq 70 \text{ kg N/ha*yr}$
 - since 2009-2011: $\leq 60 \text{ kg N/ha*yr}$
- Threshold for 6-yrs average of acceptable P balance surplus:
 - $\text{P}_2\text{O}_5 \leq 20 \text{ kg P/ha*yr}$

=> Assumption that requirements of Fertiliser Ordinance are fulfilled

Nutrient management plan

Amendment of Fertiliser Ordinance (DüV 201x)



Amendment for N balance calculations:

- Adaption of minimum N-indices for organic manure application
- N removal with forage crops have to be consistent with N excretion
- Threshold for 3-yrs average of acceptable N balance surplus:
 - Until 2018: $\leq 60 \text{ kg N/ha*yr}$
 - After 2018: $\leq 50 \text{ kg N/ha*yr}$

Amendment for P balance calculations:

- Threshold of 20 kg P/ha*yr for 6-yrs average only for P-supply stages A, B & C
- Application of P fertilisers (min. & org.) on high supplied soils to P-offtake
- Duty for depletion on high supplied soils:
 - From 2018: 75% of P-offtake
 - From 2020: 50% of P-offtake

Implementation

Control and consequences



Control




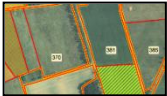
- Federal States are responsible for control
 - Assigned mostly by specialized authorities of lower administration level
- Within the scope of Cross Compliance (approx. 1% of farms)
 - Systematic controls and „cross checks“
- Risk-related, specialised control of sectoral legislations (e.g. Nitrate Directive)

Consequences

- Breaches of cross compliance requirements → Deductions of direct payments
- Breaches of Fertiliser Ordinance requirements → Administrative Offences
 - If nutrient management plan (N- and P balances) is incorrect or not prepared
- Amendment of Fertiliser Ordinance (**DüV 201x**) :
 - Administrative offences if fertiliser requirements are incorrect or not prepared

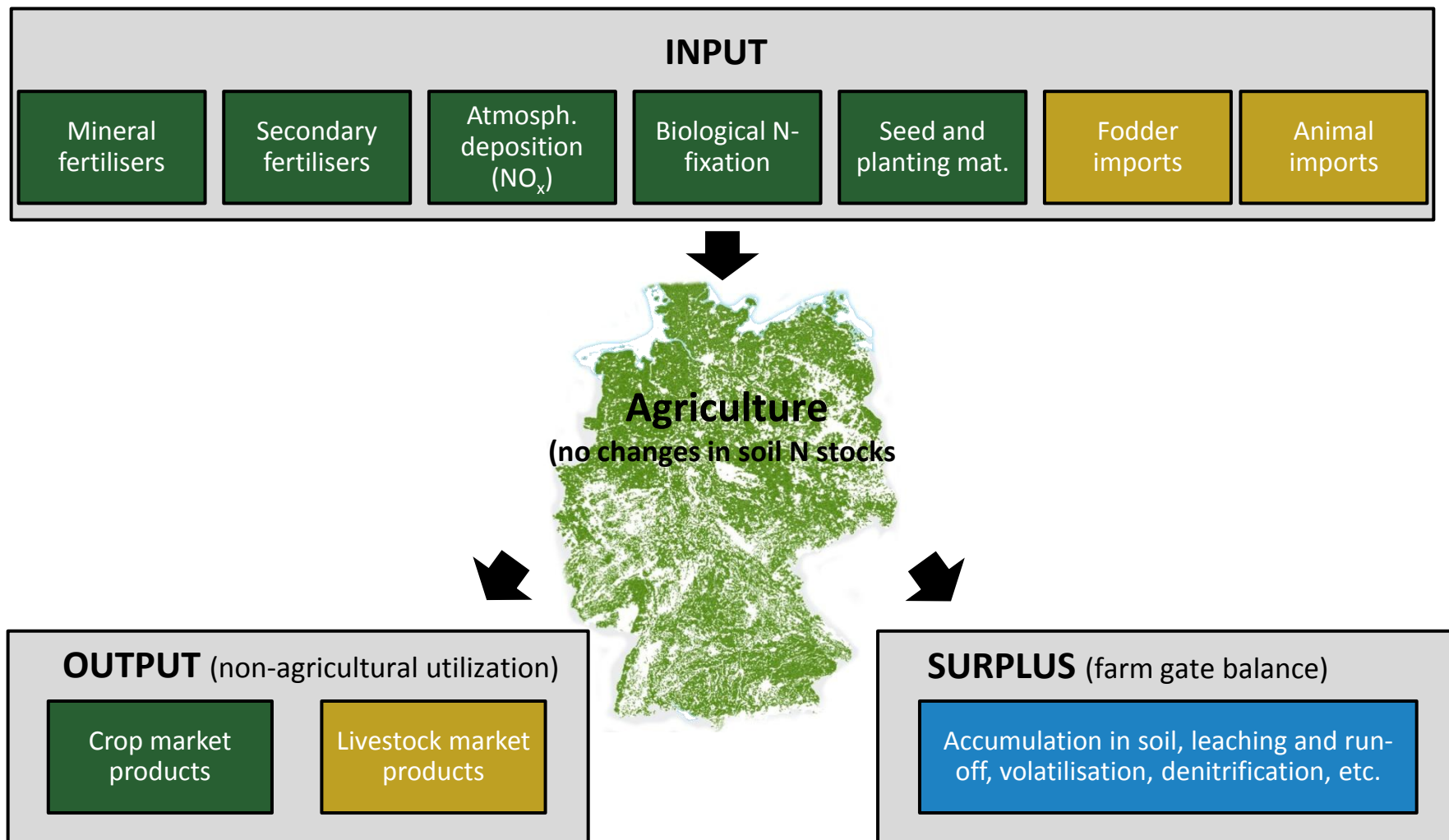
Nutrient balances at different scales



Scale	Balance	Data source	Purpose
National level 		Statistical data (Destatis) and estimations	Eurostat/OECD => reporting duty Nitrate report => monitoring Agri-Environmental Indicator: Sustainability Strategy, Biodiversity
Regional level 		FSS data and estimations FADN data, bookkeeping	Implementation of EU-WFD => Emission monitoring
Farm level 		Estimations and bookkeeping Bookkeeping	Fertiliser Ordinance => Monitoring & control of GAP Advisory service
Field level 		Field record	Advisory service

Methodology

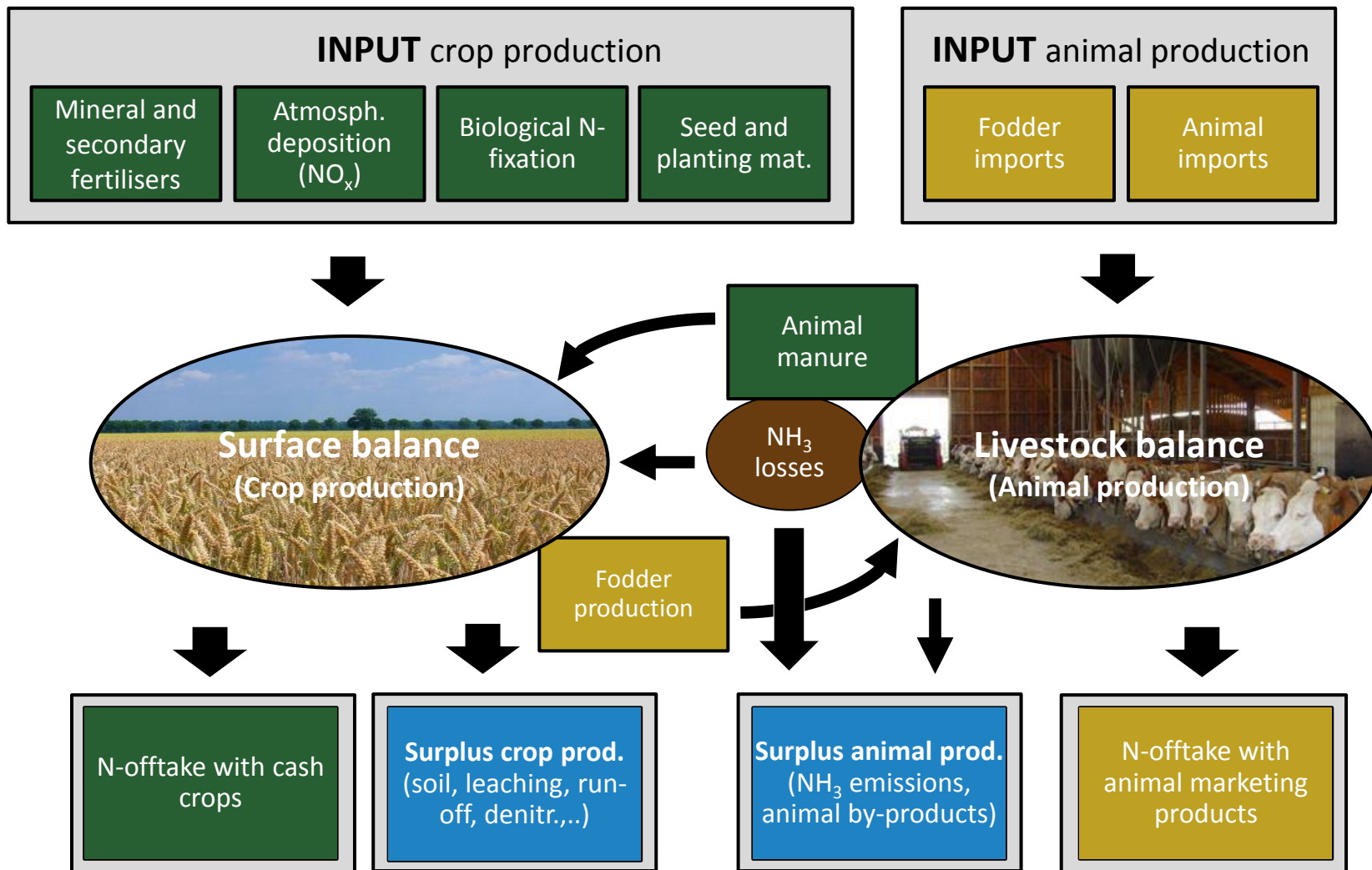
National N Balance – Farm Gate Balance



Bach & Frede (2005), modified

Methodology

Surface & Livestock balance



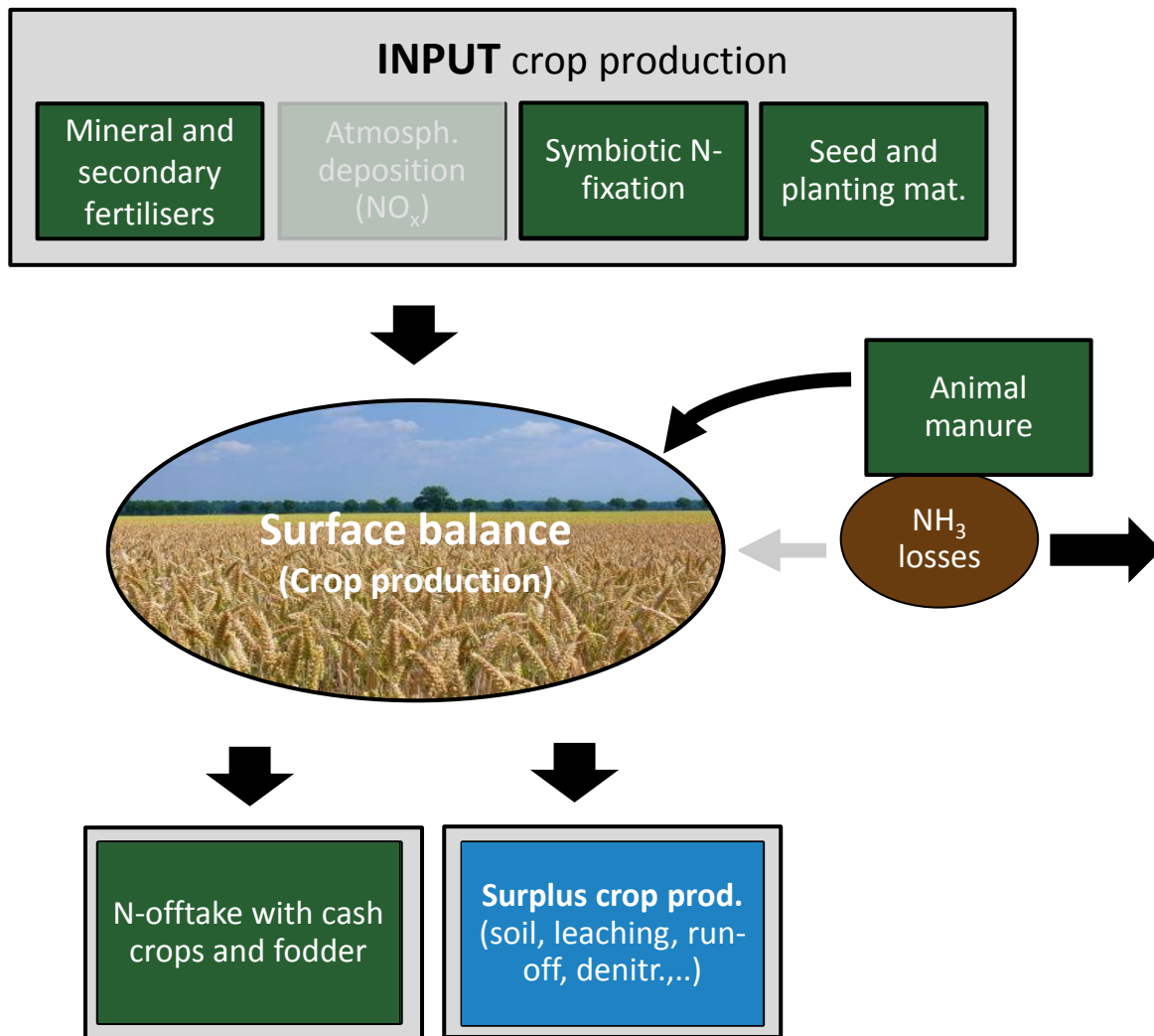
Bach & Frede (2005), modified

Methodology

Fertiliser Application Ordinance



Bach & Frede (2005), modified



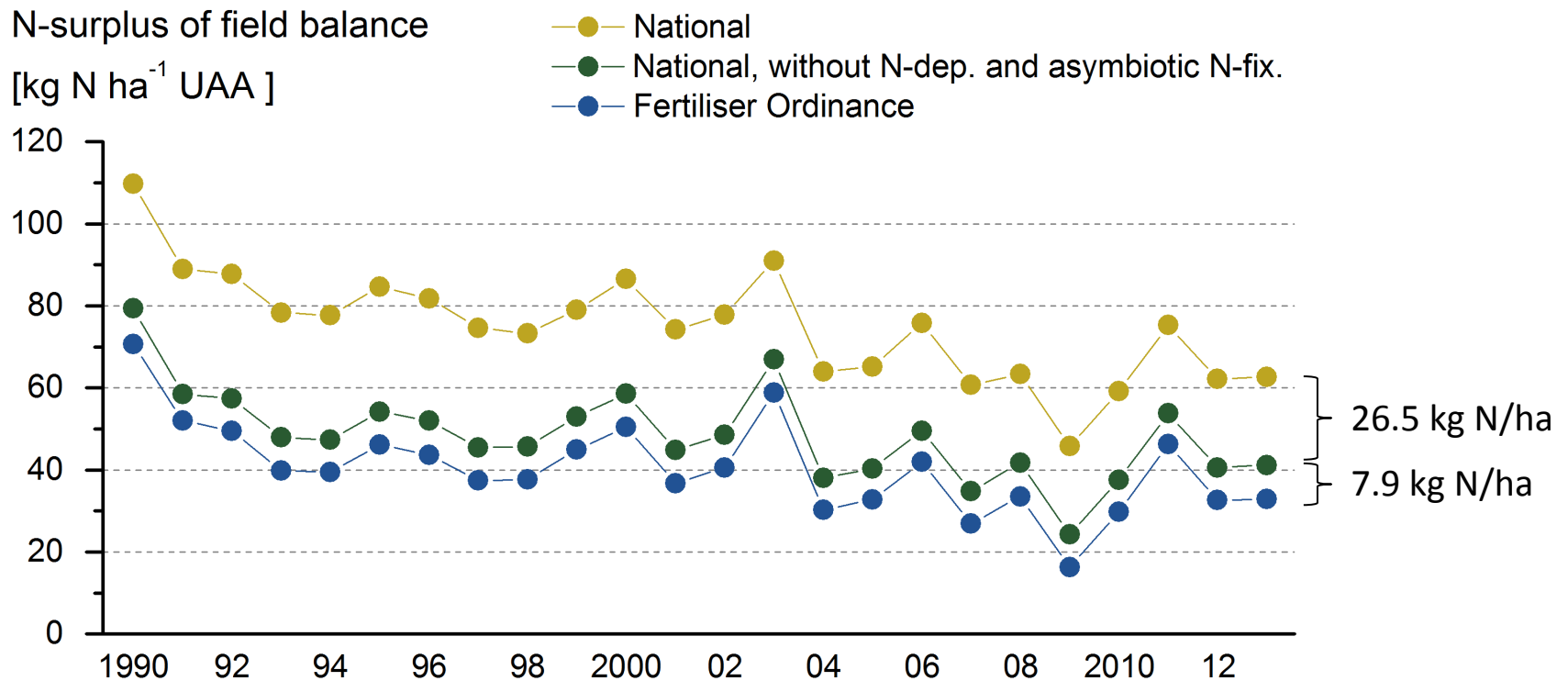
Nutrient balances

Effects of accounting methods



→ High influence of methodology on N-balance surplus

- 35 kg N/ha lower N-surplus of surface balance according to Fertiliser Ordinance



Uncertainties

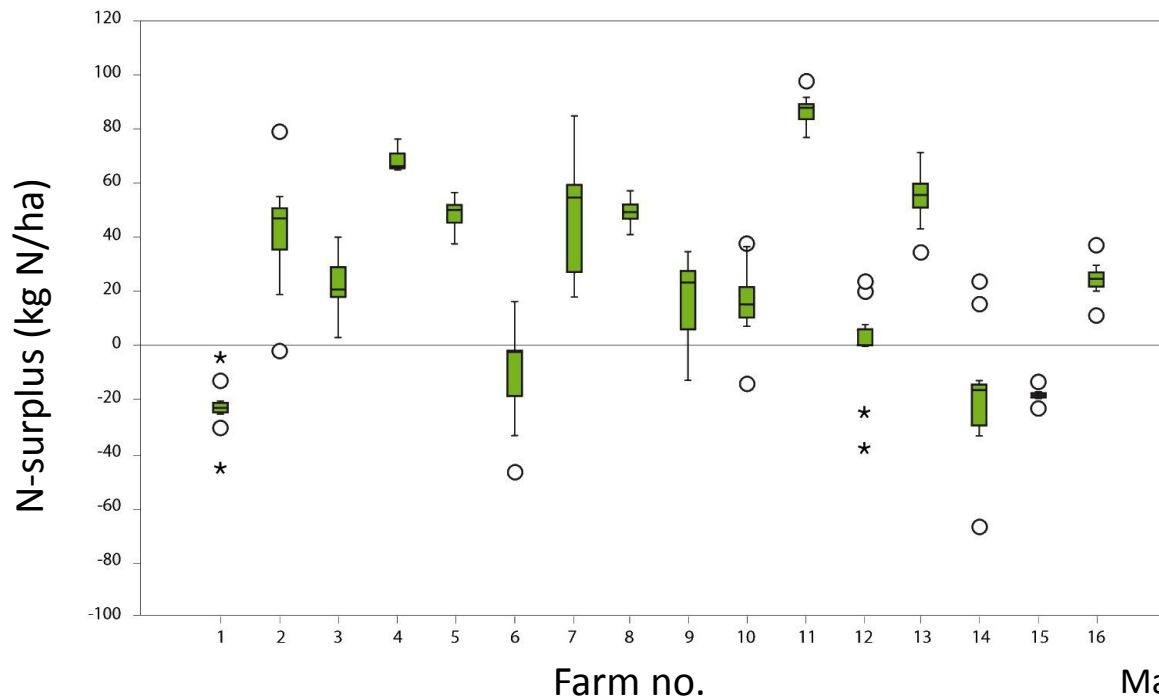
Different guidelines for balance calculation



Influence of Federal State-specific guidelines on N-surplus:

- Range of N-surplus of aggregated field balances from 16 dairy farms; calculated according to the guidelines of 11 Federal States

→ Average range of different calculation methods was 43 kg N/ha (8-91 kg N/ha)



Machmüller & Sundrum (2014)

www.jki.bund.de

Uncertainties

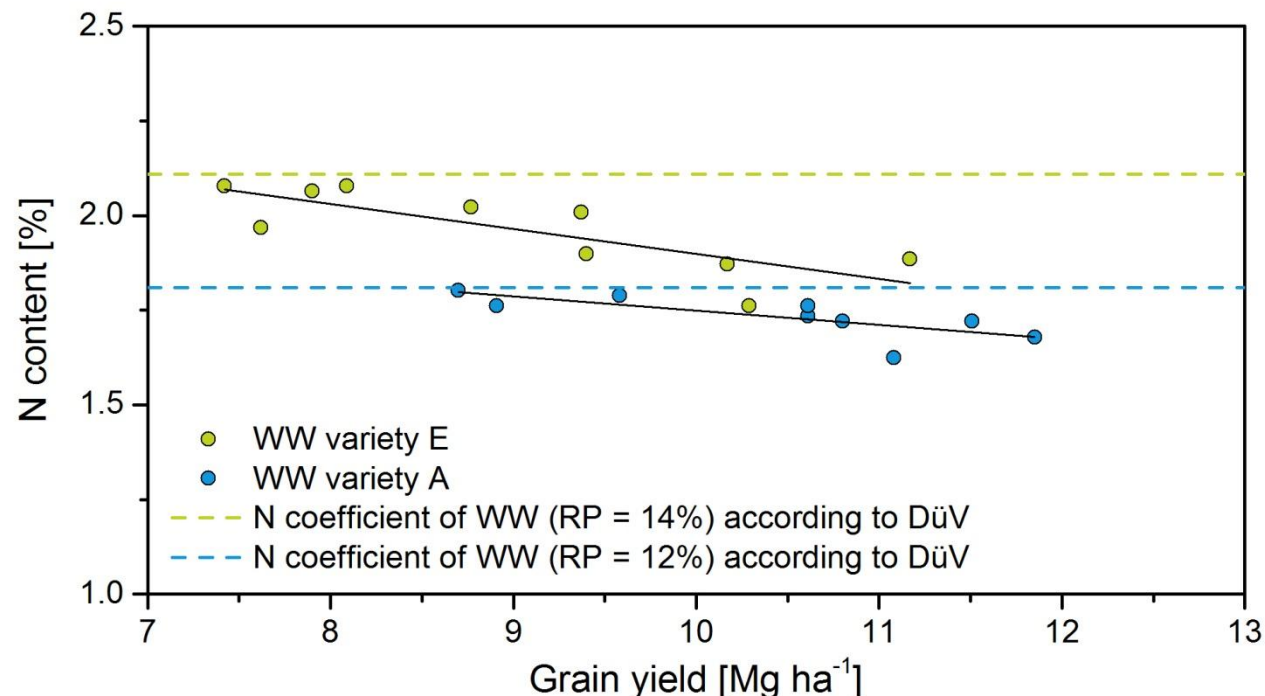
N-coefficients



Relationship between grain yield and N uptake

- 2 winter wheat varieties in Clauen, Germany from 1995 to 2007*

→ N uptake of winter wheat is usually overestimated



*Data provided by the Federal Plant Variety Office

Uncertainties

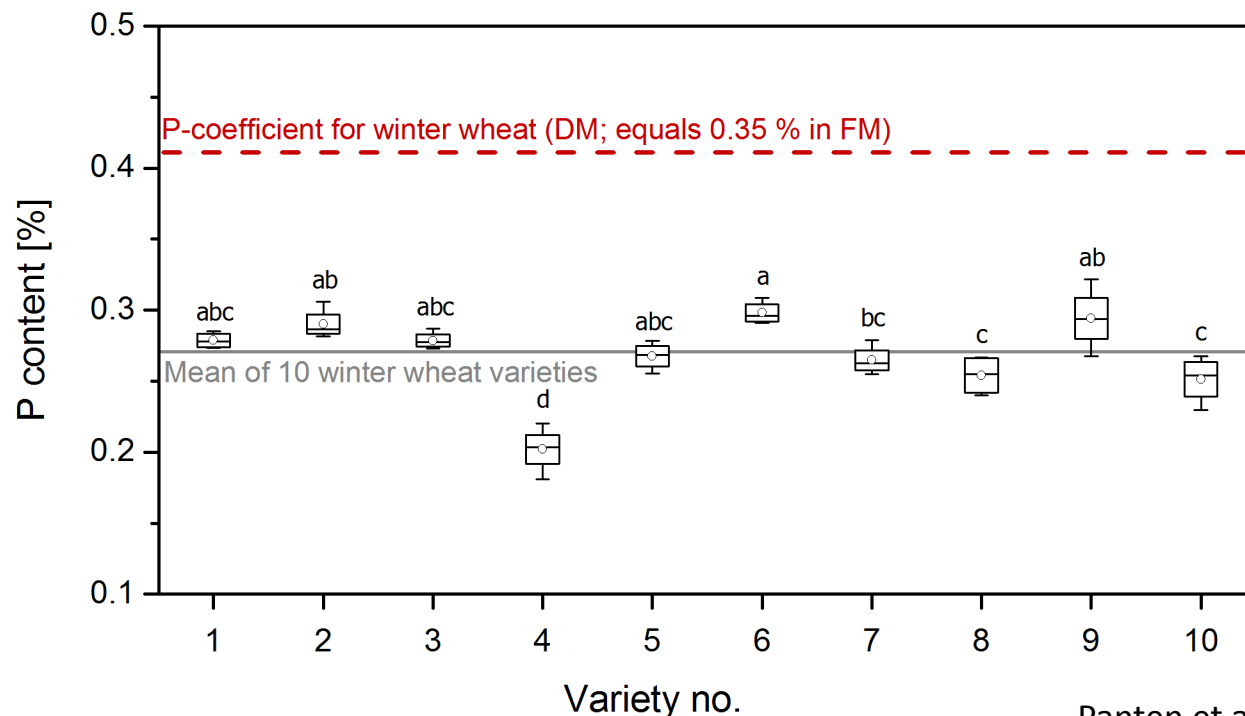
P-coefficients



Variation of P concentration in soft winter wheat grain

- 10 common varieties tested across two soil types

→ P coefficient from Fertiliser Ordinance is highly overestimated



Panten et al. (2015)

Uncertainties & Enhancements

National level



Uncertainties

- N- and P-coefficients
- Changes in assessment methodologies and classification of statistical data
- Instead of actual use data, only selling data for mineral fertilisers are available
- Data on fodder productions are estimations (by BMEL) and only available on national level.
- Data about import/export of animal manure from/to the Netherlands are not reliable
 - Changes with the Ordinance on Marketing and Transport of Manure

Enhancements

- Implementation of biogas plants (energy production) and anaerobe digestates

Assessment of effectiveness

N-surplus of national N-balance

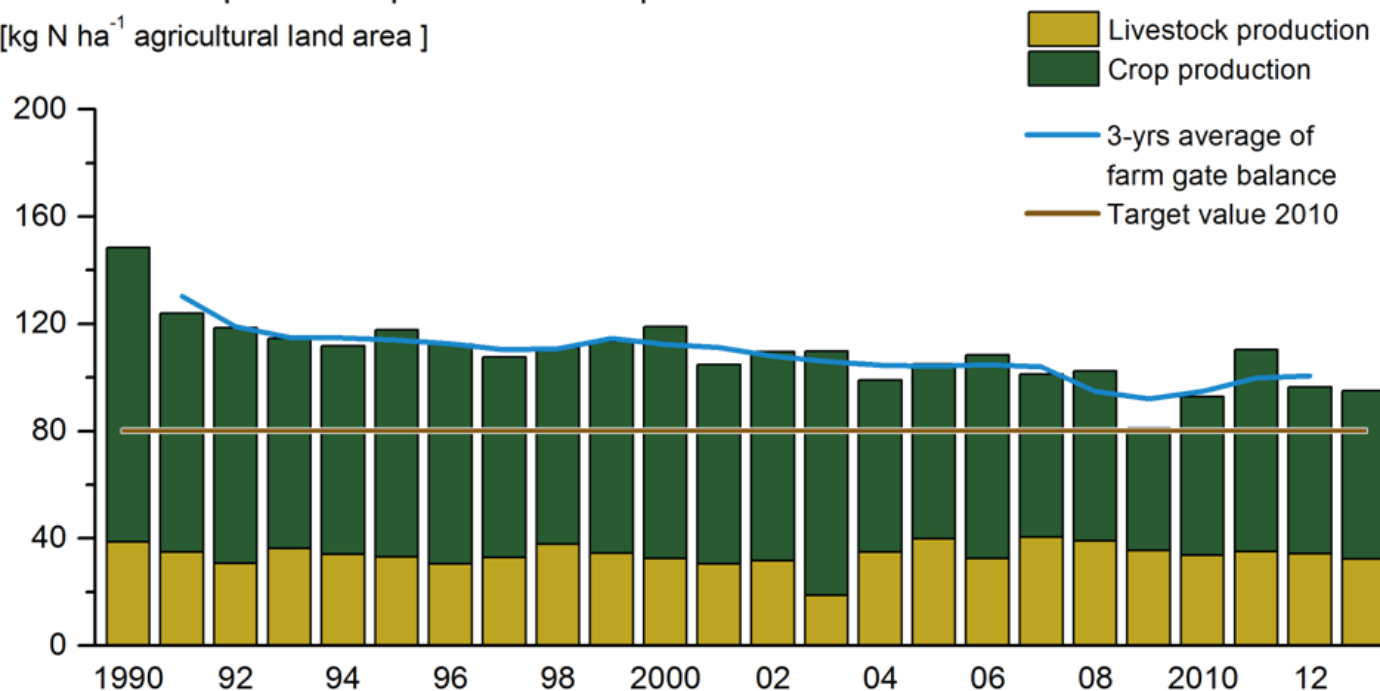


Agri-environmental indicator 'N-balance surplus'

– Target value for 2010 was 80 kg N/ha

→ Continuous decline since 1990 by totally 52 kg N/ha

N-balance surplus of crop and livestock production
[kg N ha⁻¹ agricultural land area]

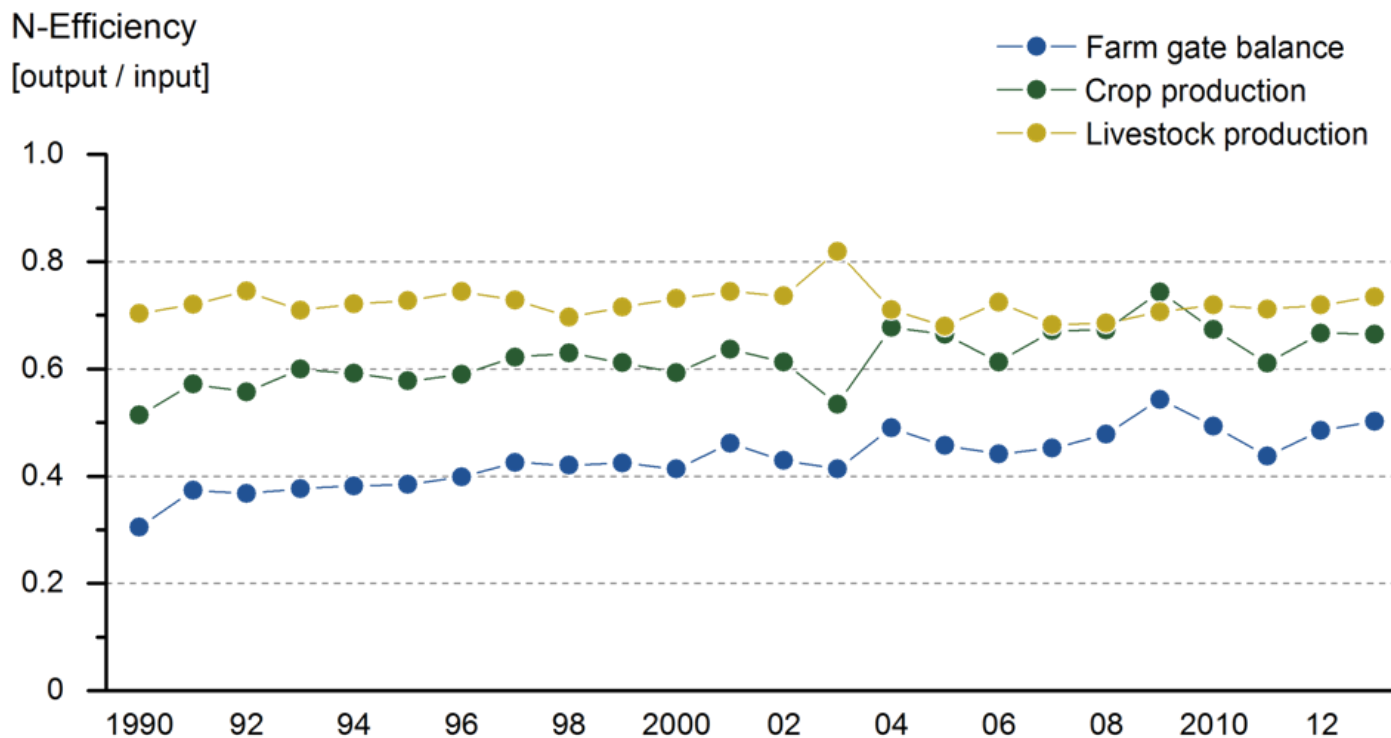


Assessment of effectiveness

N-efficiency



→ Main increase of N-efficiency in crop production (Field balance)



Assessment of effectiveness

Nitrates report

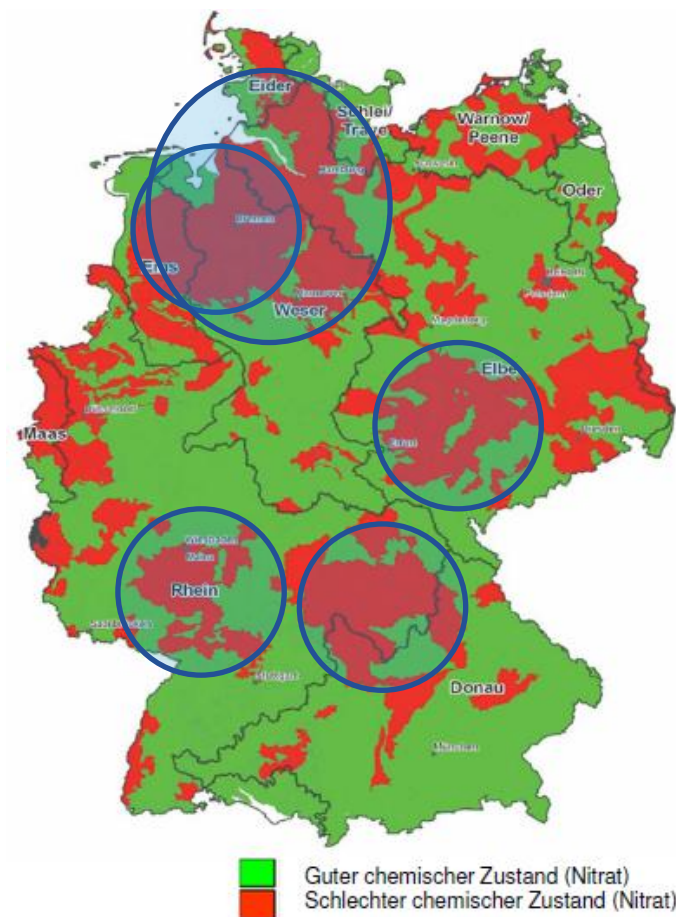


Nitrates report 2012:

- 49% of the groundwater monitoring stations have a poor chemical status ($\text{NO}_3^- - \text{N} > 50 \text{ mg/l}$)
- This are 28% of the UAA
- Rising trend in some areas

Espacially in areas with:

- High animal numbers
- Intensive cultivation of vegetables
- High concentration of biogas plants
- Low groundwater recharge rate



Quelle: BMU (2010)

Fertiliser Application Ordinance as legislative background for

- Fertiliser planning before fertiliser application
- Nutrient bookkeeping (N- and P-balances) after fertiliser application

Parties involved

- Federal Ministries, Ministries of Federal States, Chambers of Agriculture, Federal Research Institutions/Environmental Agency, Associations, NGOs, etc.
- Sometimes too many...

Methodology of nutrient bookkeeping

- National level – Farm gate balance (whole sector) based on official statistical data
- Farm level – Aggregated field balance

Uncertainties

- Federal State-specific guidelines for balance calculation
- N- and P-coefficients
- Calculation of N-offtake with forage (roughage, i.e. grass, silage maize etc.)
- Uncertainties in official statistical data for calculation of national N-balance (e.g. mineral N fertilisers, fodder production)

Assessment of effectiveness

- Agri-environmental Indicator ‚N-surplus‘ of national N-balance
- Nitrates Report

Thank you for your attention!



- Standard values for N demand at a specific yield level
 - From the Annex to the amendment of the Fertiliser Ordinance

Crop	Yield level [Mg/ha]	N demand [kg N/ha]
Winter rape	4	200
Winter wheat (A, B)	8	230
Winter wheat (C)	8	210
Winter wheat (E)	8	260
Durum wheat	5.5	200
Winter barley	7	180
Winter rye	7	170
Silage maize	45	200
...		

- Minimum N-indices for organic manure application after deduction of shed, storage and application losses
 - Annex to DüV (2007) and changes in the amendment of the Fertiliser Ordinance

Livestock	Slurry	Solid manure, liquid manure, deep litter
	[% of N _{tot}]	
Cattle	70	60
Pigs	60 70	55-60
Poultry		50
Other (horses, sheep)		50
Grazing, all animals		25