Nutrient cycling in soil – focus on N (and P) balances

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- Plant nutrient balances
  - Scale and methods can vary
    - Scale (system boundary): field-farm-catchment-county-country
    - What inputs and outputs are considered
    - Losses accounted or not (typically not)
  - Appropriate interpretation is important
    - Indirective indicator of agronomic efficiency and environmental pressure
    - Single year results can be misleading
    - Surplus ≠ leaching

Nutrient cycling

Atmospheric deposition

Photosynthesis

CO_2

Microbial
N fixation

Mineral fertilizers

CO_2, N_2O, N_2 ..

Runoff/erosion

Cation
exchange
with
colloids

**NO_3^-, NH_4^+,
PO_4^{-3}, HPO_4^{-2},
K^+ etc**

**Nurients in
soil solution**

Weathering of
minerals/rocks

(P, K etc)

Organic matter

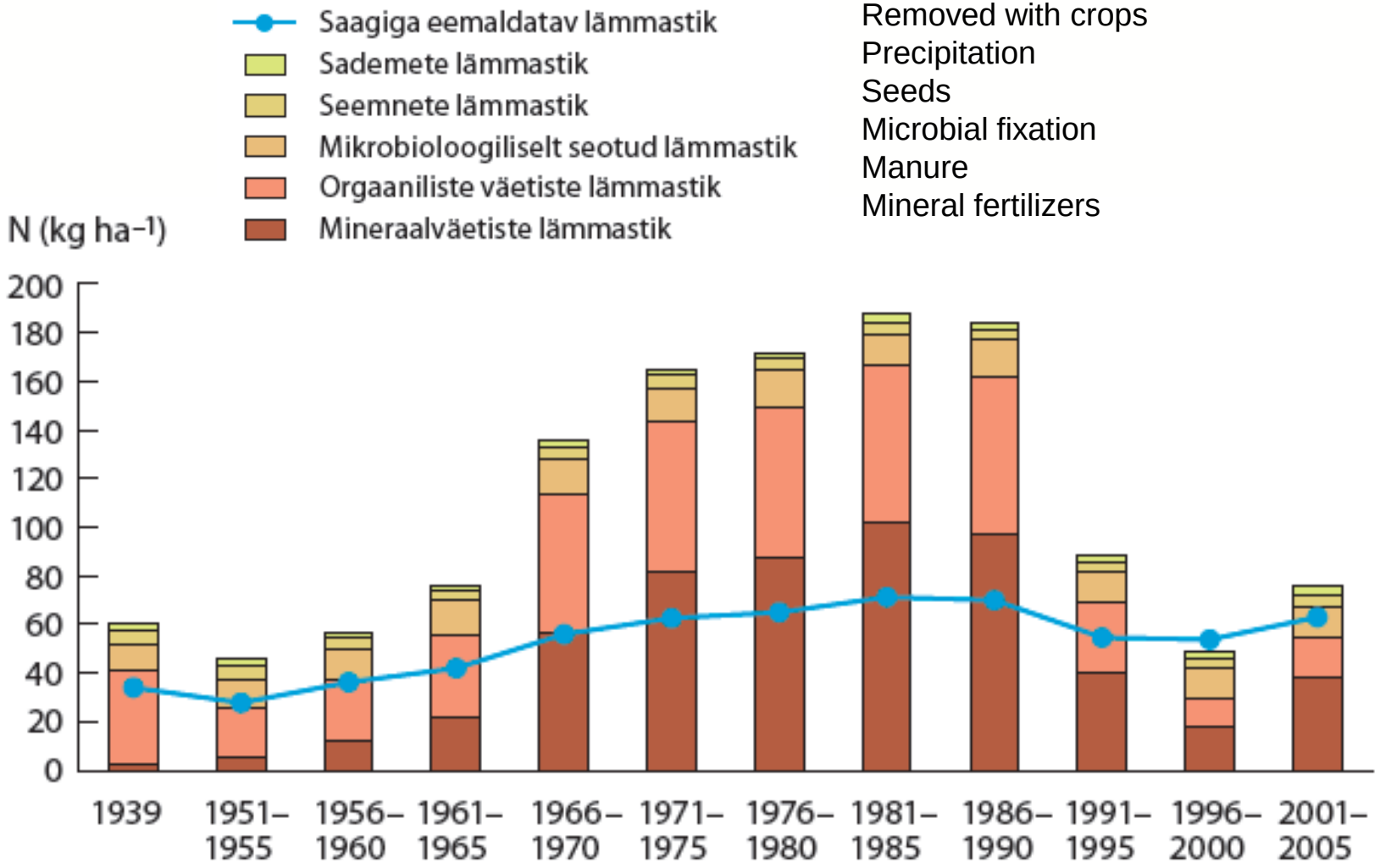
Soil biota

Mineralisation

Humification

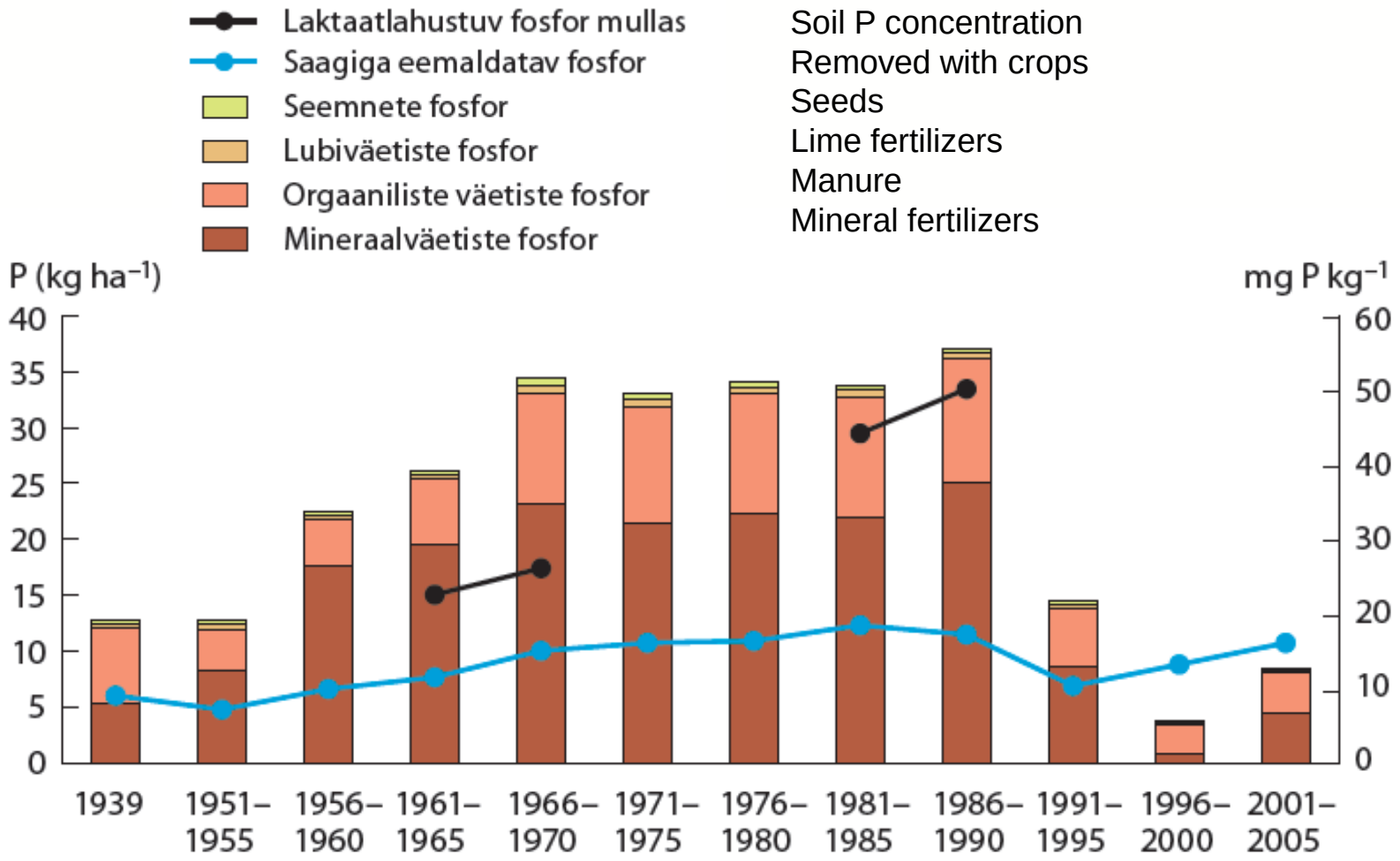
Leaching

N soil surface balance of arable land in Estonia

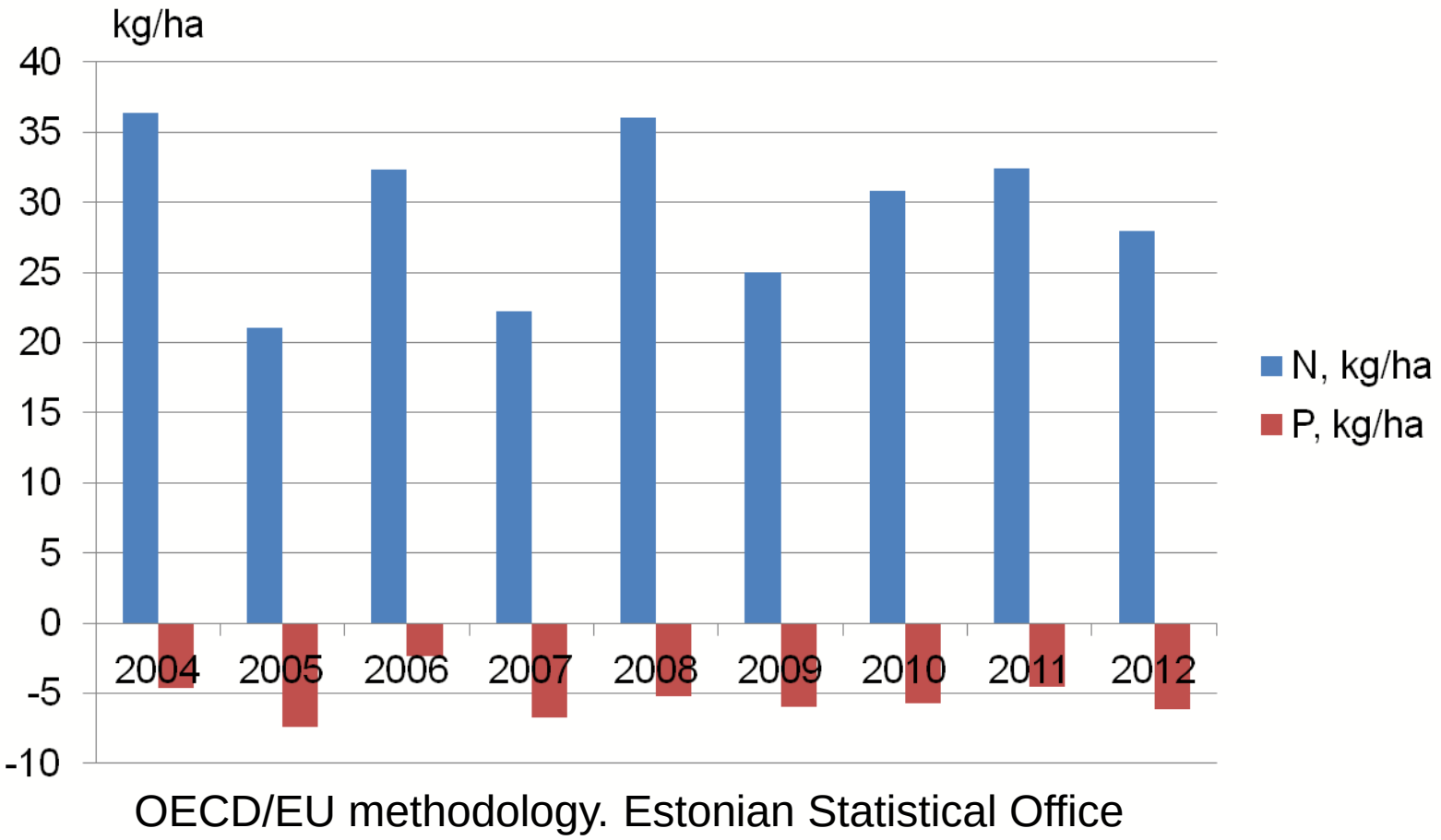


Removed with crops
Precipitation
Seeds
Microbial fixation
Manure
Mineral fertilizers

P soil surface balance of arable land in Estonia

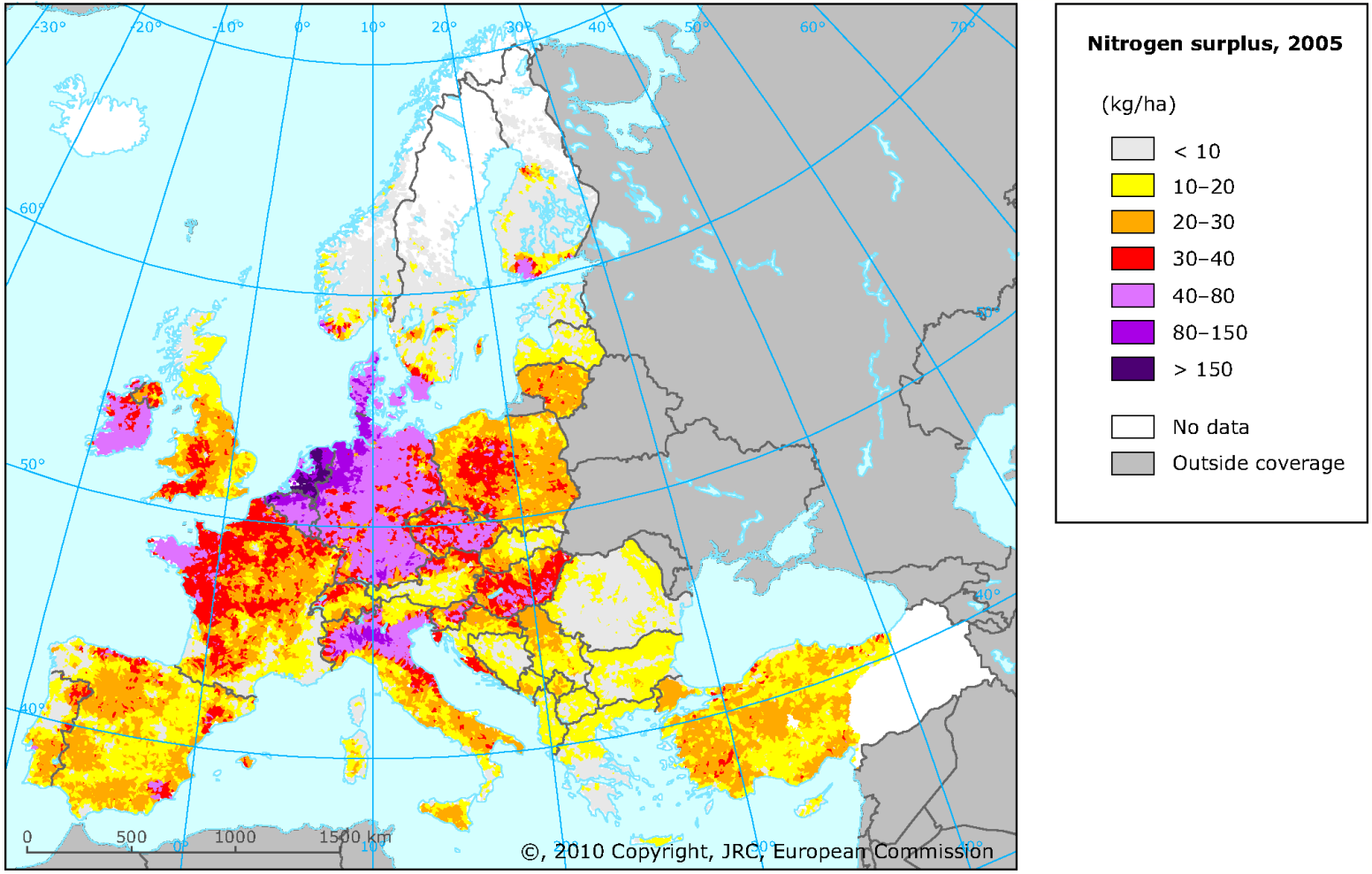


N, P soil surface balance in Estonia



OECD/EU methodology. Estonian Statistical Office

N balance in Europe (agricultural land)



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NO_3^- concentration in diferent „farming systems“

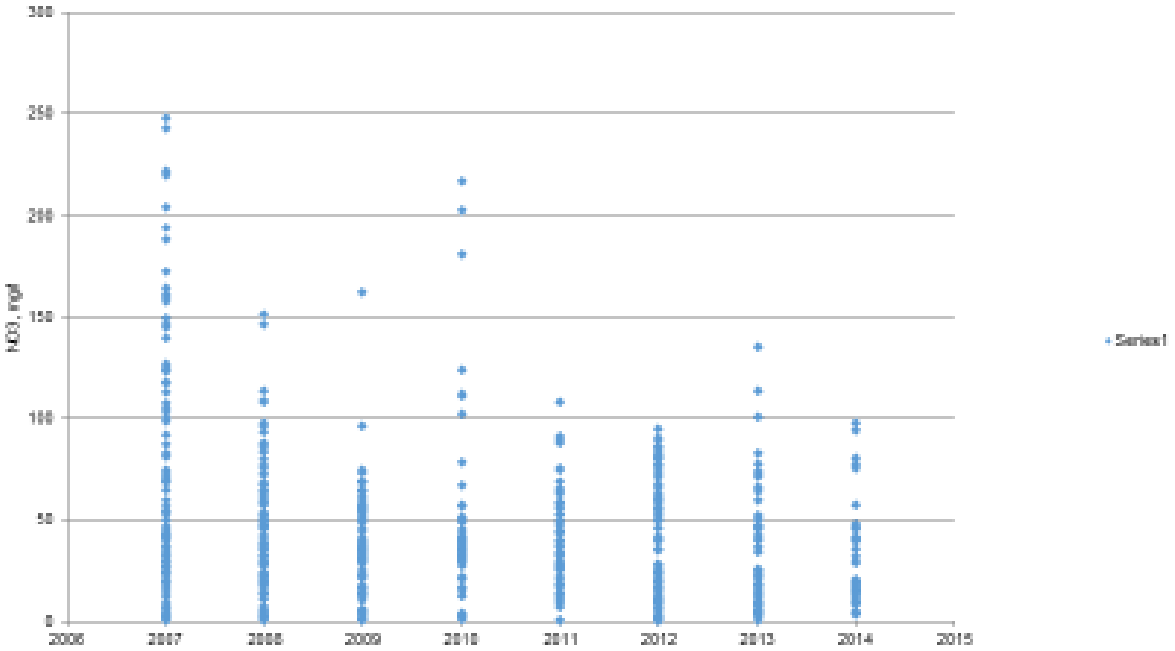
Nitraatiooni keskmised kontsentratsioonid toetustüübiti aastatel 2007-2014

NO_3, mg/l	2007	2008	2009	2010	2011	2012	2013	2014
KSM	52,2	46,7	39,8	43,7	44,0	32,7	35,4	37,6
ÜPT	30,1	39,6	14,7	2,9	10,4	23,0	19,9	14,9
MAHE	48,5	16,3	2,8	14,1	41,1	25,5	9,8	5,4
Piirnorm	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0

Särekannno ja Kanger 2015

NO_3^- concentration in drainage water in farms with „environmental friendly“ production

Nitraatiooni kontsentratsiooni muutus ja trend KSM põldude dreenivees aastatel 2007-2014



Särekannno ja Kanger 2015

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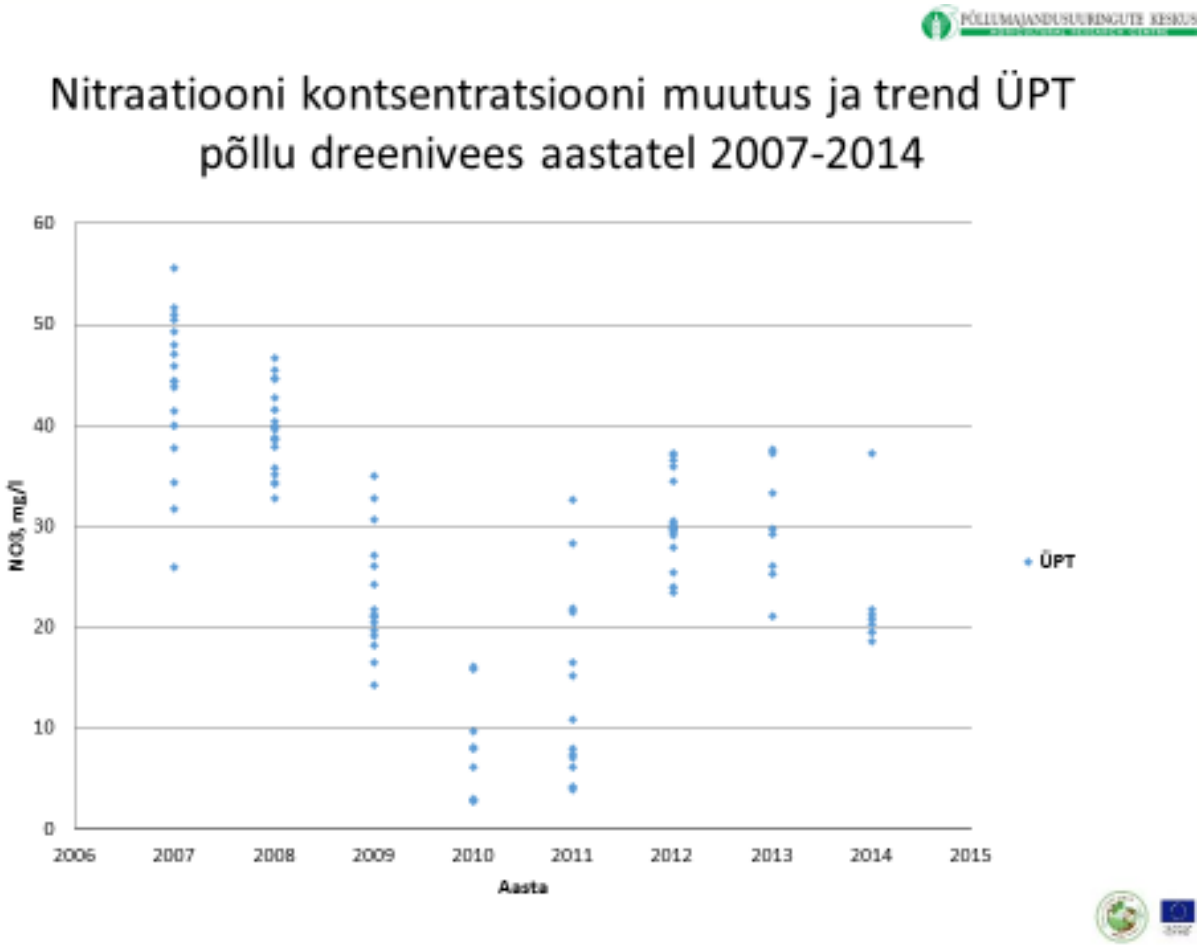
NO_3^- concentration in drainage water in farms with „conventional“ production



Särekannno ja Kanger 2015

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N, P leaching in different „farming systems“

Lämmastiku ja fosfori leostumine toetustüübiti aastatel 2007-2014

Toetustüüp	Lämmastiku leostumine, kg/ha/a								
	2006/07	2007/08	2008/09	2009/2010	2010/11	2011/12	2012/13	2013/14	keskmine
KSM/KST	16,7	23,8	8,7	7,7	9,4	21,8	11,2	11,3	13,8
ÜPT	36,9	30,7	21,2	11,0	1,0	26,3	29,5	8,3	20,6
MAHE	10,3	40,8	3,7		1,4	4,7	3,1	1,4	9,3

N, kg/ha

Toetustüüp	Fosfori leostumine kg/ha/a								
	2006/07	2007/08	2008/09	2009/2010	2010/11	2011/12	2012/13	2013/14	keskmine
KSM/KST	0,15	0,17	0,17	0,14	0,09	0,15	0,21	0,37	0,18
ÜPT	0,14	1,08	0,75	0,29	0,03	0,22	0,40	0,14	0,38
MAHE	0,18	0,64	0,30		0,03	0,07	0,15	0,22	0,23

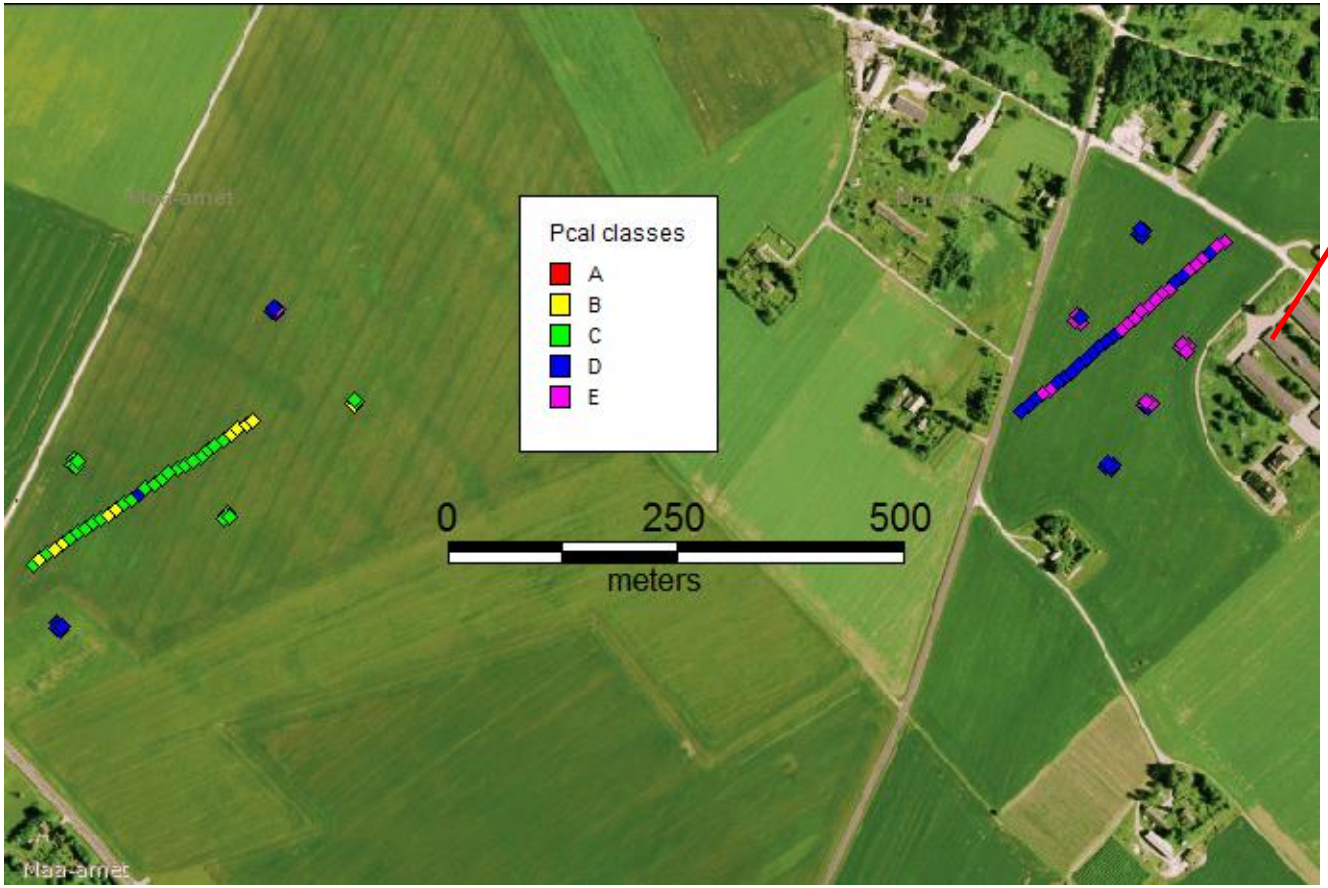
P, kg/ha

Särekannno ja Kanger 2015

Soil P level (CAL-method):

A – very low concentration (deficit)

E – very high concentration (surplus)



Chicken farm in „soviet“ time

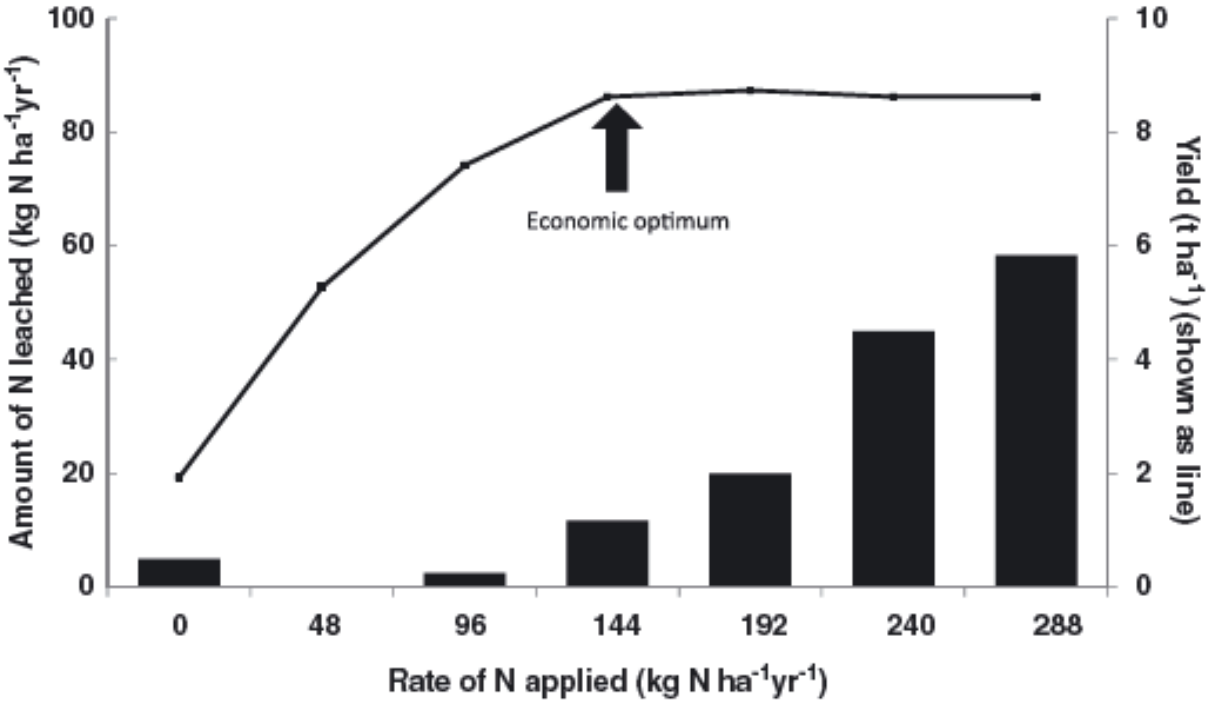


Figure 6 Nitrogen leaching losses from the Broadbalk Experiment at Rothamsted Experimental Station, in which N treatments have been repeated on the same plots since 1843 [adapted from Goulding (2000)].

Annals of Applied Biology ISSN 0003-4746

REVIEW ARTICLE

Nitrogen losses from the soil/plant system: a review

K.C. Cameron, H.J. Di & J.L. Moir

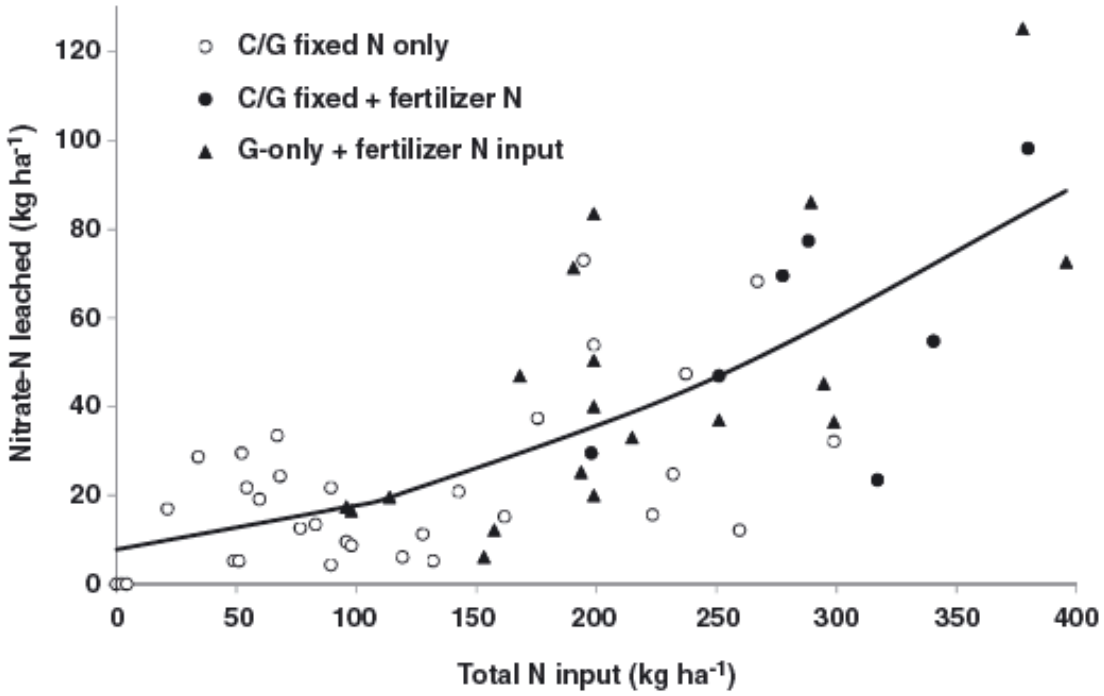


Figure 3 Relationship between N input and nitrate-N leaching loss from grassland. C, clover; G, grass [adapted from Ledgard (2001); Peoples *et al*. (2004) and Ledgard *et al*. (2009)].

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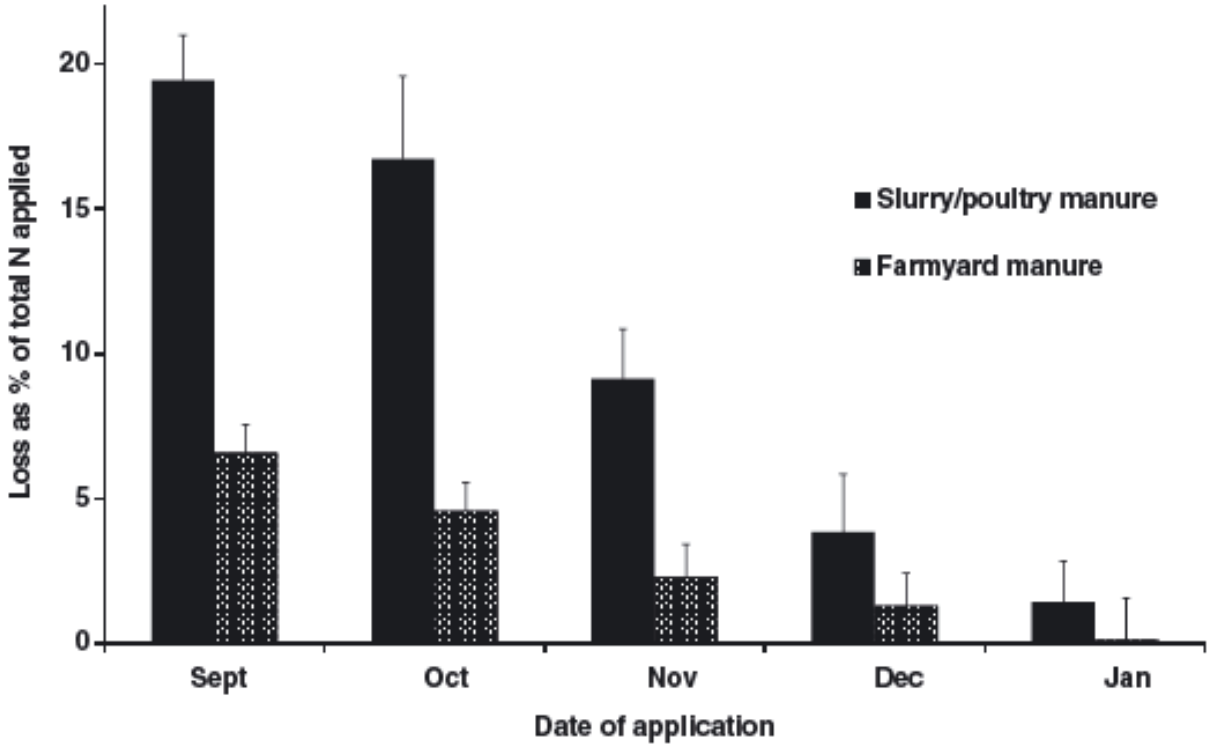

Figure 7 Nitrate leaching losses following manure applications to arable free draining sandy and shallow soils over chalk (1990/91 – 1993/94, about 250 kg total N ha^{-1} applied) [adapted from Chambers *et al.* (2000)].

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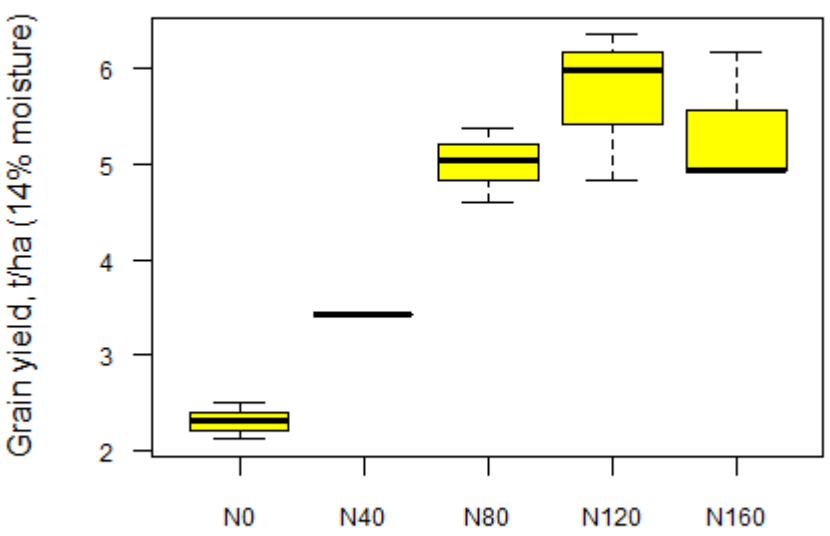
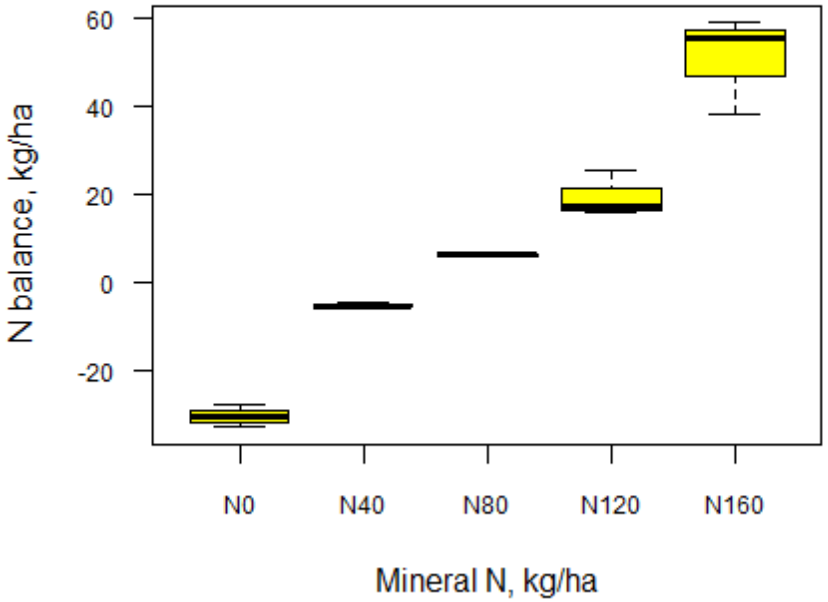
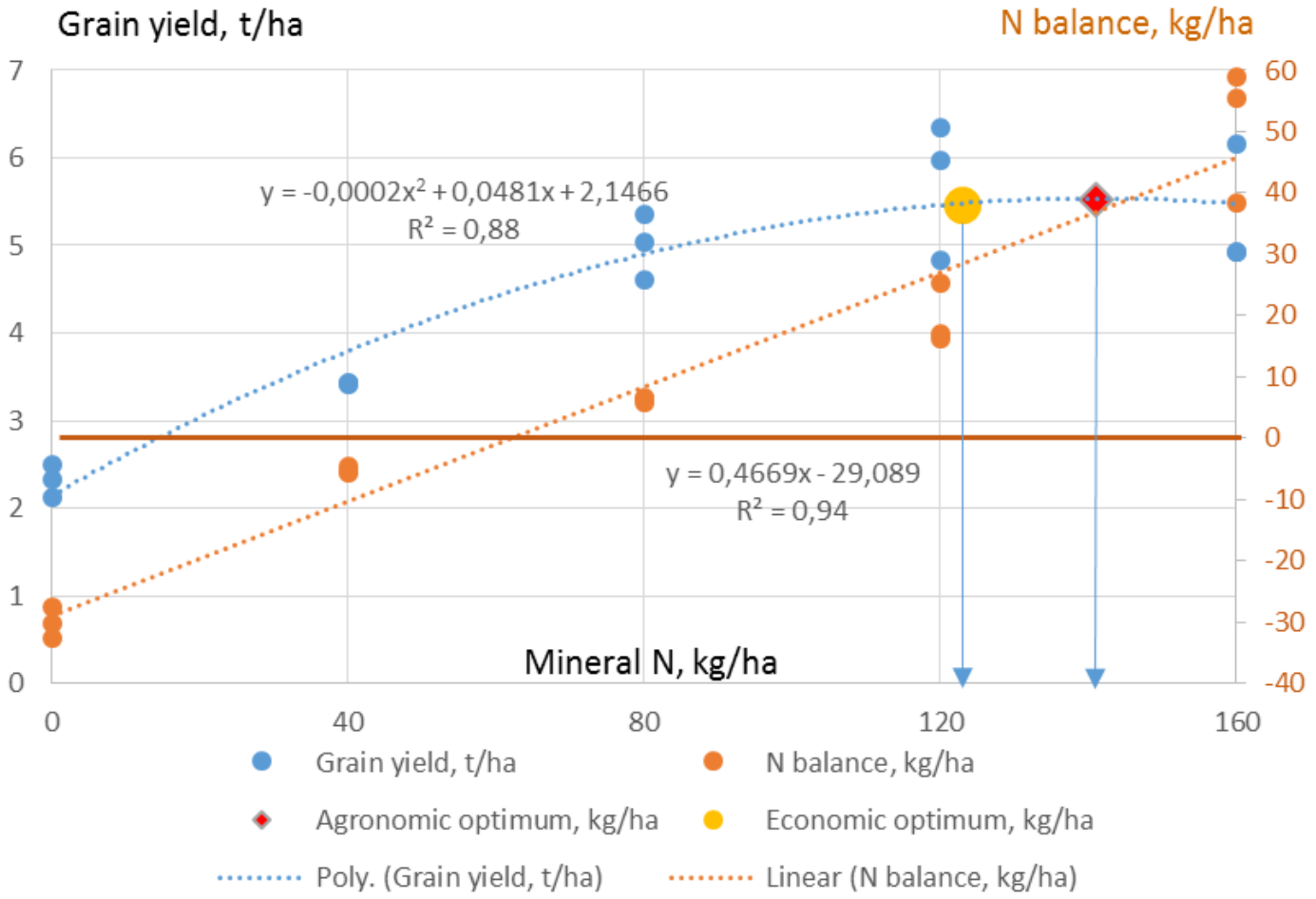
Field experiment in 2015: spring barley

Tartu, soil humus concentration 2%





Field experiment in 2015: spring barley



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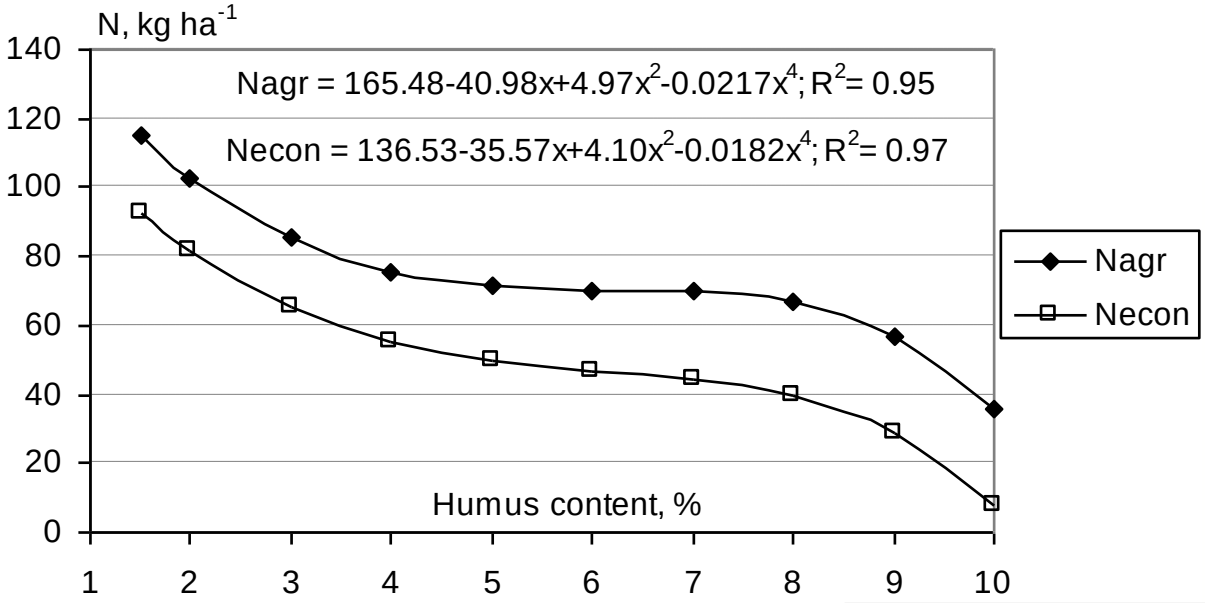
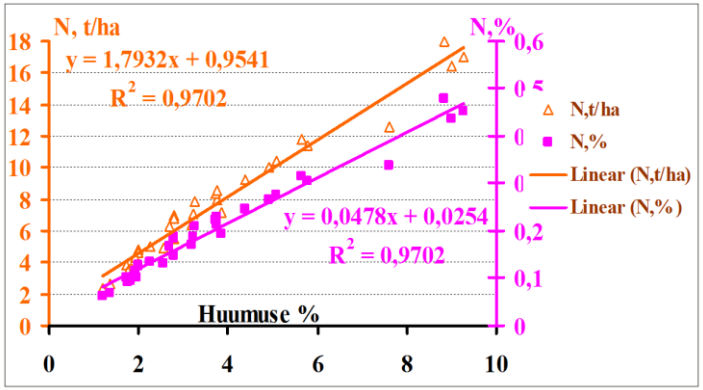
Example of spring barley: agronomic and economic optimum of mineral N fertilizer rate depending on soil humus concentration



Astover et al. 2006



H. Roostalu

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Humus balance calculator (version 1.1)

- Field scale
- Takes in account
  - Soil
  - Fertilization
  - Crop specifics, yield etc

Mainly non-lineaar functions. Example of humus balance in case of spring barley (grain yield 3 t/ha) depending on N fertilization

Huumusbilansi kalkulaator v 1.1
Eesti Maaülikool, põllumajandus- ja keskkonnainstituut. 2015.

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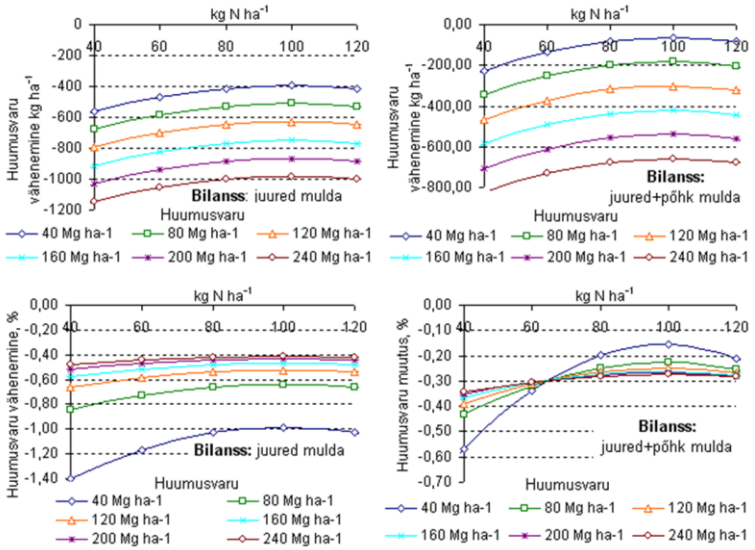
Institute of Agricultural and Environmental Sciences

Kasuta kalkulaatorit

Uuendused ja täiendav info

Kalkulaator on tasuta kasutamiseks ja levitamiseks.
Selle sisuline täiendamine ja arendus on lubatud ainult eelneval kokkuleppel väljaandjaga.
Kalkulaatori koostamist on toetanud Eesti Vabariigi Põllumajandusministeerium.

Kasutusjuhend
Kalkulaator töötab MS Office Exceli ning ka vabavarilise Libre Office tarkvaraga.
Huumusbilanss sõltub tootmistasemest, mullast, kasvatatavast kultuurist ja väetamisest. Kalkulaatorit saab hetkel kasutada ainult mineraalmuldadel huumusbilansi arvutamiseks enamlevinud põllukultuuride külvikorra jaoks.
Tulemused: algne huumusvaru (t/ha); huumusbilanss (kg/ha aastas); huumusvaru muutus (% algsest huumusvarust aastas). Kalkulaator võimaldab leida tulemit konkreetse kõlviku kui ka kogu külvikorra kohta.
Kultuurid on jaotatud nelja gruppi: teraviljad, muud kultuurid, heintaimed, haljsaväetised. Esmalt valitakse lahtri aktiviseerimisel avanevast valikmenüüst kasvatatav kultuur ja sisestatakse selle



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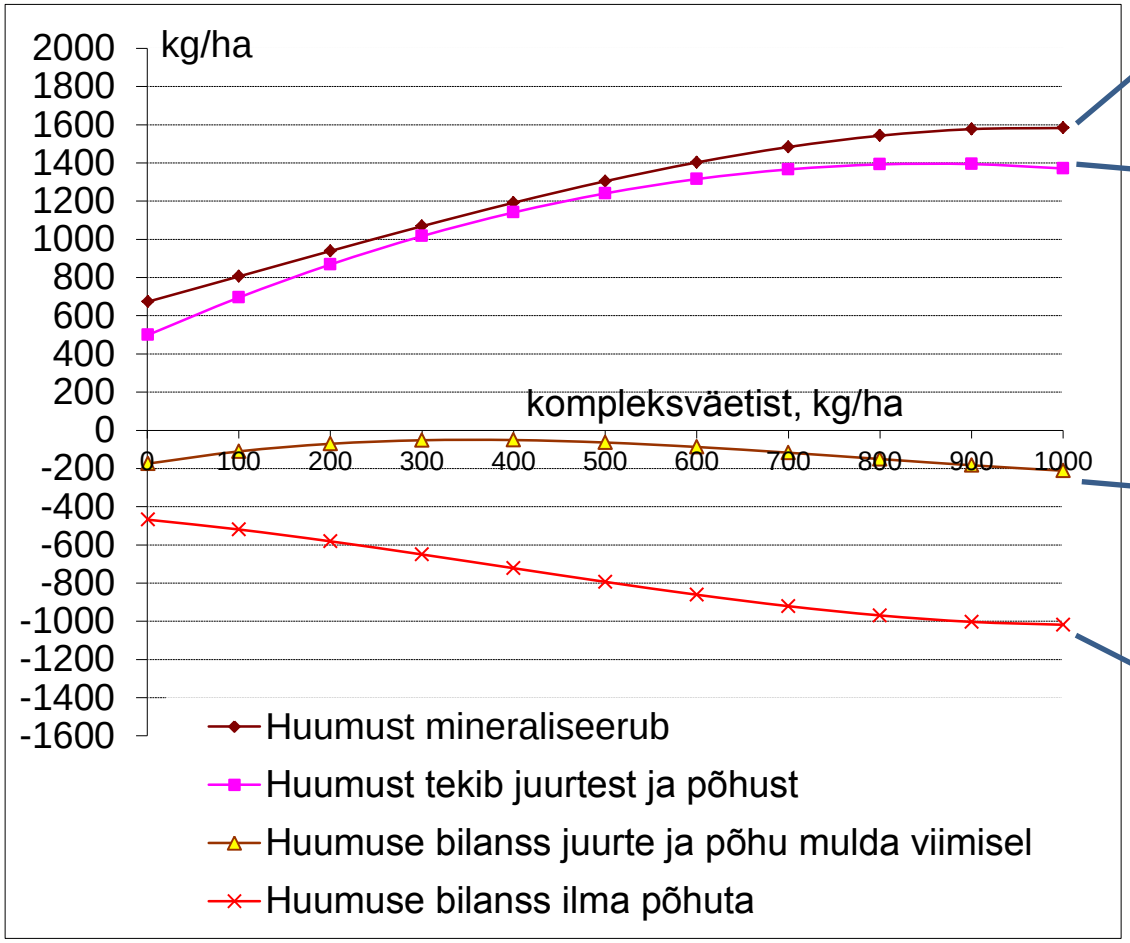
Humus balance: effect of complex fertilizers, spring wheat



Mineralisation

Humus formation (straw into soil)

Balance(straw into soil)

Balance(straw removed)

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Example from pilot farm
Humus balance in 2012–2014

Viljavaheldus Crop rotation	Pind, ha Area	Keskmine huumusevaru t/ha Humus stock	Huumuse bilanss kg/ha/year Humus balance	Huumuse kulu üldvarust, % Ratio to stock
Raps-teravili-raps Rapeseed-cereal-rapeseed	53,54	96	-417	-0,47
Teravili-raps-teravili Cereal-rapeseed-cereal	336,03	91	-520	-0,35
Hernes-teravili-raps Pea-cereal-rapeseed	123,81	98	-115	-0,11
Teravili-hernes-teravili Cereal-pea-cereal	150,65	84	-118	-0,12
Teravili-teravili-teravili Cereal-cereal-cereal	37,83	66	-599	-0,91
Kokku talu Total/Average	**701,86**	**90**	**-359**	**-0,30**

Soil of the Year 2016 in Estonia is Fibric Histosol (bog soil)
Aasta muld 2016 - rabamuld

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Estonian Soil Science Society

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