Ekologiskt kretsloppsjordbruk
Ecological Recycling Agriculture (ERA)
<u>Ecological Regenerative Agriculture (ERA)</u>

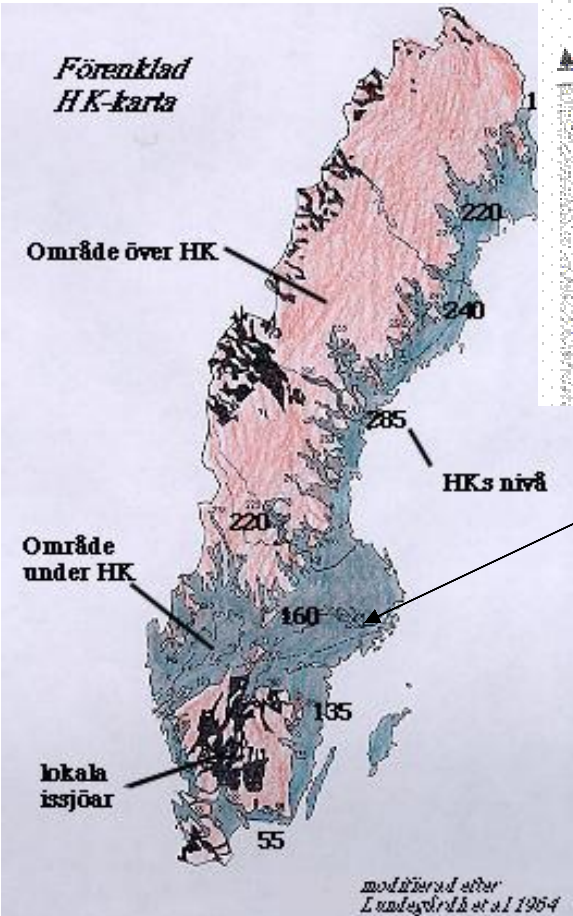
Artur Granstedt
artur.granstedt@beras.eu
The Biodynamic Reserach Institute www.beras.eu

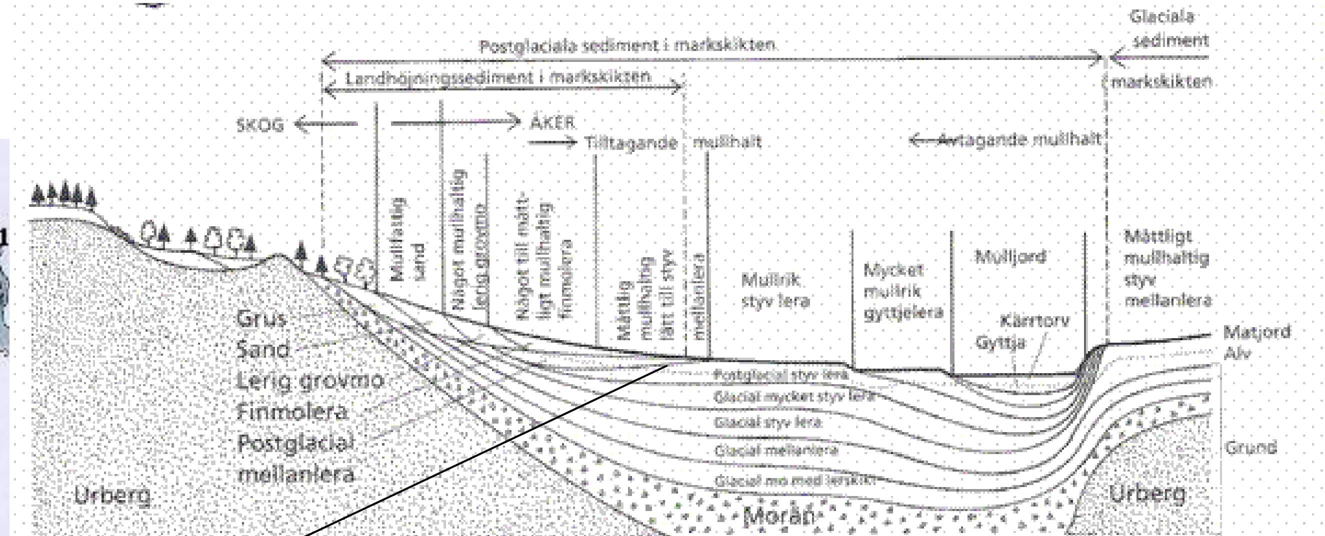
Om jordartsgeologi

Quaternary Period

De vita områdena på kartan ovan representerar inlandsisens utbredning för 20 000–17 000 år sedan. Det var under denna period som den senaste inlandsisen hade sin maximala utbredning i norra Europa. Norra Atlanten täcktes då periodvis av havsis (ljust blått) medan sydligare havsområden, exempelvis Medelhavet, var fria från is (blått). Eftersom stora mängder vatten var uppbundet i inlandsisar så stod havsytan

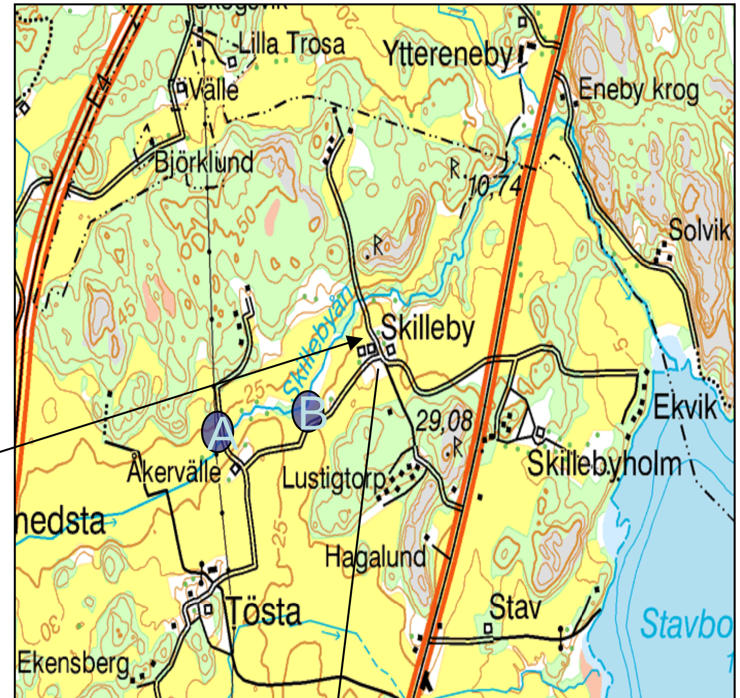
Natural history

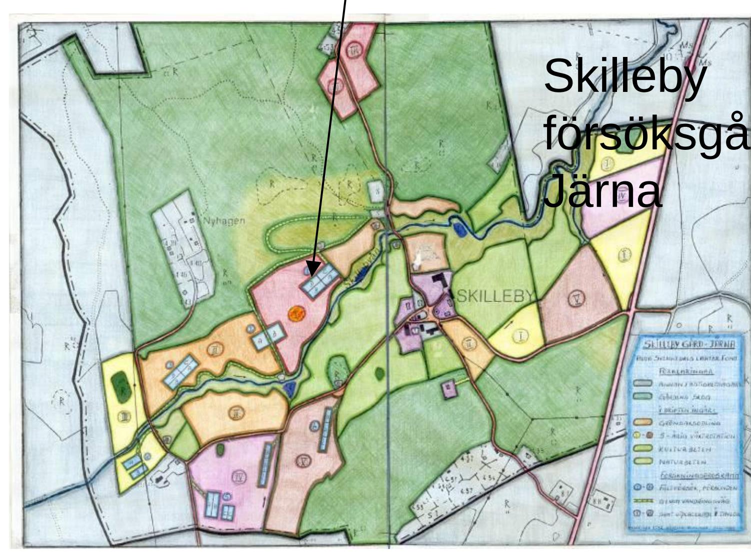




Map with high coast-line (HK), Area above the HK and under the

In Sweden most arable land is found where there are sedimentary soil types below the high coast- line after last ice time 10 000 years ago. The soils with limestone content balancing the acid quarts (silicia) dominated parent material have the best natural fertility.





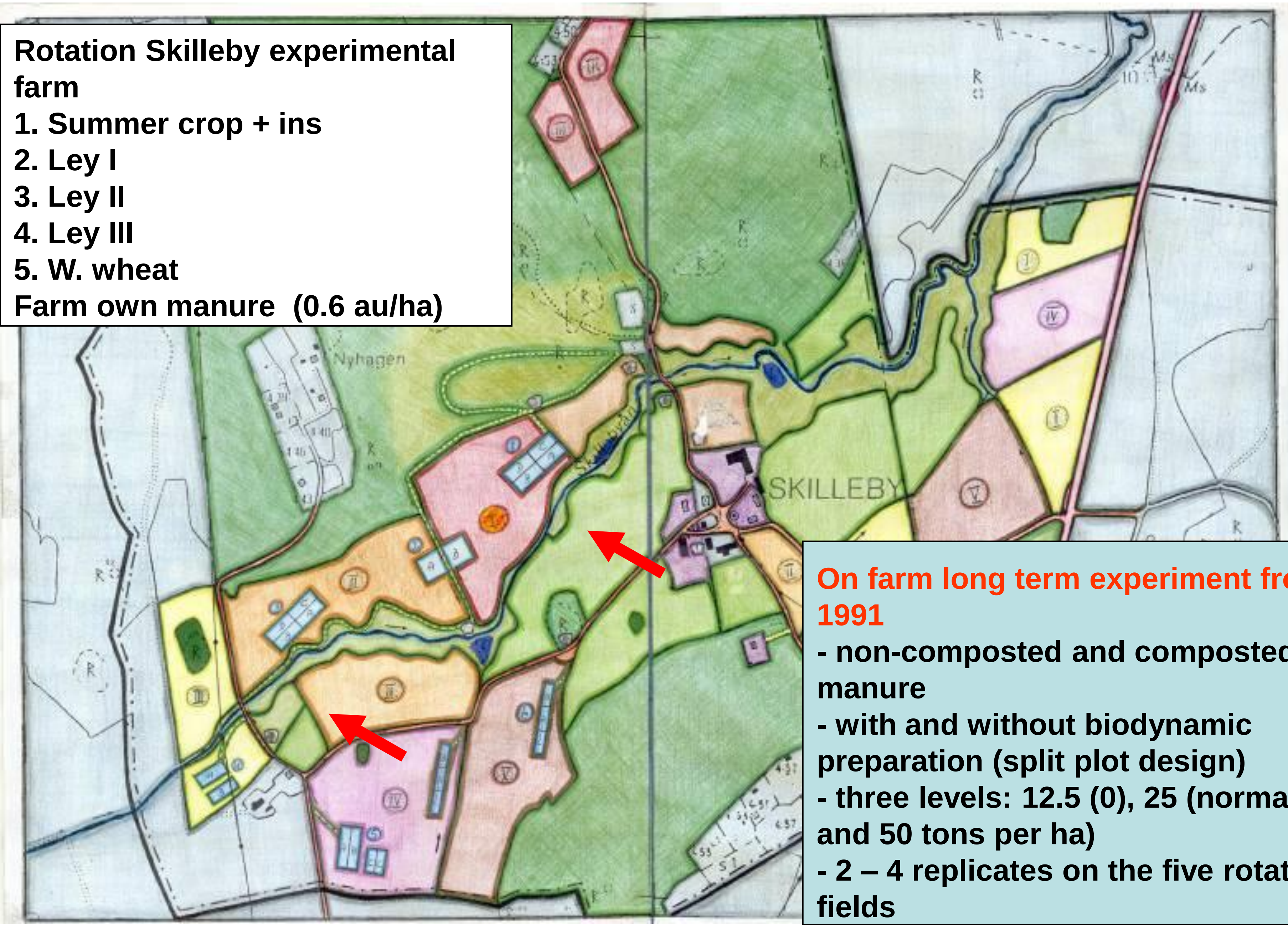
Skilleby
försöksgård
Järna

Lokalisering typgårdar I
Östersjöprojektet BERAS

Rotation Skilleby experimental farm

1. Summer crop + ins
2. Ley I
3. Ley II
4. Ley III
5. W. wheat

Farm own manure (0.6 au/ha)



On farm long term experiment from 1991

- non-composted and composted manure
- with and without biodynamic preparation (split plot design)
- three levels: 12.5 (0), 25 (normal) and 50 tons per ha)
- 2 – 4 replicates on the five rotation fields

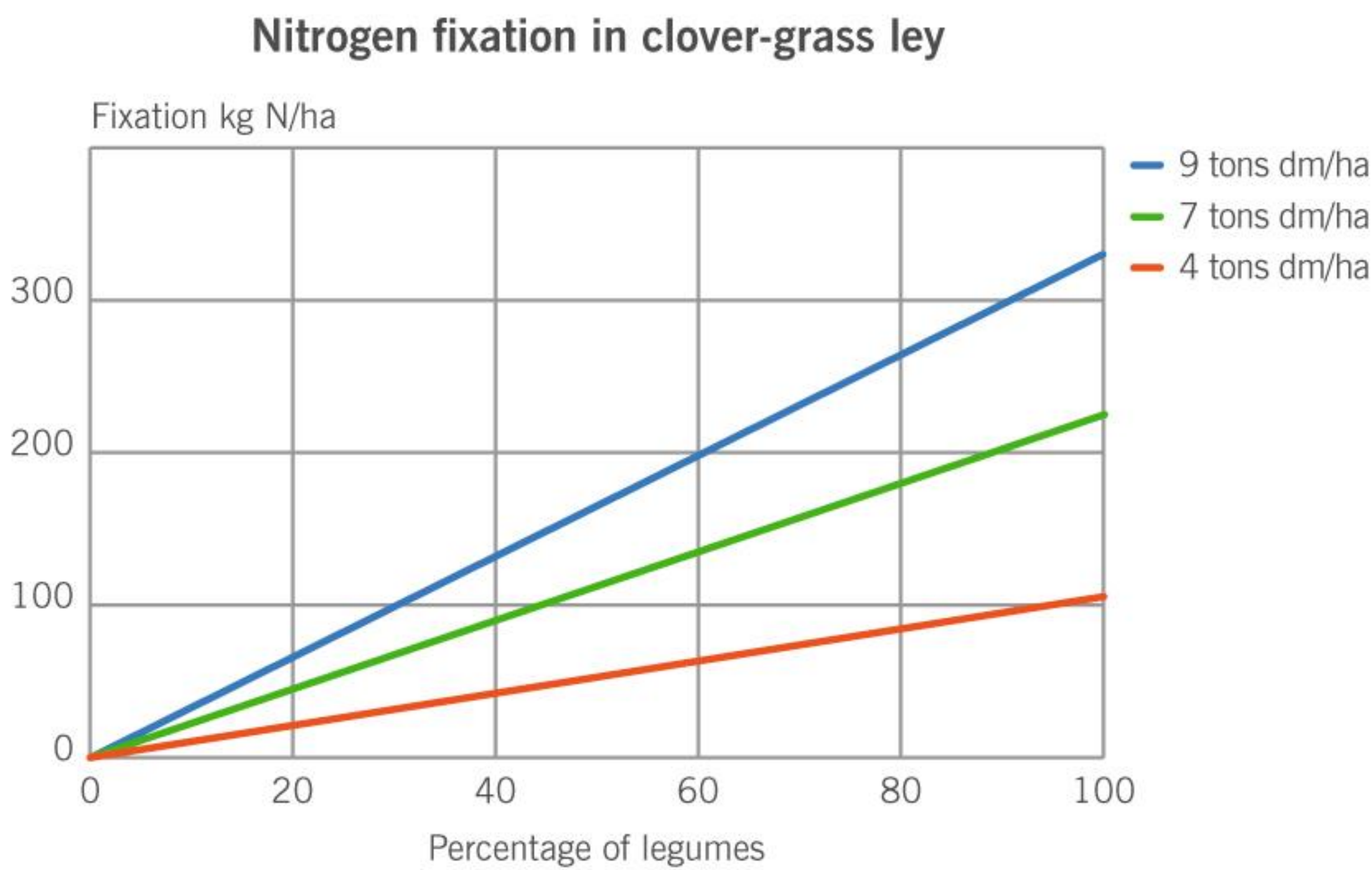
Long term manure experiment

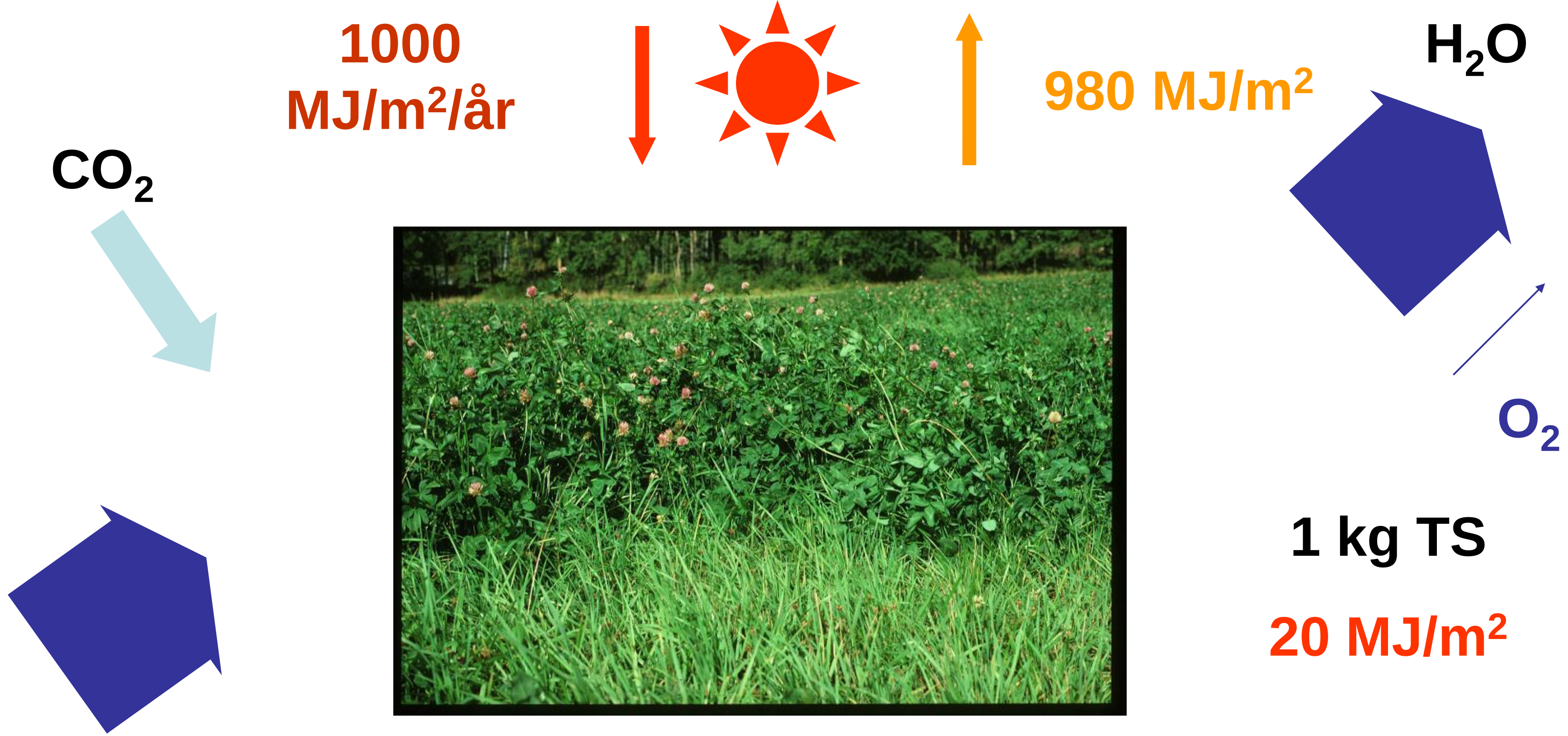
Experimental plan from 1991

Main plot	Treatments winter wheat
F1	Not composted manure 12.5 ton (0 from 1995)
F2	25 ton
F3	50 ton
K1	Composted manure 12.5 ton (0 from 1995)
K2	25 ton
K3	50 ton
Subplot (split plot) +	BD preparation each plot each year
-	Without BD preparation


www.avenirsem.ch
SÅ FRAMTIDEN!




Nitrogen fixation in clover-grass ley
Fixation kg N/ha
300
200
100
0
0
20
40
60
80
100
Percentage of legumes
9 tons dm/ha
7 tons dm/ha
4 tons dm/ha

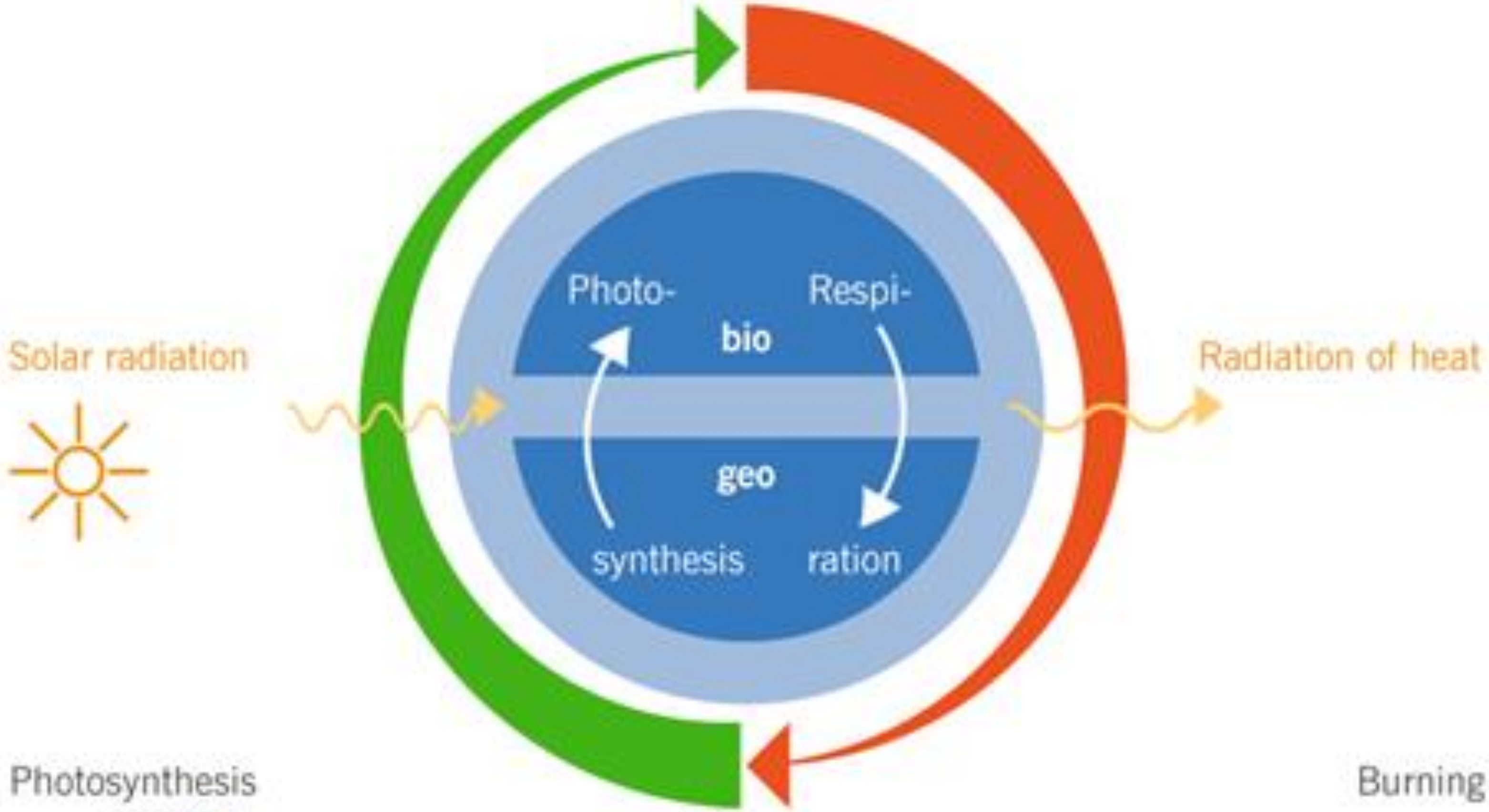


6 tons harvest DM yield/ ha and year = 10 tons above and underground DM (1kg DM / m^2). 5 tons C/ha (C from 50 000 000 m3 air)

200 000 MJ /ha (20 MJ/m^2), of which 120 000 MJ is harvested for the above ground organisms (about 1 milk cows/ha) and 80 000 MJ for the underground organisms.

Basic ecological conditions

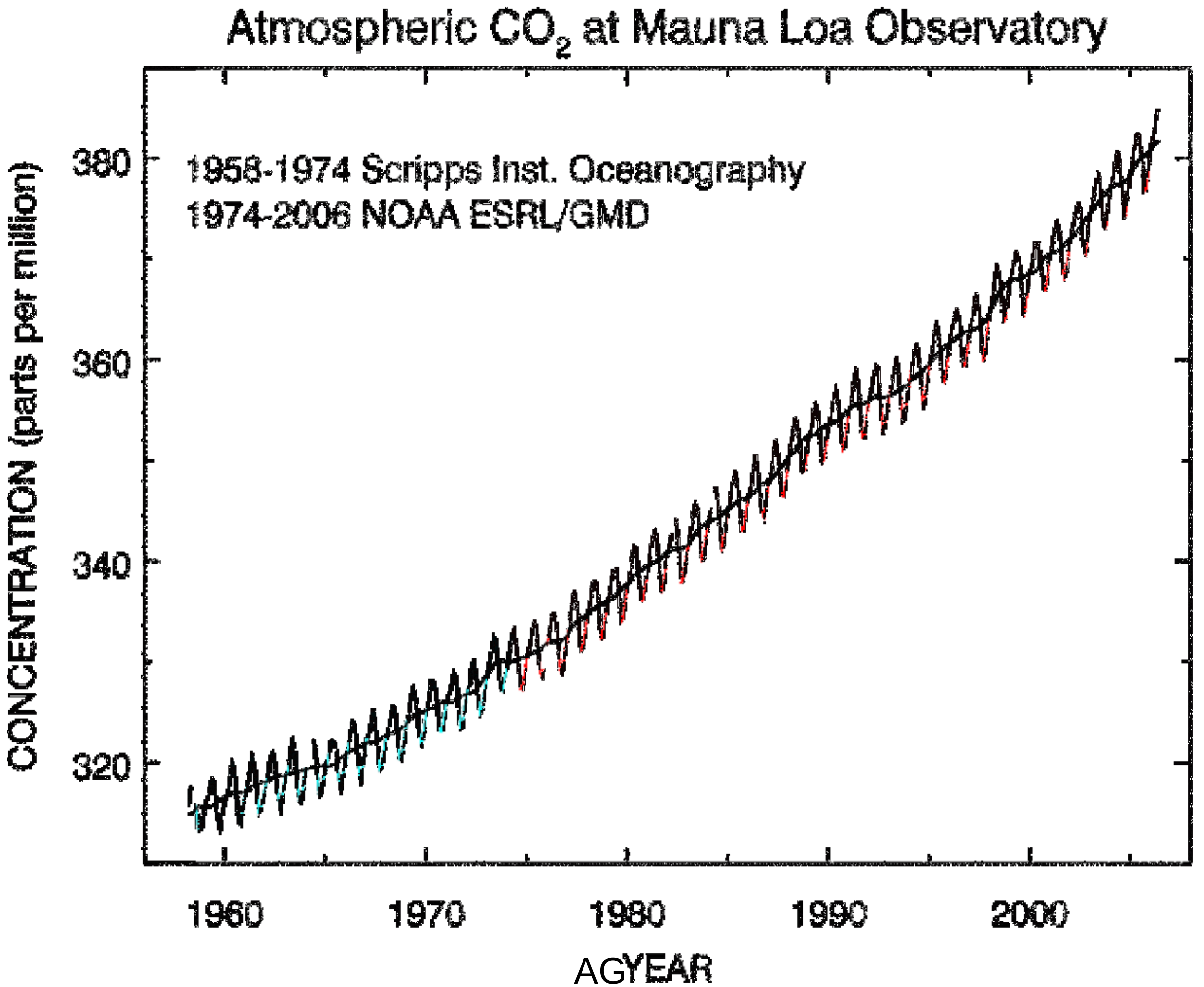
energy flow, recycling and biological diversity



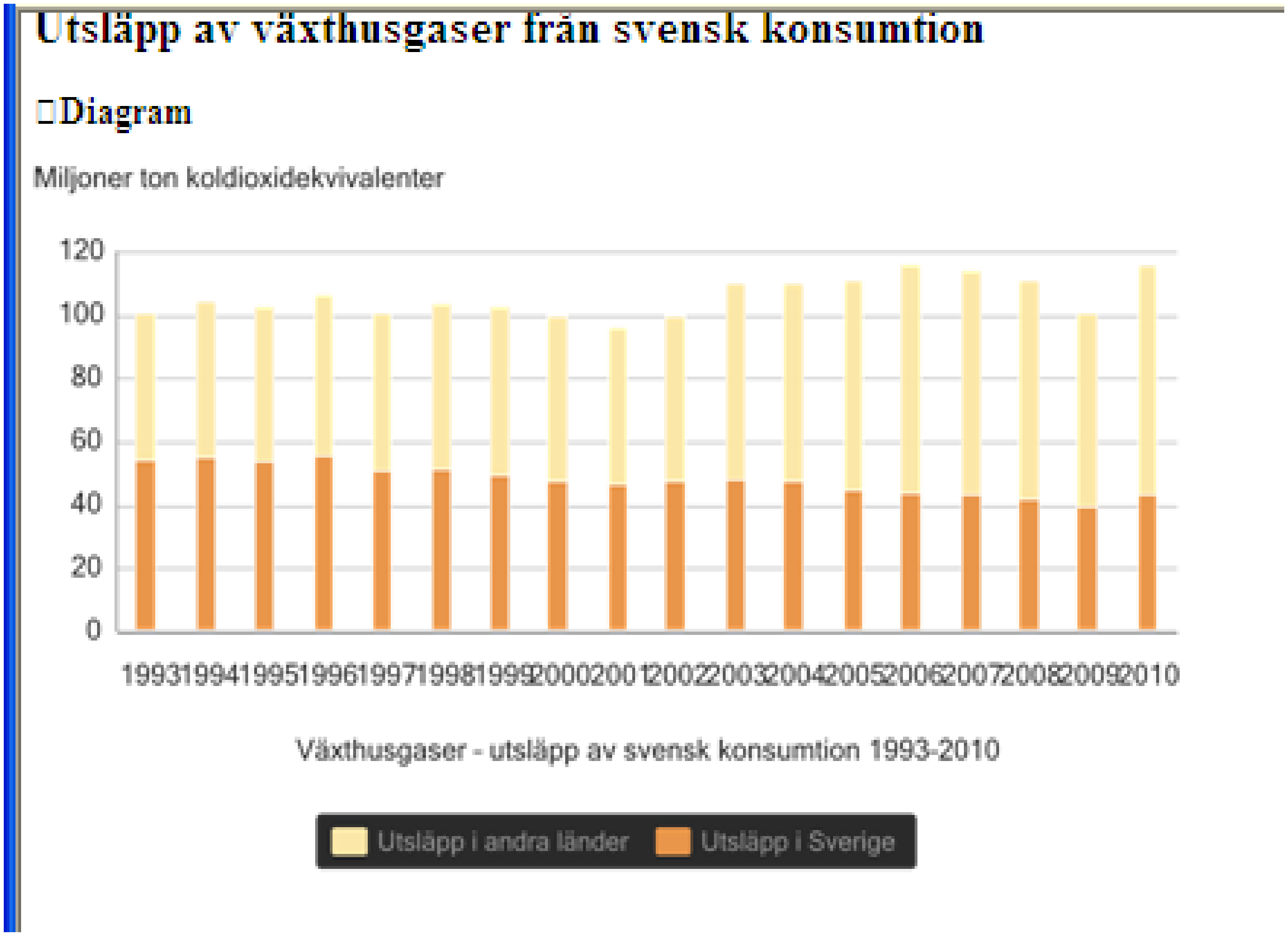
Ecosystem earth out of balance

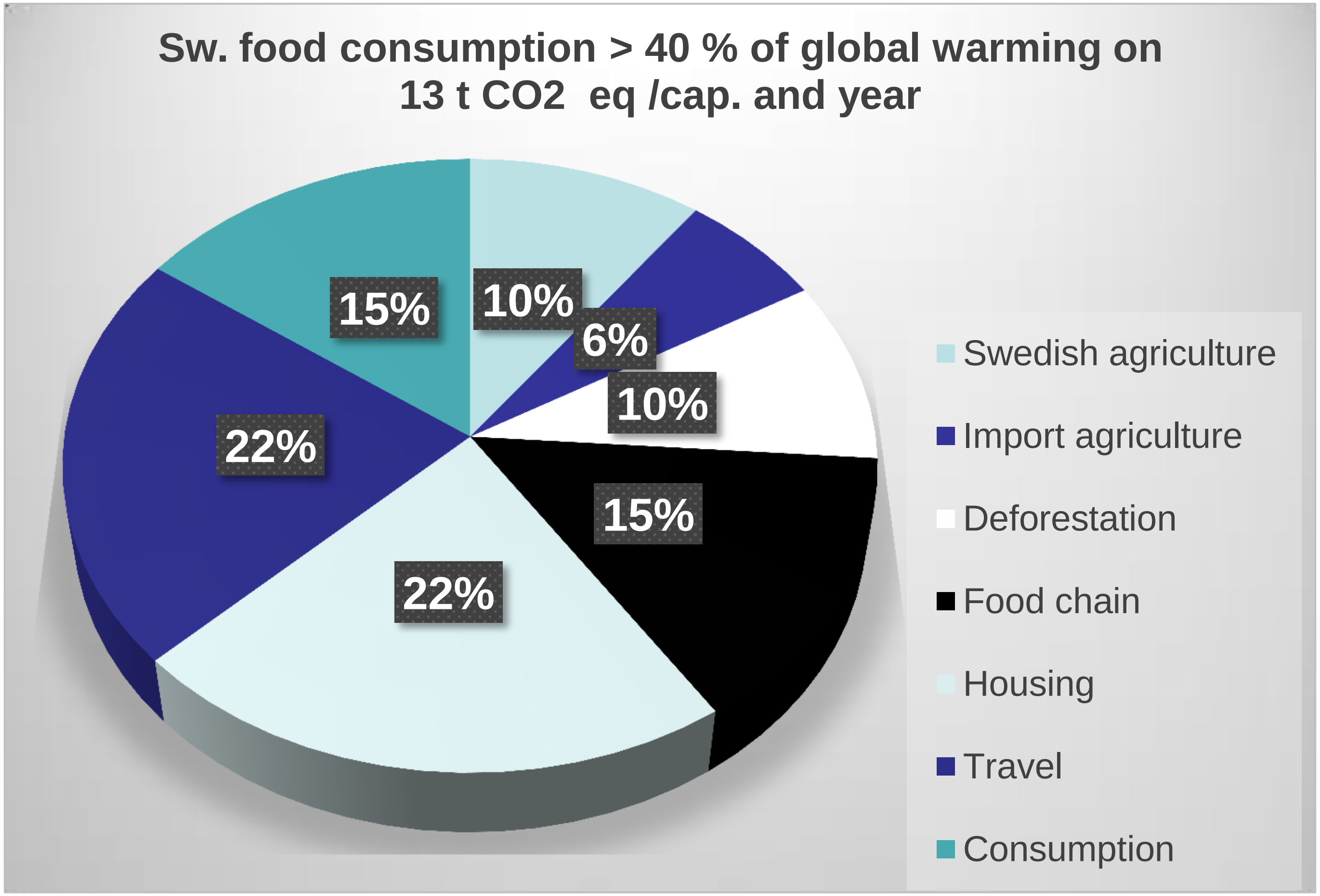
Ch. D. Keeling mobilized enough resources so he could, starting 1958,

measure the CO_2 in the atmosphere o'n Mauna Loa observatory in Hawaii

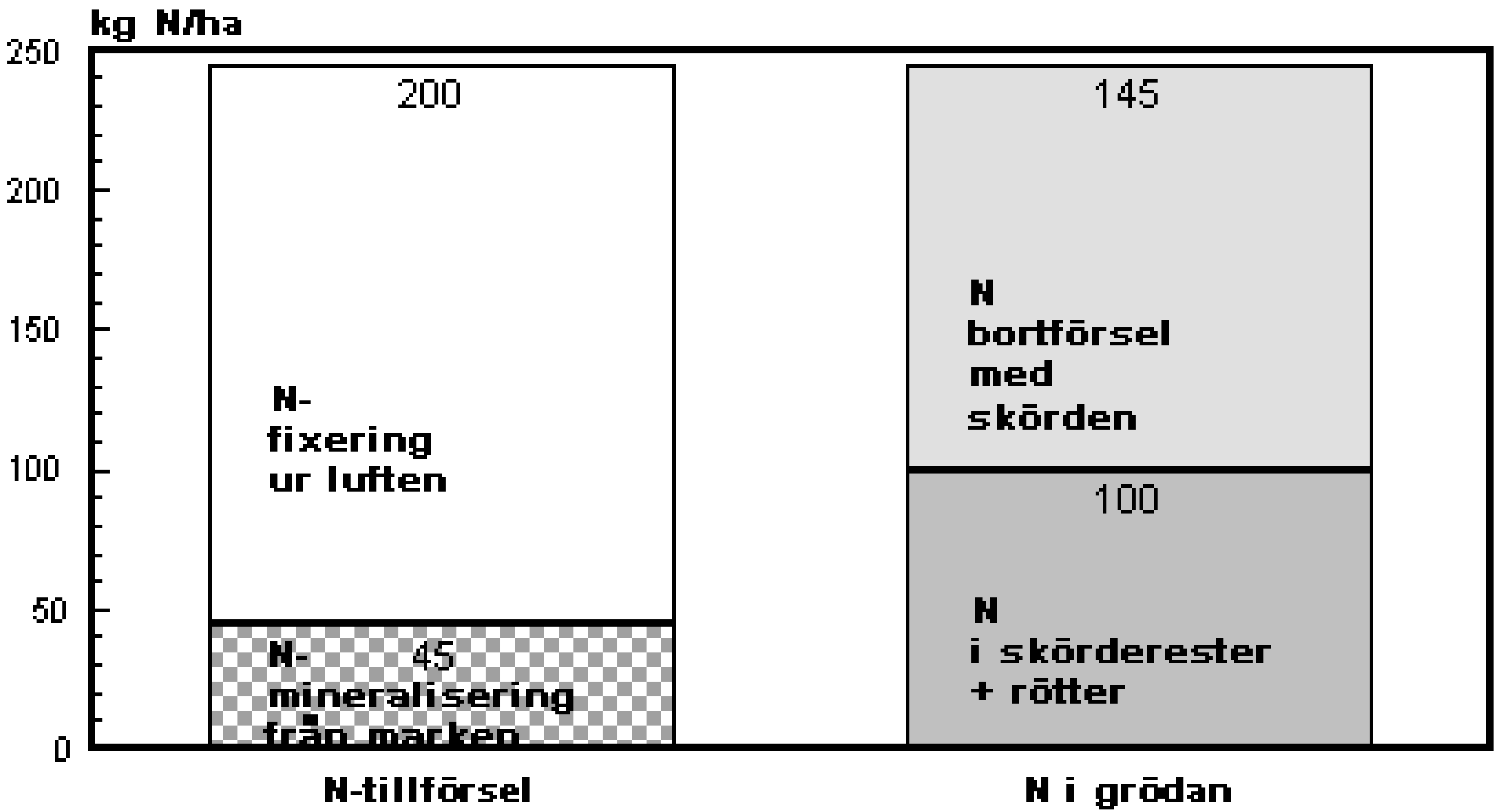


Utsläppen orsakade av svensk konsumtion har ökat med 17 procent 1993–2011



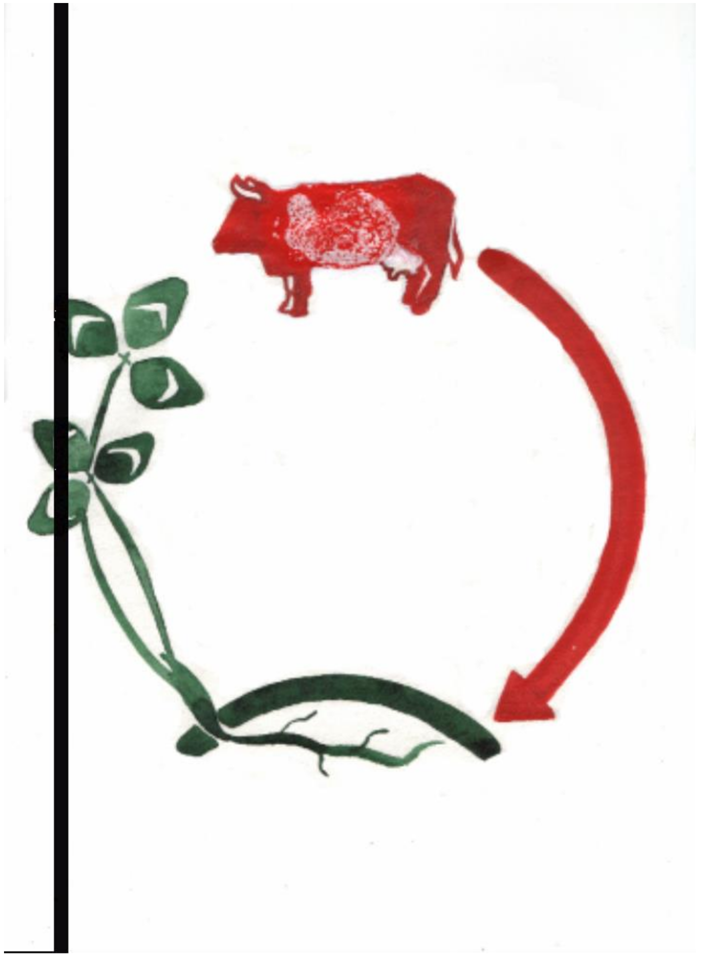

Sw. food consumption > 40 % of global warming on
13 t CO2 eq /cap. and year
15%
10%
6%
10%
22%
15%
22%
Swedish agriculture
Import agriculture
Deforestation
Food chain
Housing
Travel
Consumption

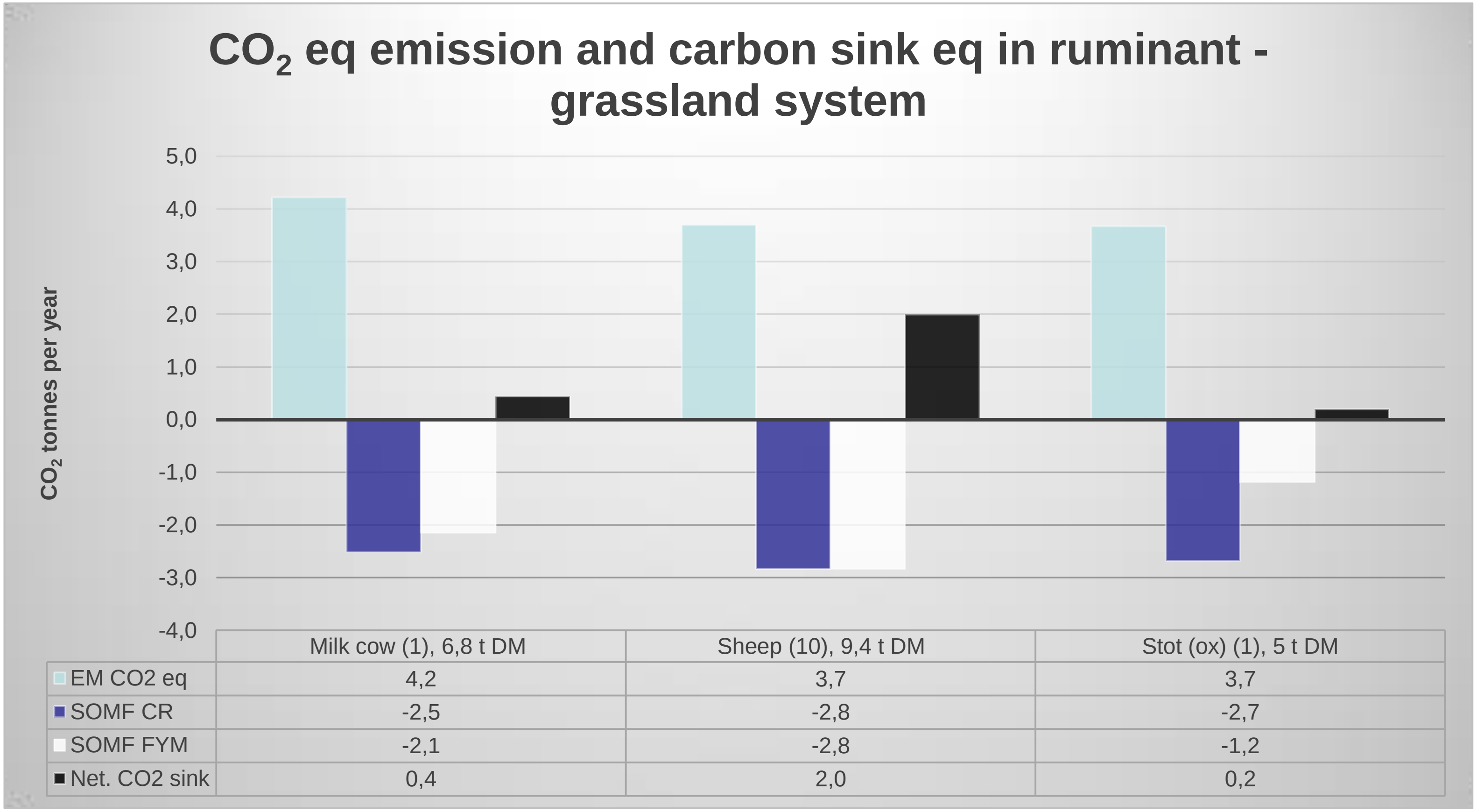




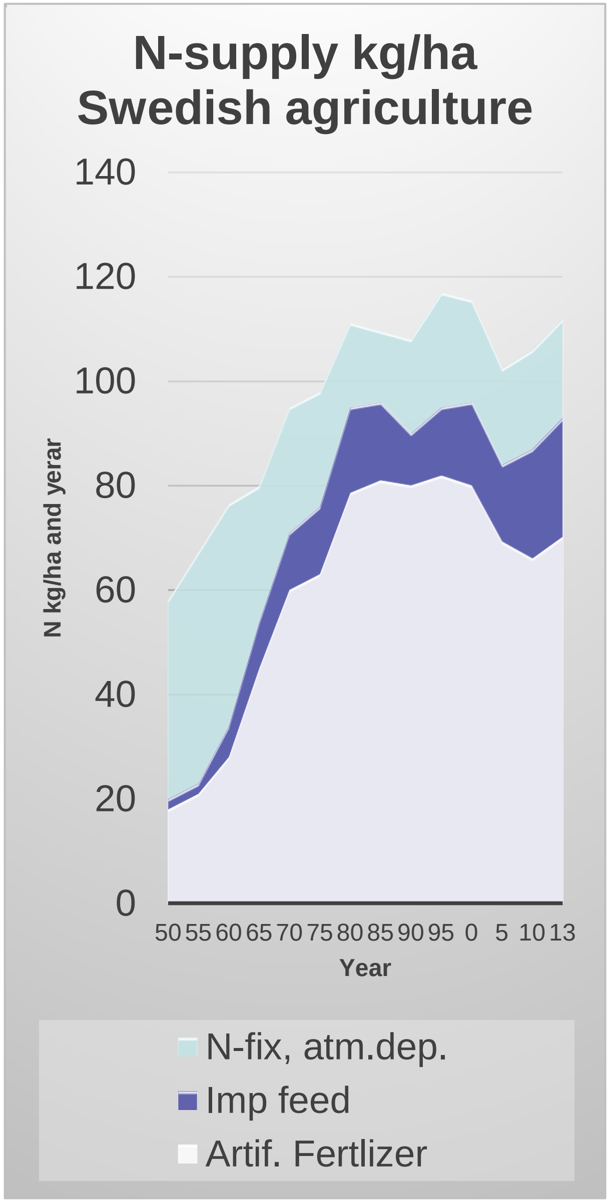
kg N/ha
250
200
150
100
50
0
200
N-
fixering
ur luften
N-
45
mineralisering
från marken
145
N
bortförsel
med
skörden
100
N
i skörderester
+ rötter
N-tillförsel
N i grödan

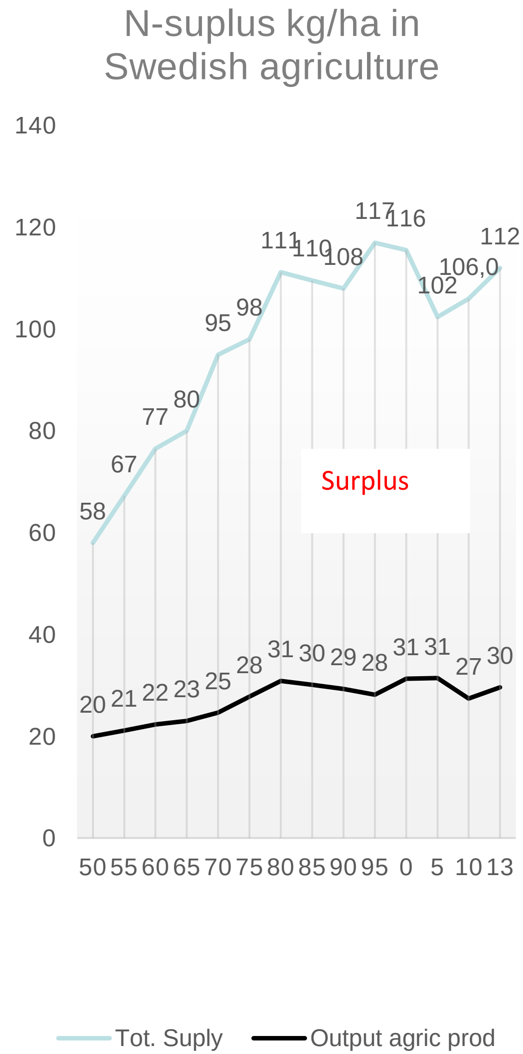
Klövern blev åkerns gröda och djurens föda som kunde åkern göda

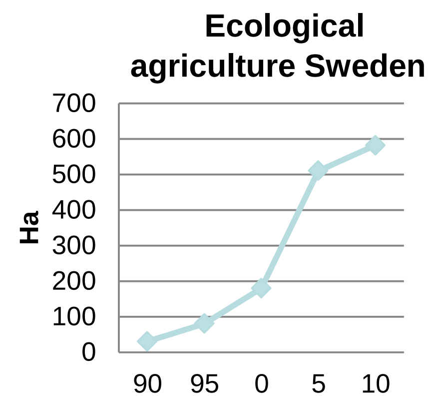




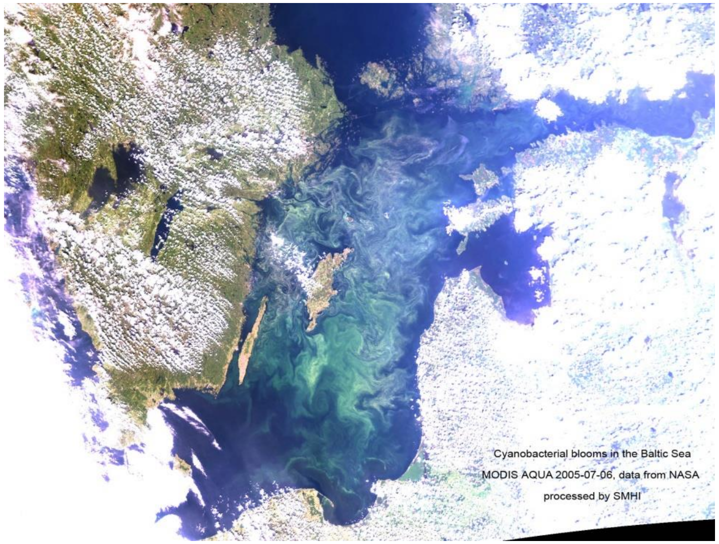
CO2 eq emission and carbon sink eq in ruminant - grassland system
CO2 tonnes per year
5,0
4,0
3,0
2,0
1,0
0,0
-1,0
-2,0
-3,0
-4,0
Milk cow (1), 6,8 t DM
Sheep (10), 9,4 t DM
Stot (ox) (1), 5 t DM
EM CO2 eq 4,2 3,7 3,7
SOMF CR -2,5 -2,8 -2,7
SOMF FYM -2,1 -2,8 -1,2
Net. CO2 sink 0,4 2,0 0,2

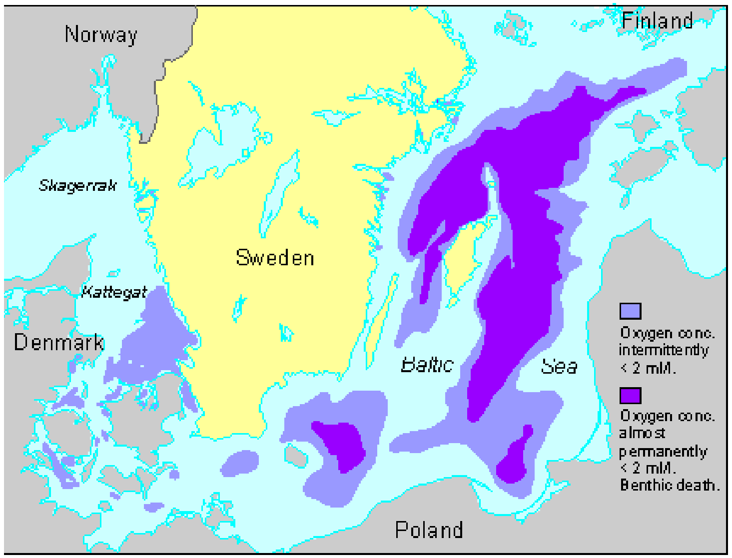

N-supply kg/ha Swedish agriculture
140
120
100
80
60
40
20
0
N kg/ha and yerar
50 55 60 65 70 75 80 85 90 95 0 5 10 13
Year
N-fix, atm.dep.
Imp feed
Artif. Fertlizer

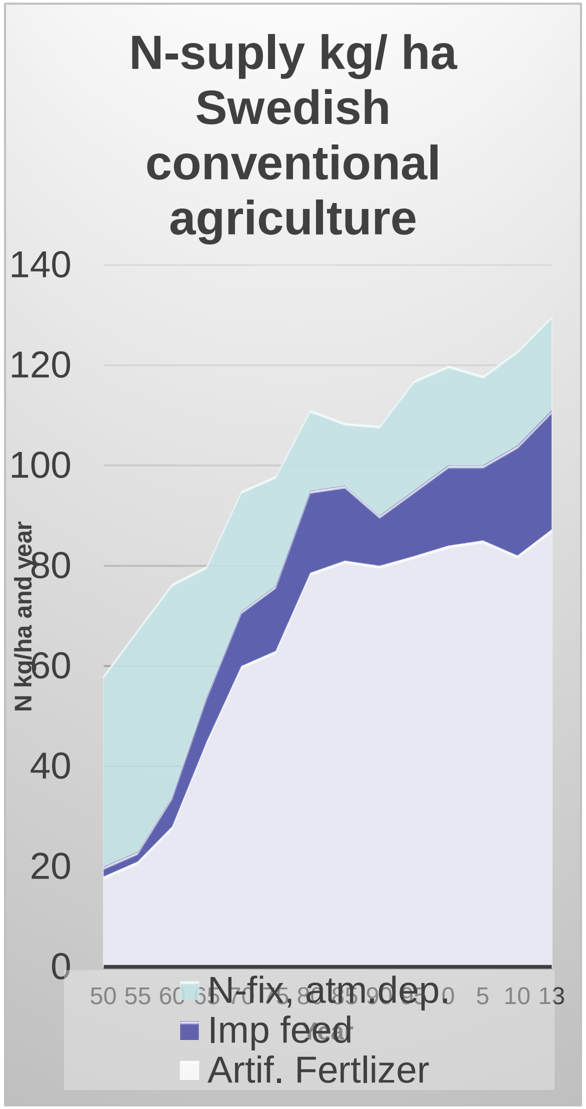

N-suplus kg/ha in Swedish agriculture
140
120
100
80
60
40
20
0
58 67 77 80 95 98 111 110 108 117 116 102 106,0 112
20 21 22 23 25 28 31 30 29 28 31 31 27 30
Surplus
50 55 60 65 70 75 80 85 90 95 0 5 10 13
Tot. Suply
Output agric prod

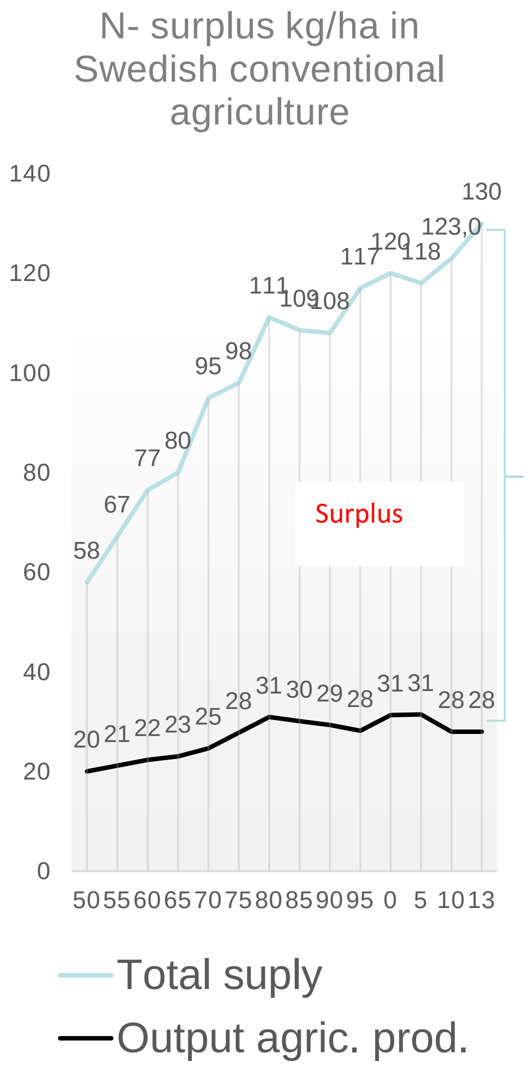

Ecological agriculture Sweden
700
600
500
400
300
200
100
0
Ha
90 95 0 5 10

Depleted arable fields, eutropficated sea and climate warming

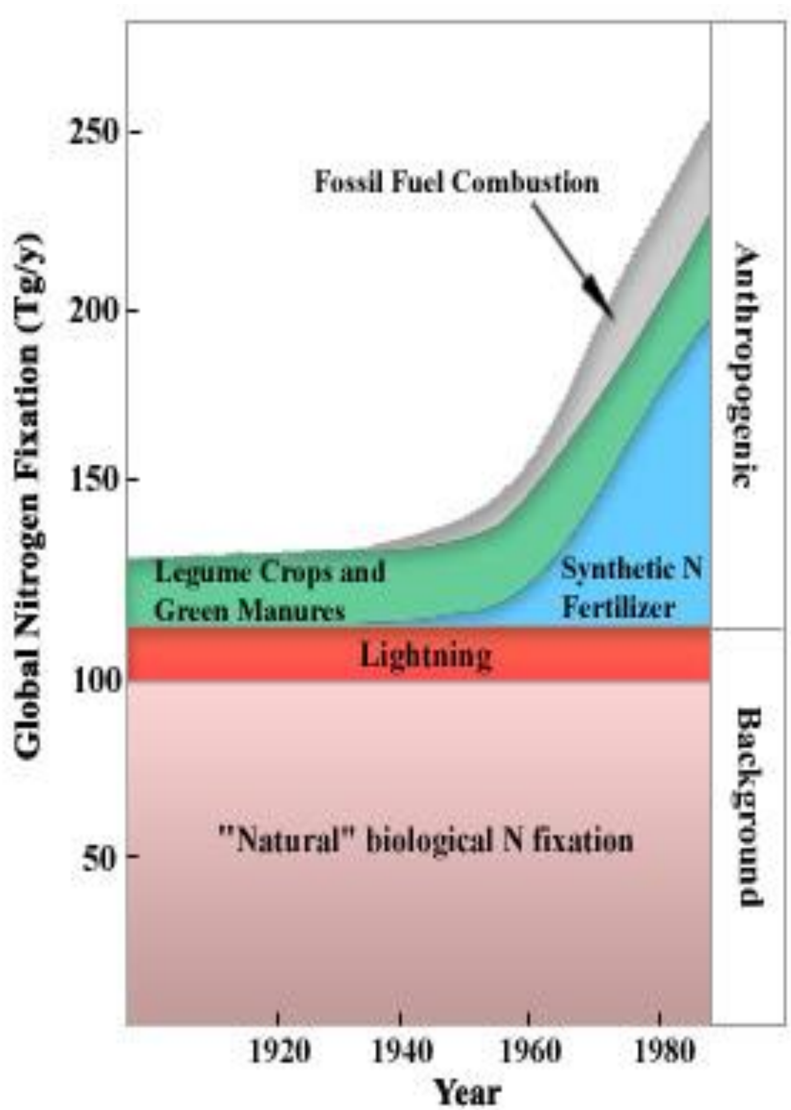





N-suply kg/ ha Swedish conventional agriculture
140
120
100
80
60
40
20
0
N kg/ha and year
50 55 60 65 70 75 80 85 90 95 0 5 10 13
N-fix, atm.dep.
Imp feed
Artif. Fertlizer

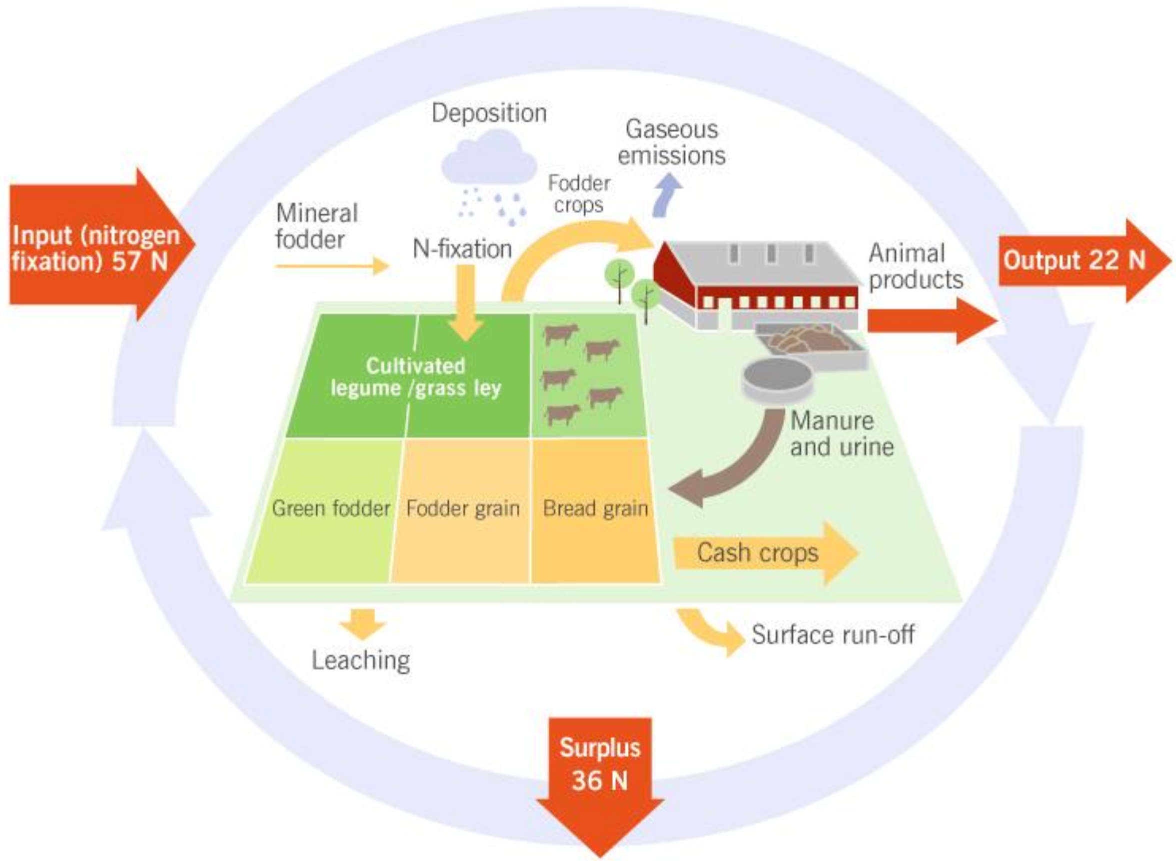

N- surplus kg/ha in Swedish conventional agriculture
140
120
100
80
60
40
20
0
58
67
77
80
95
98
111
109
108
117
120
118
123,0
130
20
21
22
23
25
28
31
30
29
28
31
31
28
28
Surplus
50 55 60 65 70 75 80 85 90 95 0 5 10 13
Total suply
Output agric. prod.

The Global Nitrogen Cascade



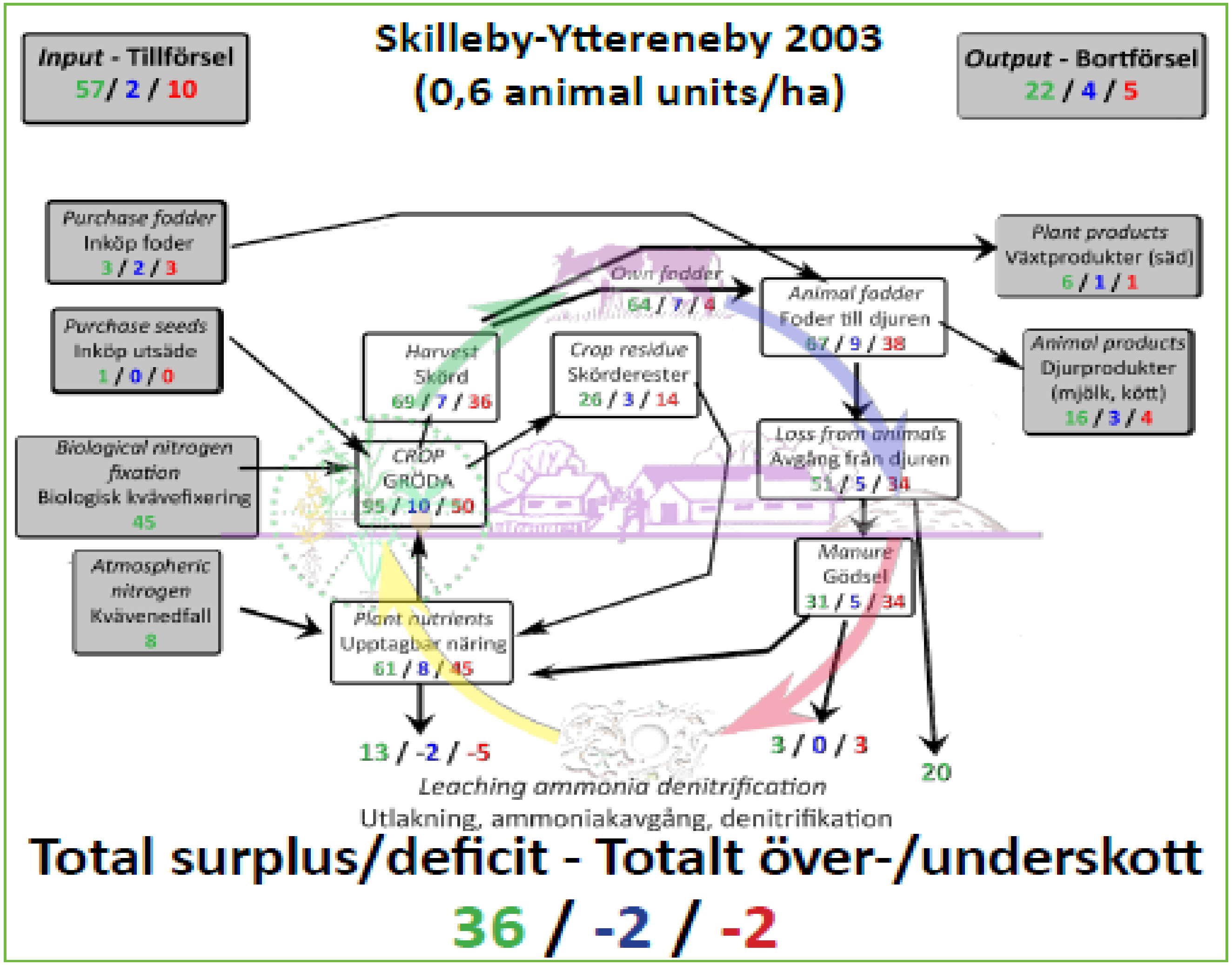
Ecological Recycling Agriculture (ERA)

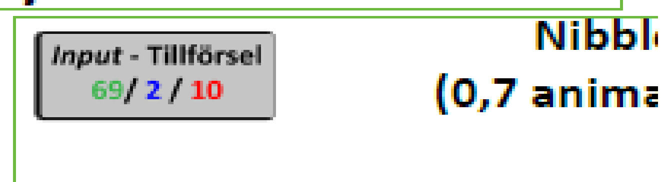
57



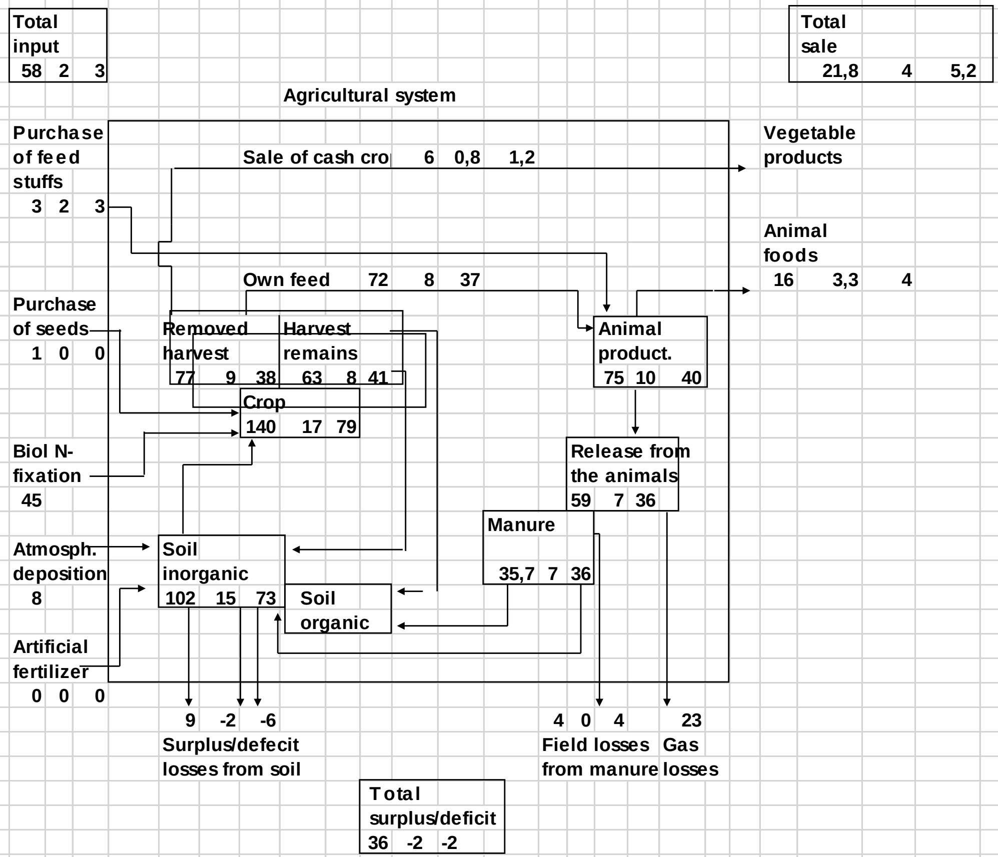
22

Losses 36


Skilleby-Yttereneby 2003
(0,6 animal units/ha)
Input - Tillförsel
57/ 2 / 10
Output - Bortförsel
22 / 4 / 5
Purchase fodder
Inköp foder
3 / 2 / 3
Purchase seeds
Inköp utsäde
1 / 0 / 0
Biological nitrogen fixation
Biologisk kvävefixering
45
Atmospheric nitrogen
Kvävenedfall
8
Harvest
Skörd
69 / 7 / 36
Own fodder
64 / 7 / 4
Crop residue
Skörderester
26 / 3 / 14
Animal fodder
Foder till djuren
67 / 9 / 38
Plant products
Växtprodukter (säd)
6 / 1 / 1
Animal products
Djurprodukter
(mjölk, kött)
16 / 3 / 4
CROP
GRÖDA
95 / 10 / 50
Loss from animals
Avgång från djuren
51 / 5 / 34
Manure
Gödsel
31 / 5 / 34
Plant nutrients
Upptagbar näring
61 / 8 / 45
13 / -2 / -5
3 / 0 / 3
20
Leaching ammonia denitrification
Utlakning, ammoniakavgång, denitrifikation
Total surplus/deficit - Totalt över-/underskott
36 / -2 / -2


Input - Tillförsel
69/ 2 / 10

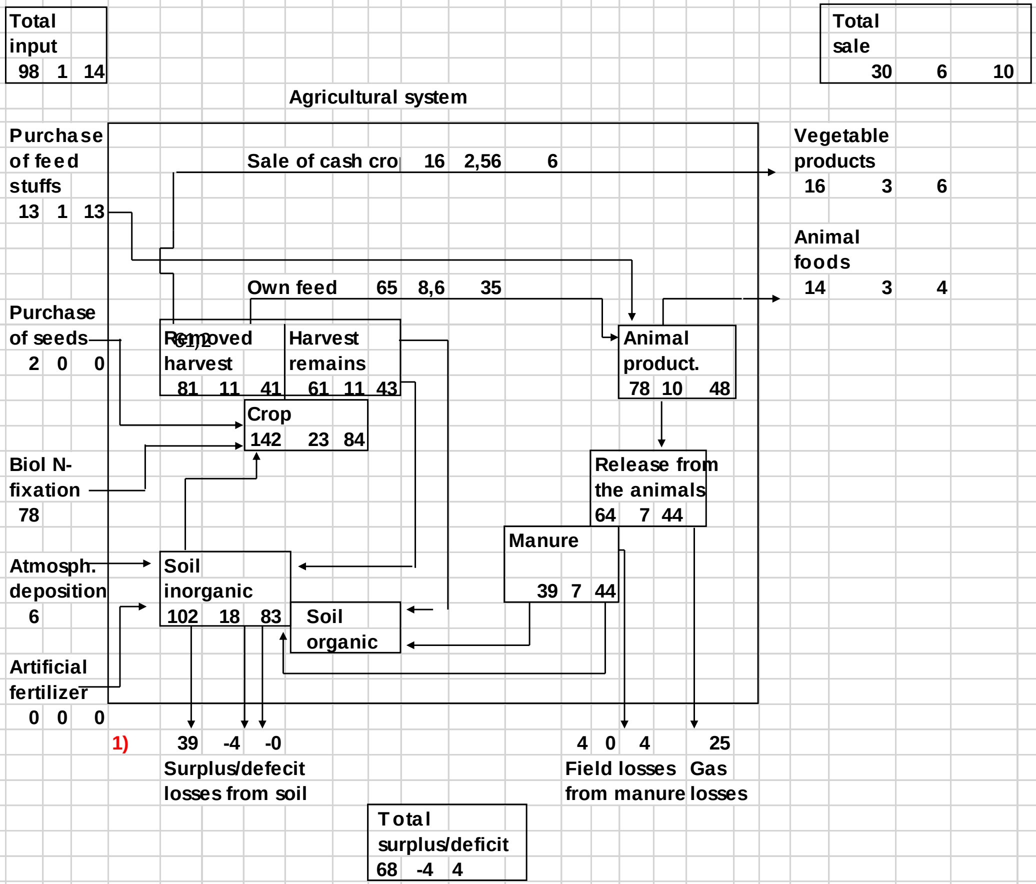
Flow of N/P/K kg ha^{-1} in the agricultural-ecosystem Yttereneby-Skilleby
Dagfinn Reder (0,6 animal unit/ha) farm 2002-2003



Calculation factors	N	P	K			
Store losses from manure	0,4					
Field losses from manure	0,1	0,05	0,1			
Fodder/animal production	4,6	3,0	10			
Harvest remains/harvest	0,8	0,9	1,1			
Balances[1]				Efficiency[1]		
	N	P	K	N	P	K
Farmgate balance	36	-2	-2	0,38	2,16	1,68
Field balance	13	-2	-2	0,94	1,33	1,06
Primery nytrient Balance	-21	-7,5	-35	1,39	6,95	13,66
Circulation factor (C=(P+S)/P)				1,62	5,21	12,90
Field balance efficiency (F=Y/P+S)				0,86	1,33	1,06
C*F				1,39	6,95	13,66

	Given figures	N	P	K	
	Purchace to anim. prod.	3	2	3	
	Purch. seeds	1	0	0	
	Biol. N-fix	45			
	Atmosph. dep.	8			
		0			
	Crop export	5,5	0,8	1,2	
	Export of animal pro	16	3,3	4	
		72	8	37	
Ca	Calculated data				
Ow	Own feed		75	10	30
Ha	Harvest remains		62,6	8,0	40,8

Flow of N/P/K kg ha^{-1} in the agric.l-ecosyst. Skäve-Yttereneby-Skilleby 2014
(248 ha, x animal unit/ha



1) Losses=surplus-inmobilisation

Calculation factors	N	P	K
Store losses from manure	0,4		
Field losses from manure	0,1	0,05	0,1
Fodder/animal production	4,6	3,0	10
Harvest remains/harvest	0,8	0,9	1,1

Given figures	N	P	K
Purchace to anim. prod.	13	1	13
Purch. seeds	2	0	0
Biol. N-fix	78		
Atmosph. dep.	6		
Export of veg prod.	16	3	6
Export of animal prod.	14	3	4
	65	9	35

Balances[1]	N	P	K	Efficiency[1] N	P	K
Farmgate balance	68	-4	4	0,30	3,92	0,74
Field balance	43	-4	4	0,68	1,66	0,92
Primery nytrient Balance	11	-10	-28	0,88	14	3,36
Circulation factor (C=(P+S)/P)				1,36	8,22	3,66

- **An ecological recycling regerneratve agriculture based on integrated crop and animal production with effective recycling of nutrients and organic biomass and crop rotation with grass/clover grassland and other legumes can:**

1. conserve basic natural resources

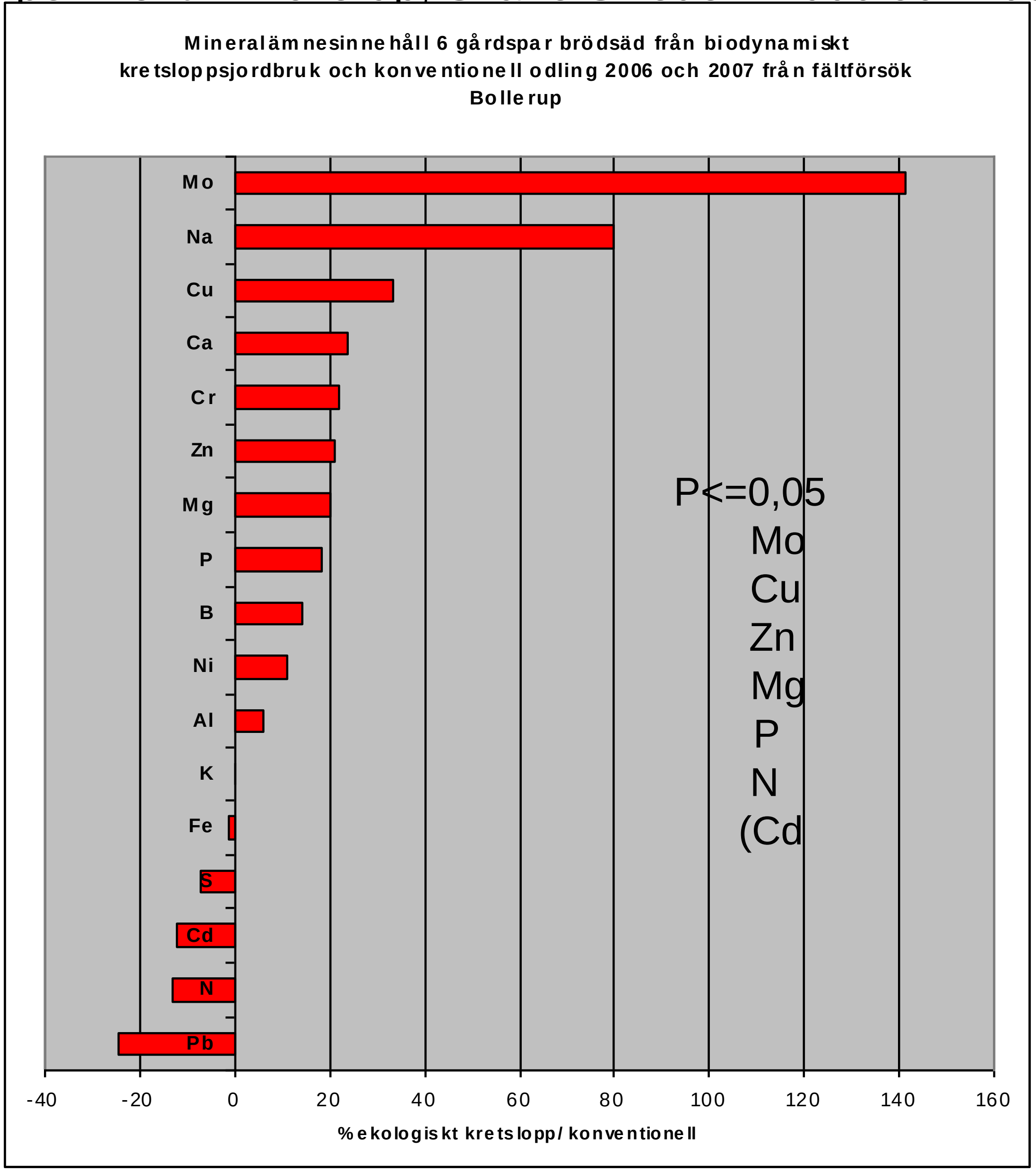
2. rebuild fertile soils

3. reduce nutrient leaching with more than 50 %

4. prevent negative human impacts on the climate from food production

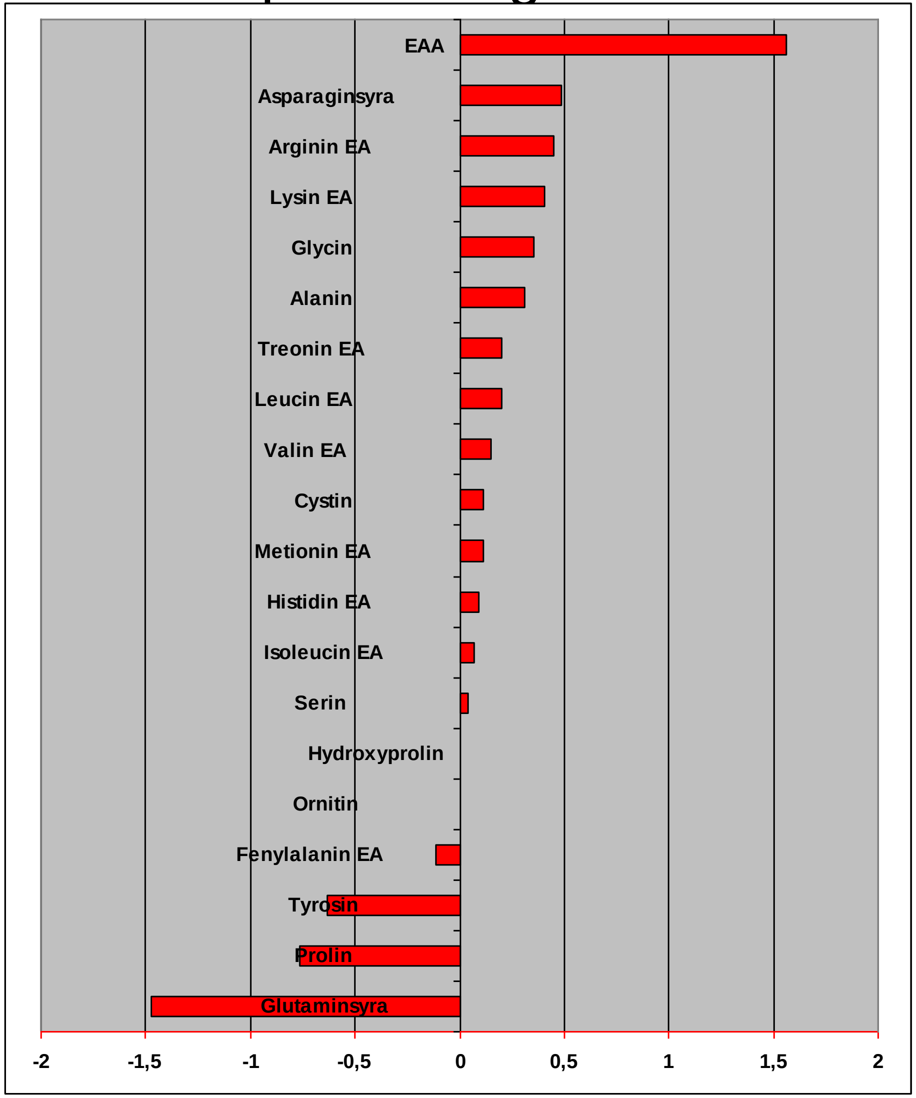
5. produce nutritionally better food

The ratio of the mineral content - biodynamically grown bread grain/conventionally grown bread grain. From a long term field experiment in Bollerup, Skåne Sweden 2006 och 2007



Aminosyror i procent av råprotein
Bollerup försöksgård 2006

Protein med högre biologiskt värde



Differens Biodynamisk - Konventionell

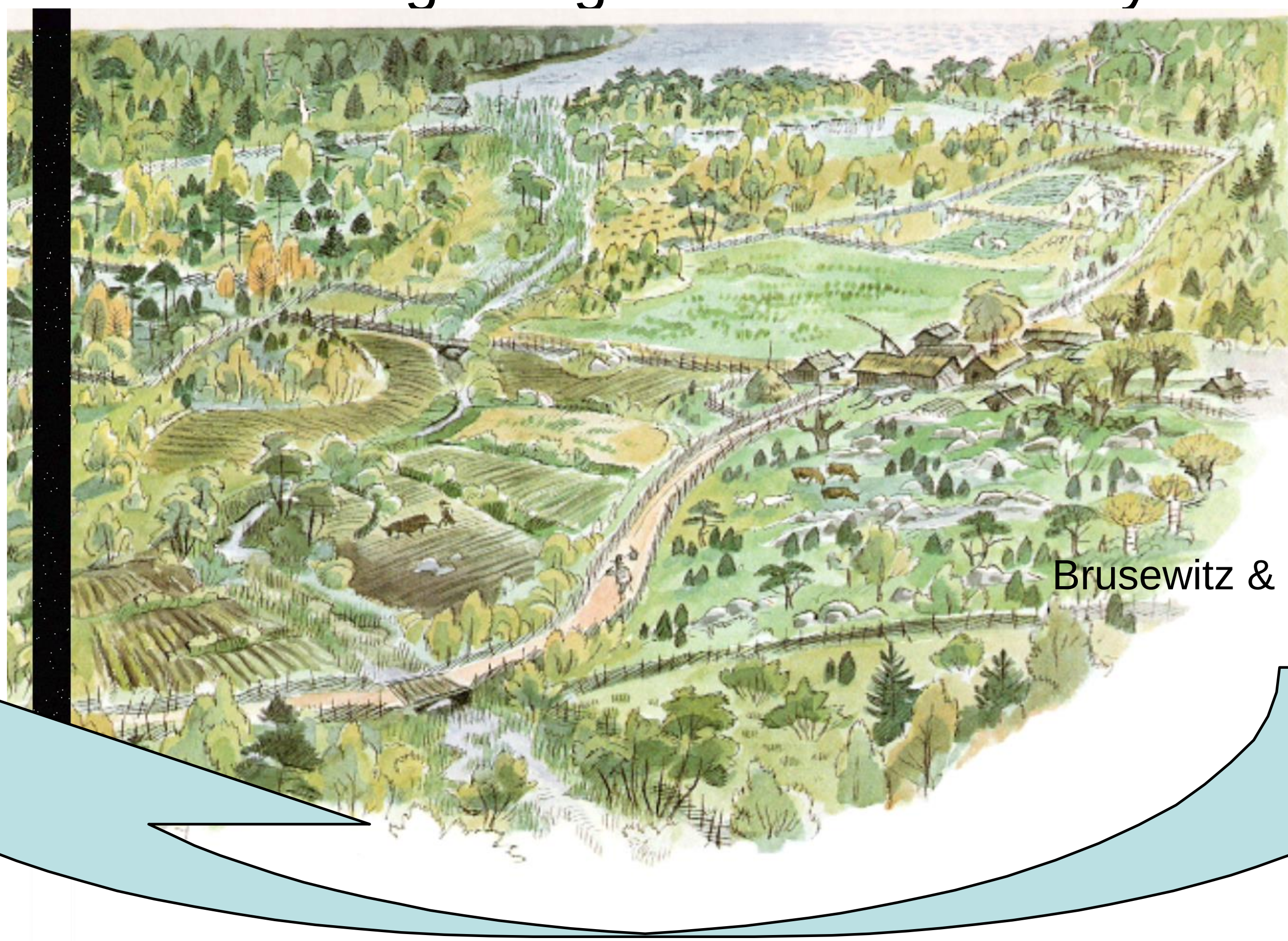
Primitivt jordbruk –
rovdrift på vad naturen byggt upp

Svedjejordbruk

[Eero Järnefelt 1863 -1937]

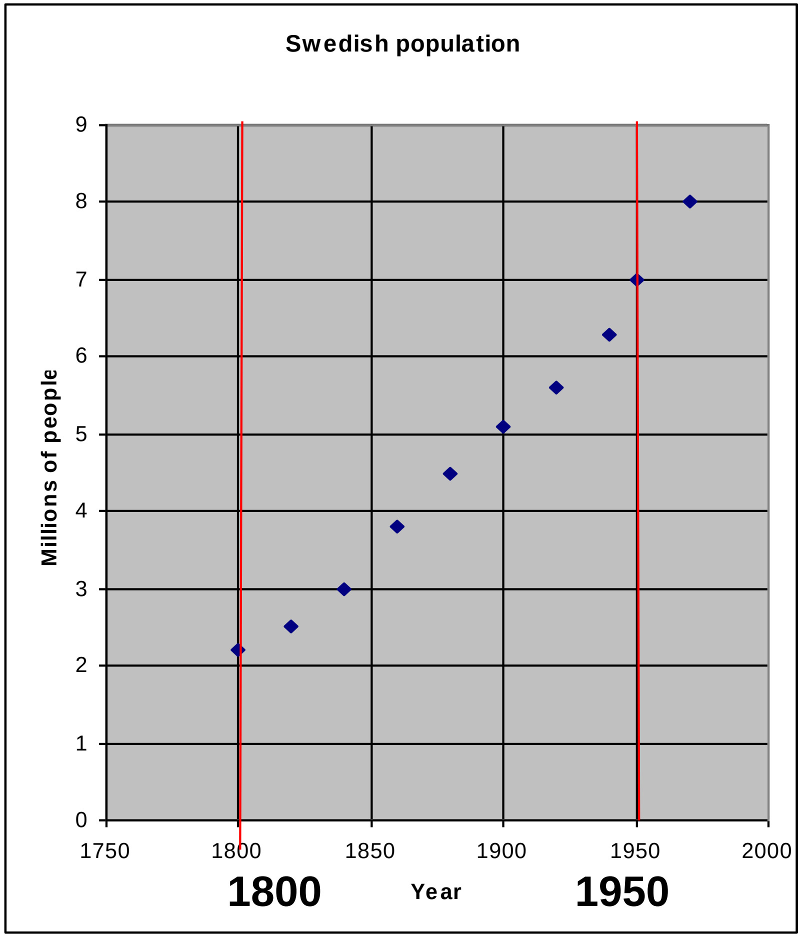
The changing agricultural landscape –example from Roslagen central Sweden – the hay making agriculture (slåtterjordbruket)

The meadow - the mother of arable land - dominated until the beginning of the 18th century



Brusewitz & Emmelin

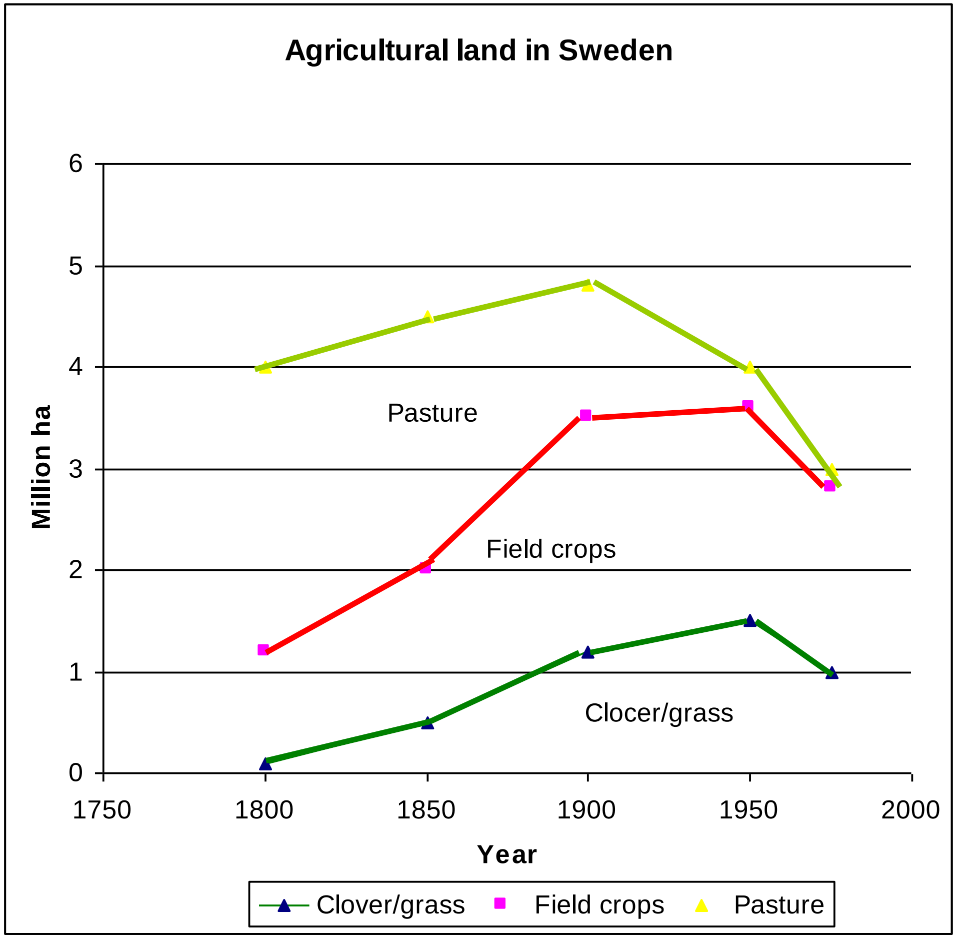
Lack of food – in the end of 18th centuary



The inhabitants in Sweden increased from **2 millions to 7 million** between 1800 to 1950 before the introduction of artificial fertilizers and pesticides. How was the increased demand for food met?

AG

Arable land with clover grass in the crop rotation increased and natural meadow land decreased

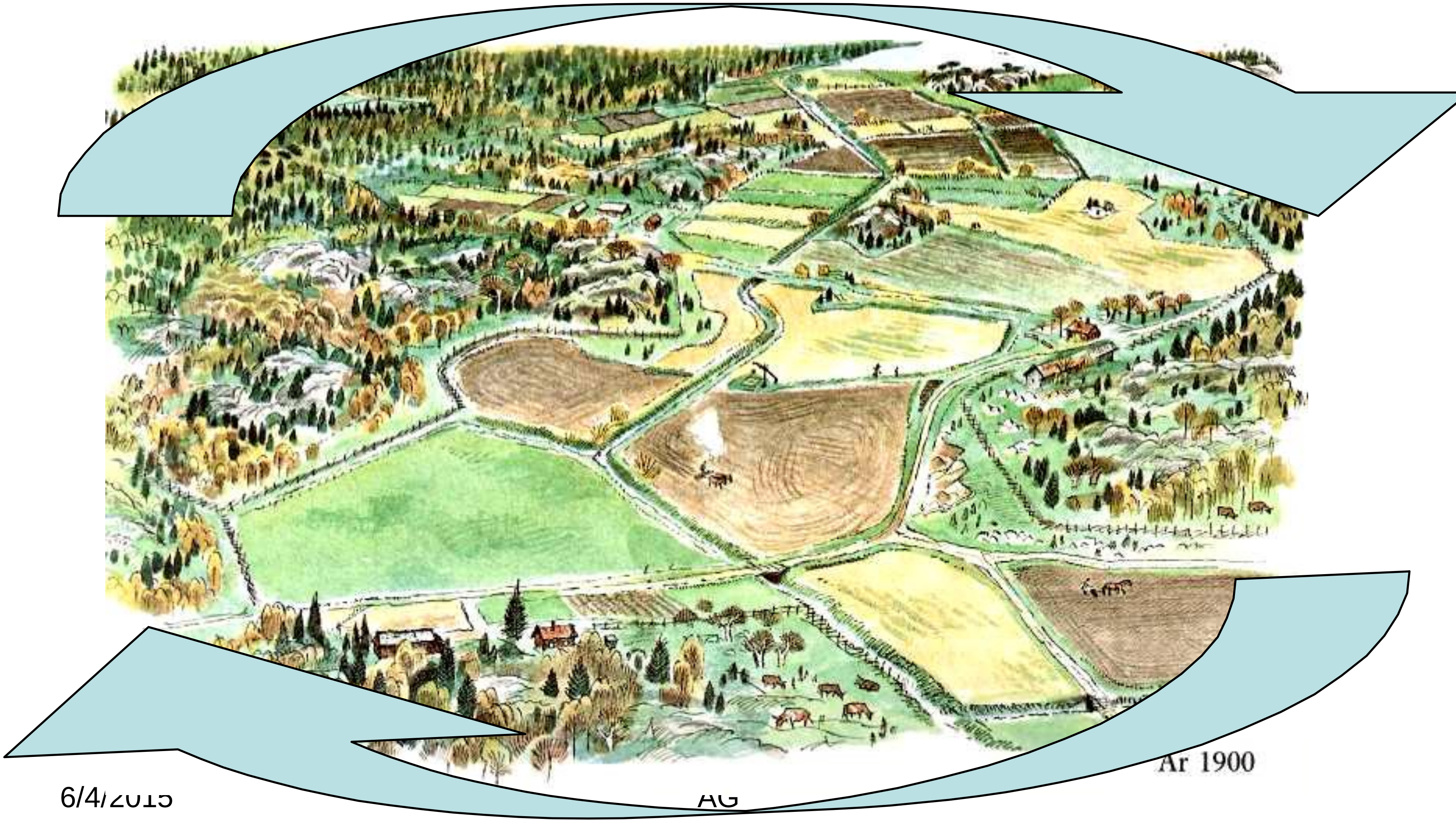


Crop rotations with symbiotic nitrogen fixation leguminous (clover grass land ley 2-3 years followed of 2 – 4 years cereal and other crops)

Integration of crop and animals on the whole farm area (before partly separated)

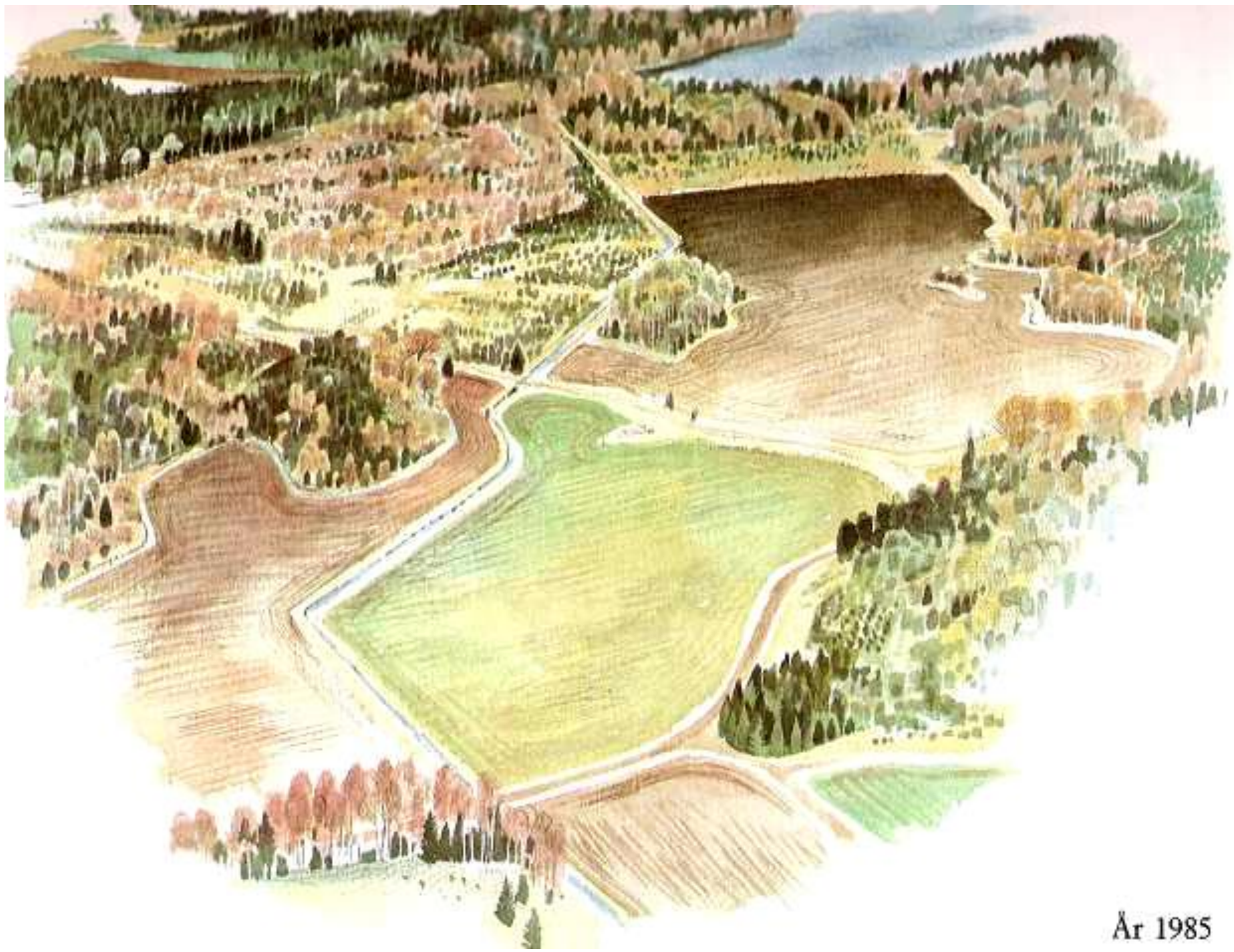
Technical improvements to utilize the nature given production potential and with help of horse power.

The same landscape after the agricultural revolution 1900



The same landscape 85 years later.

From diverse crop rotation and recycling to specialization



År 1985

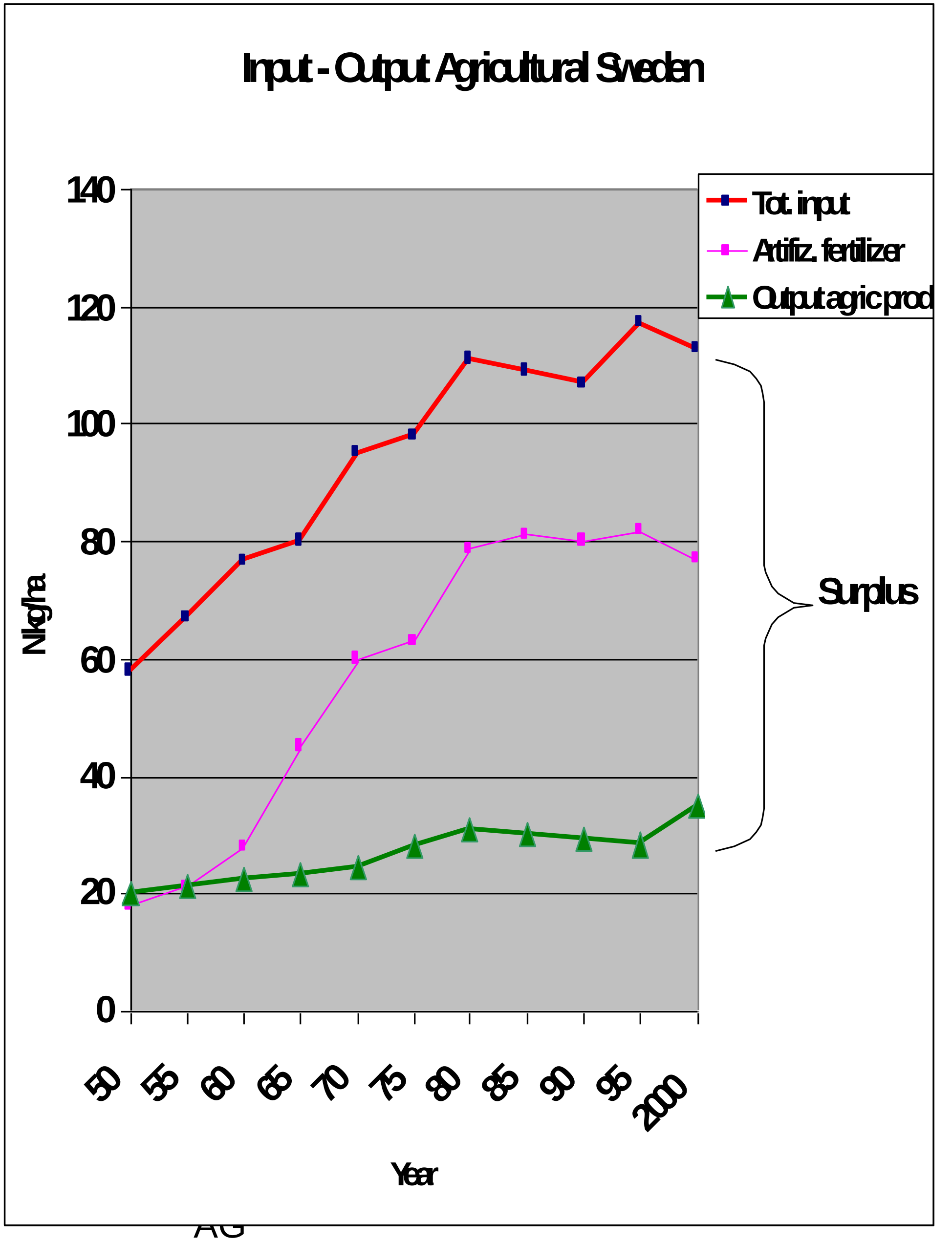
- **Increased surplus and losses**

In Sweden, from 1950 to 1980 the average use of artificial nitrogen fertilizers increased from

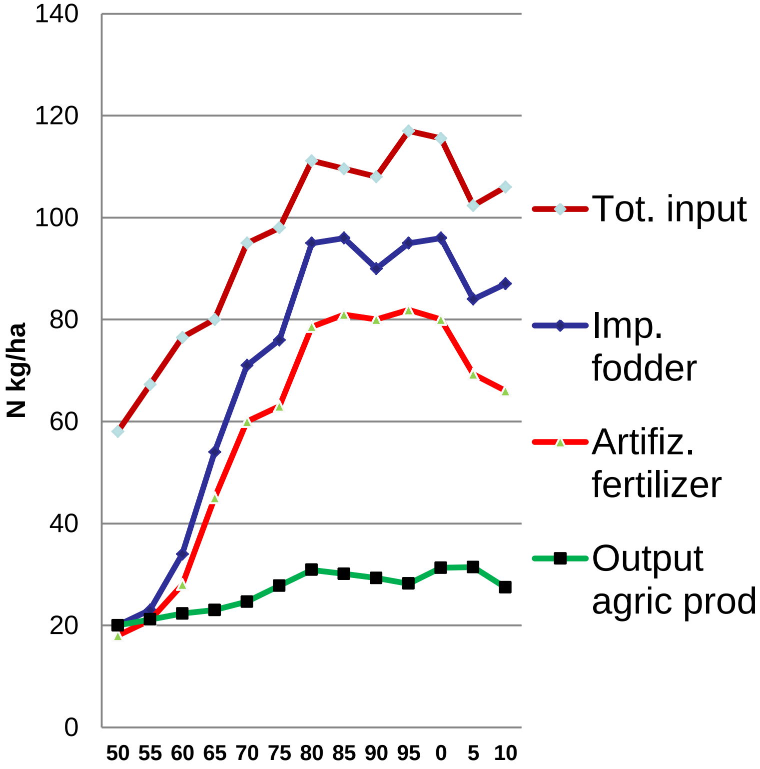
20 kg to 80 kg per

ha and year.

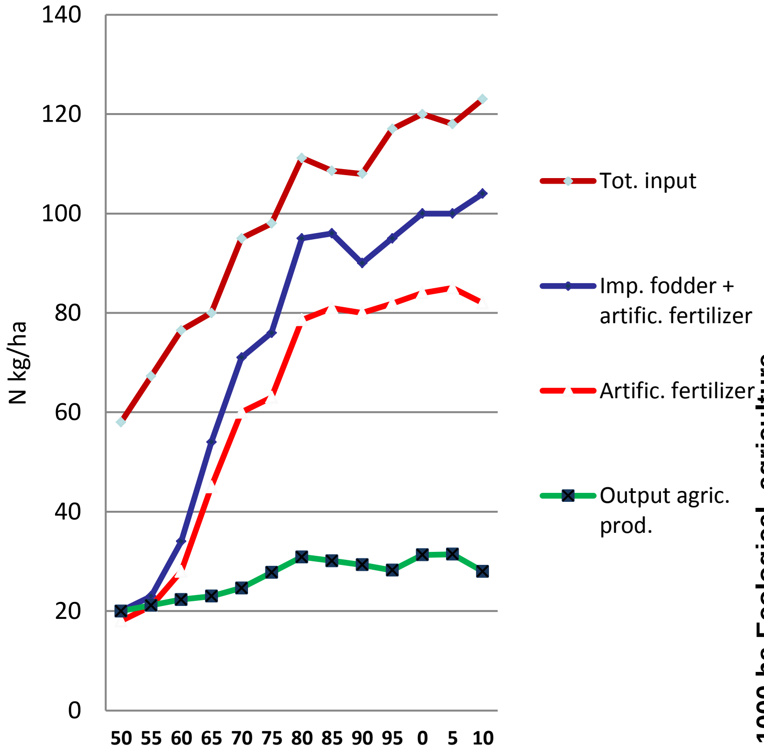
N kg/ha



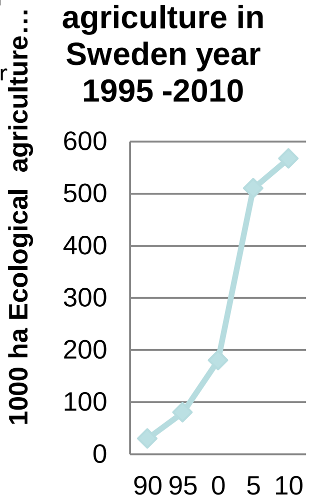
N-surplus kg/ha Swedish Agriculture 1950-2010

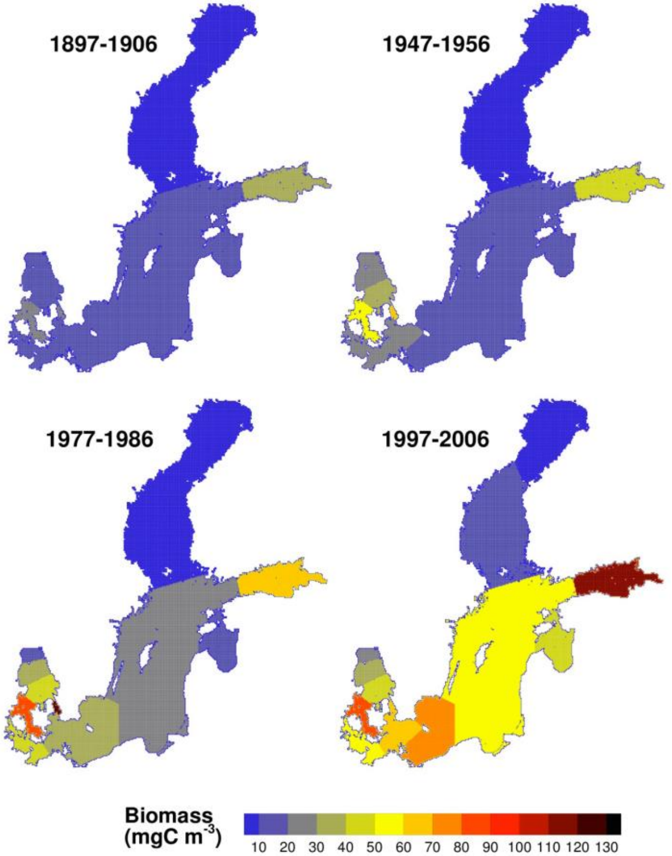


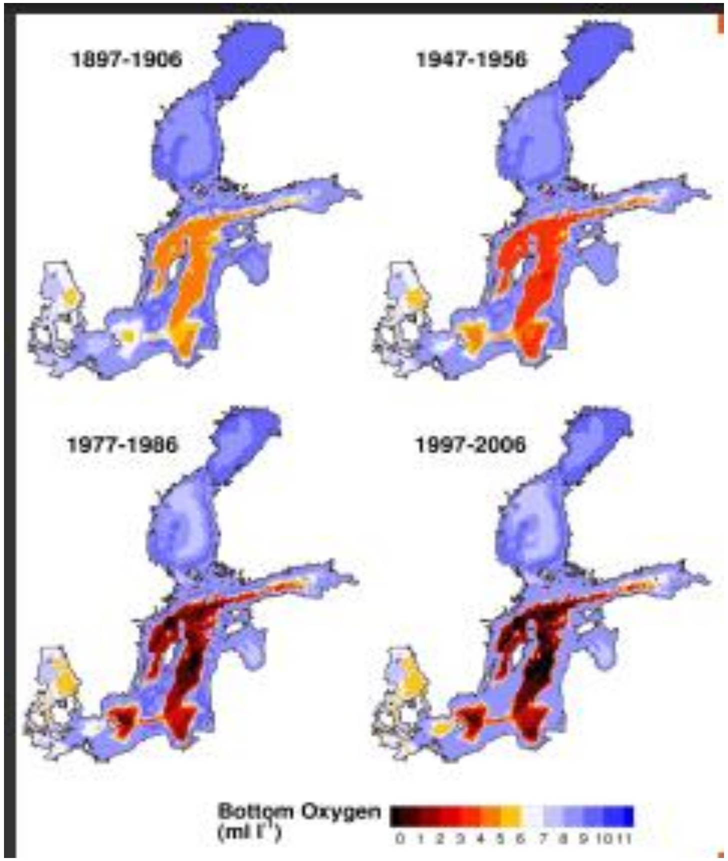
N-surplus kg/ha conventional Swedish Agriculture 1950 -2010



Areas ecological agriculture in Sweden year 1995 -2010

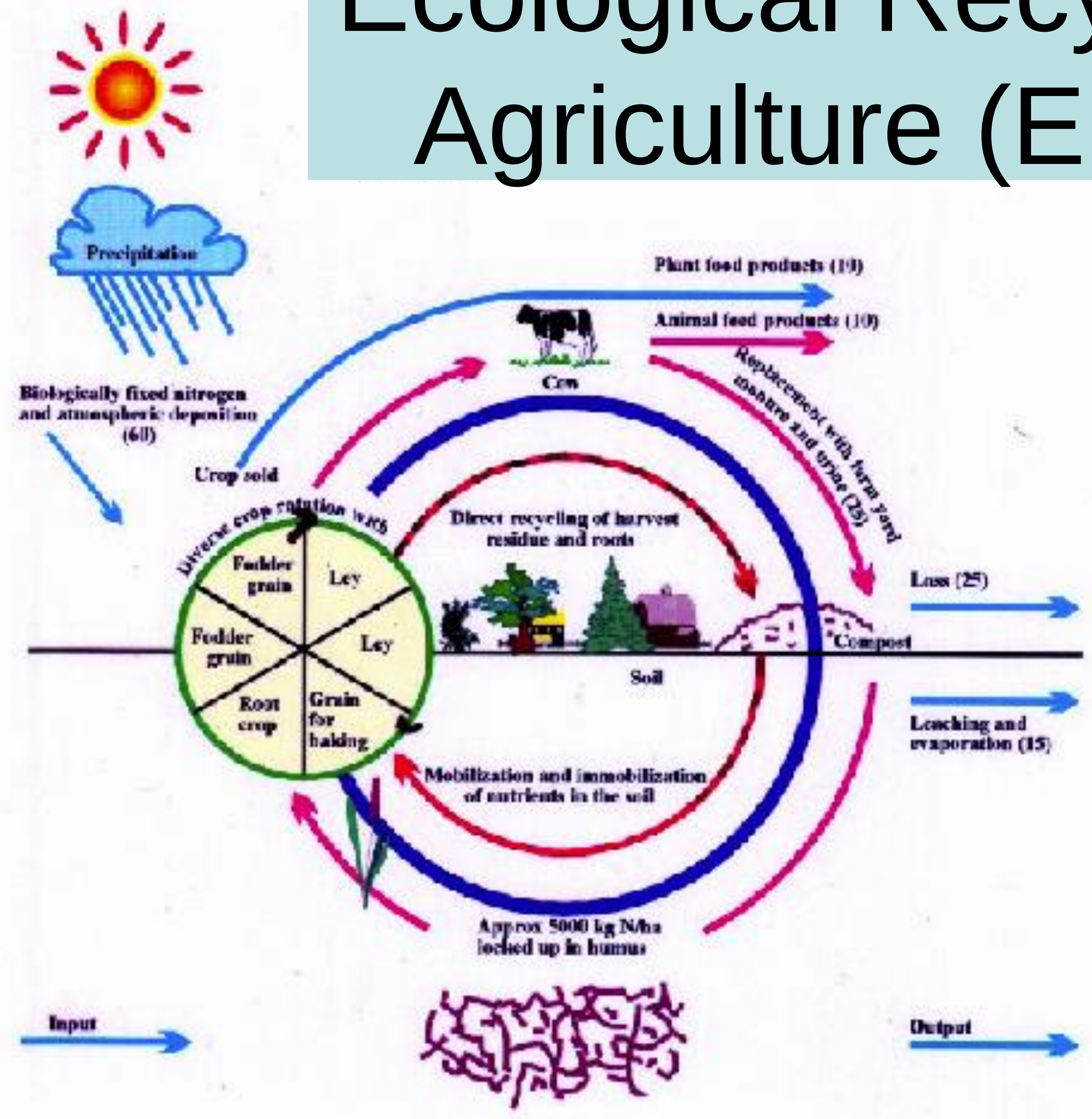


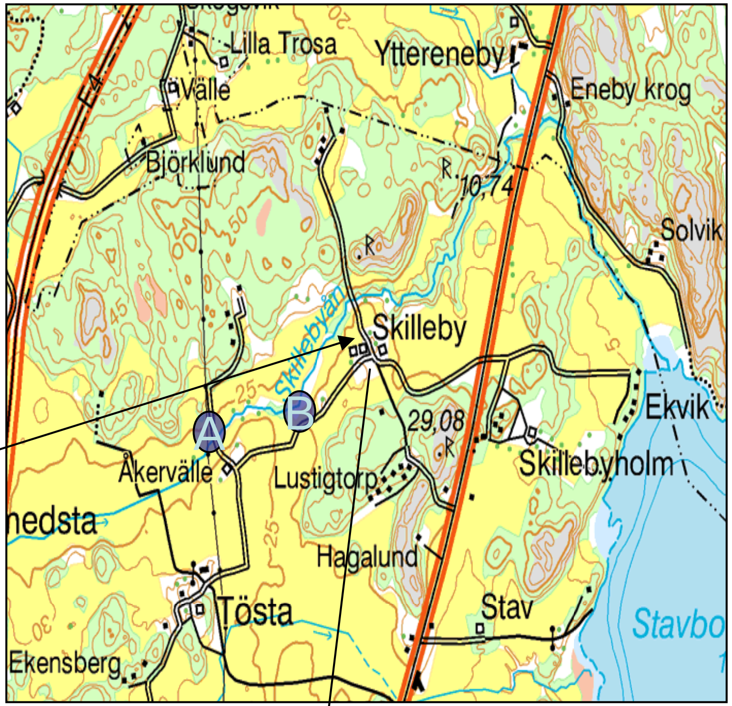

1897-1906
1947-1956
1977-1986
1997-2006
Biomass
(mgC m-3)
10 20 30 40 50 60 70 80 90 100 110 120 130

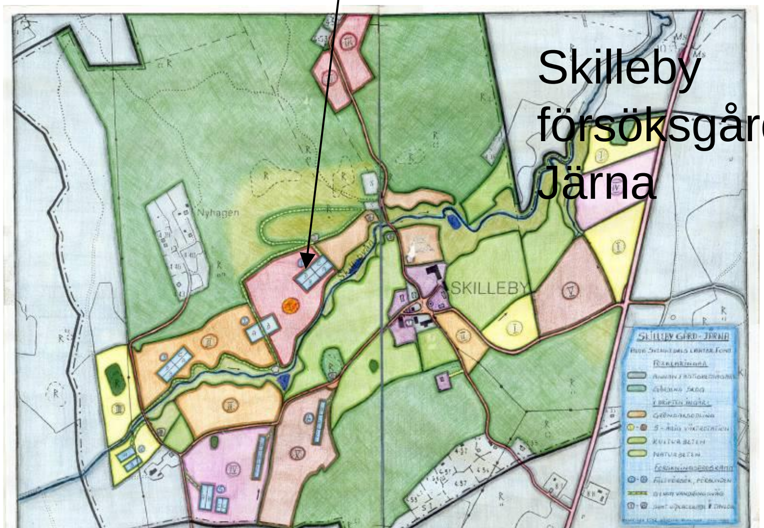

1897-1906
1947-1956
1977-1986
1997-2006
Bottom Oxygen
(ml l-1)
0 1 2 3 4 5 6 7 8 9 10 11

Ecological Recycling Agriculture (ERA)

The possible Solution





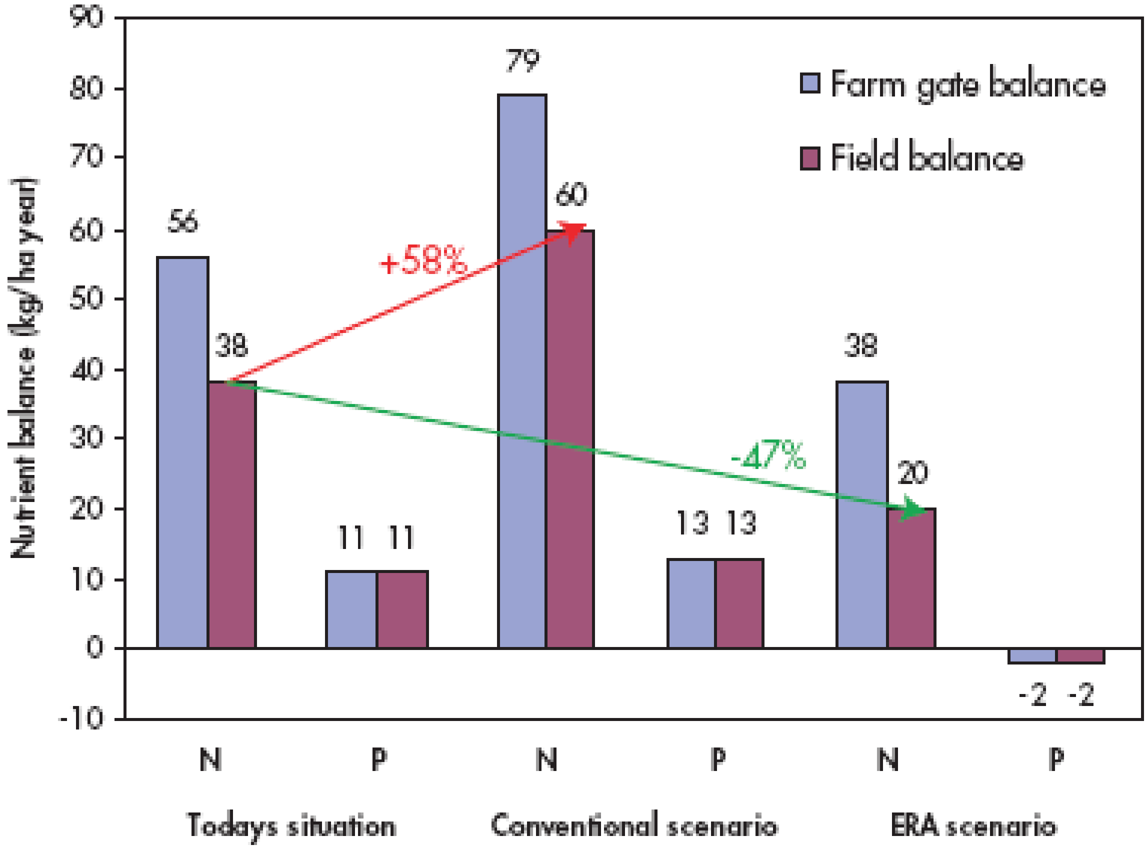


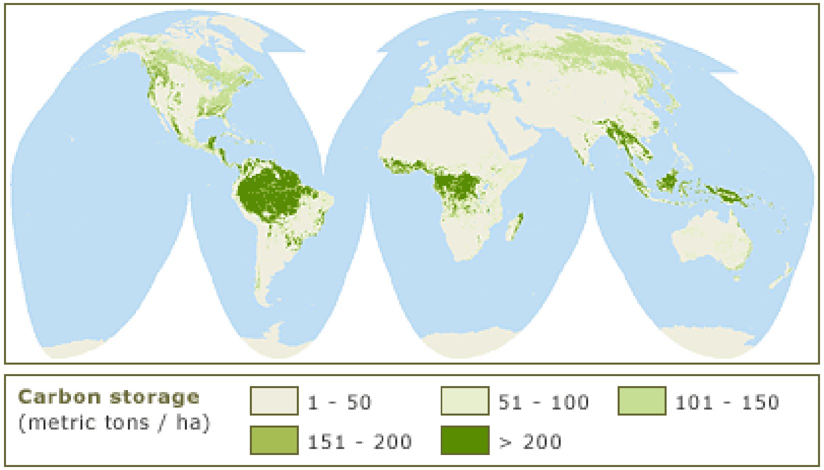
Skilleby försöksgård Järna

Lokalisering typgårdar I Östersjöprojektet BERAS

Three scenarios for the EU – countries around the baltic Sea

Nitrogen- och phosphurus surplus kg/ha and year





13 miljard ha land (30 %)

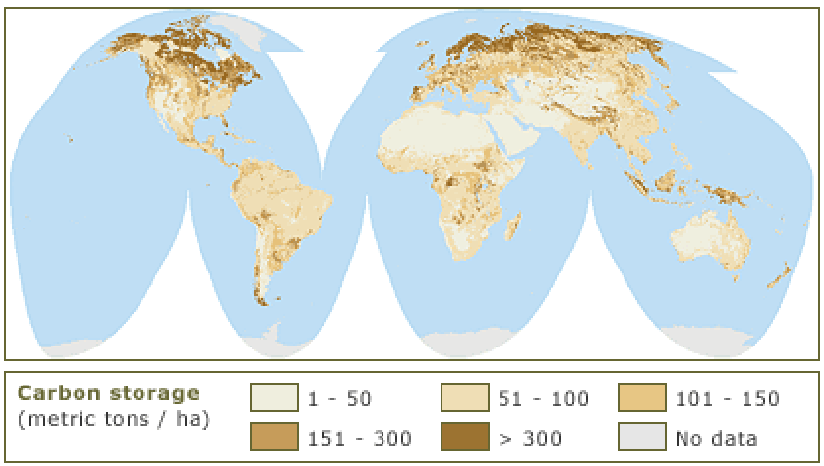
1,5 miljard ha åker (0,22/Cap)

3,7 miljard ha betsm (0,5/Cap)

4,1 miljard ha skog (0,6/Cap)

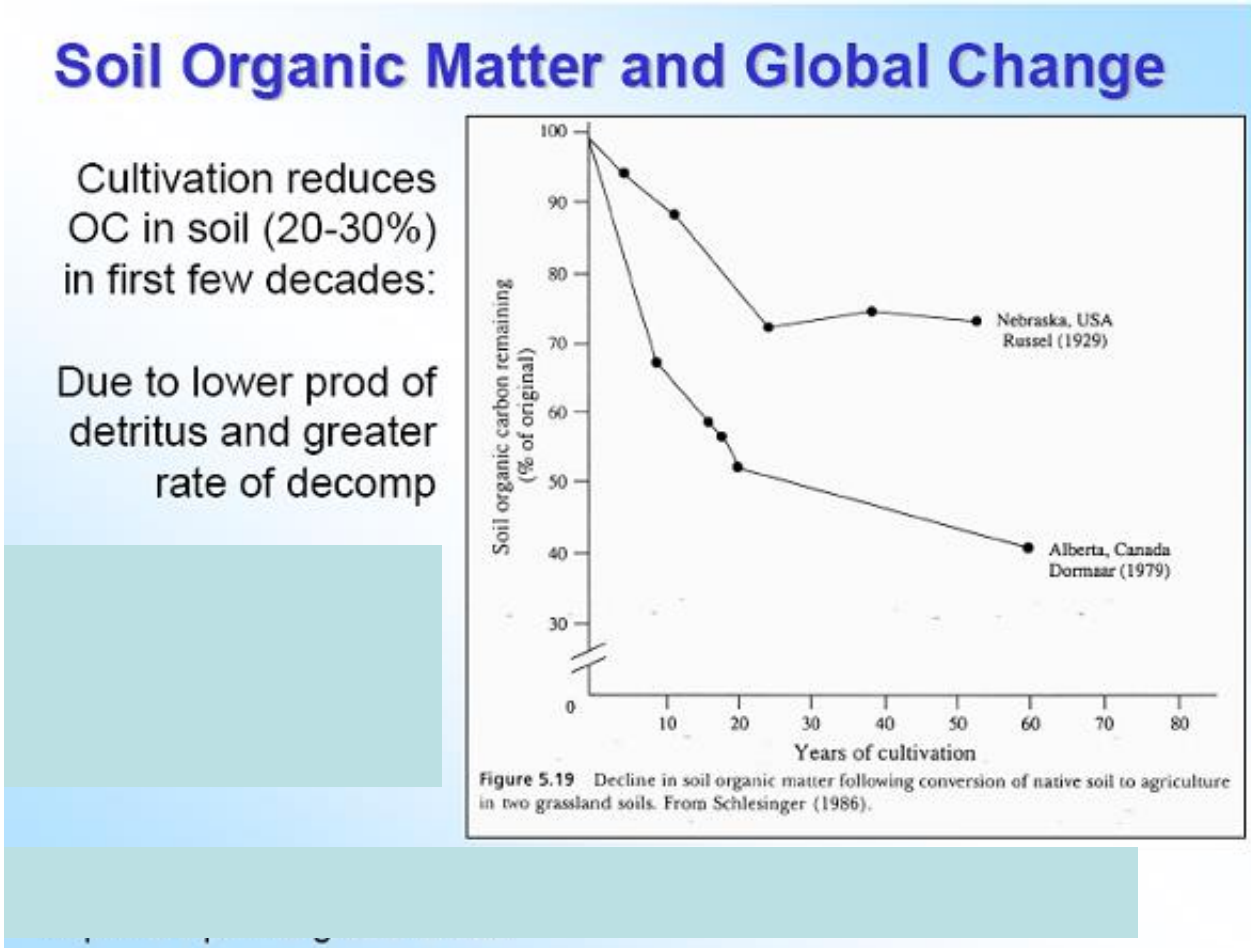
7 miljoner ha

GLOBAL CARBON STORAGE IN SOILS

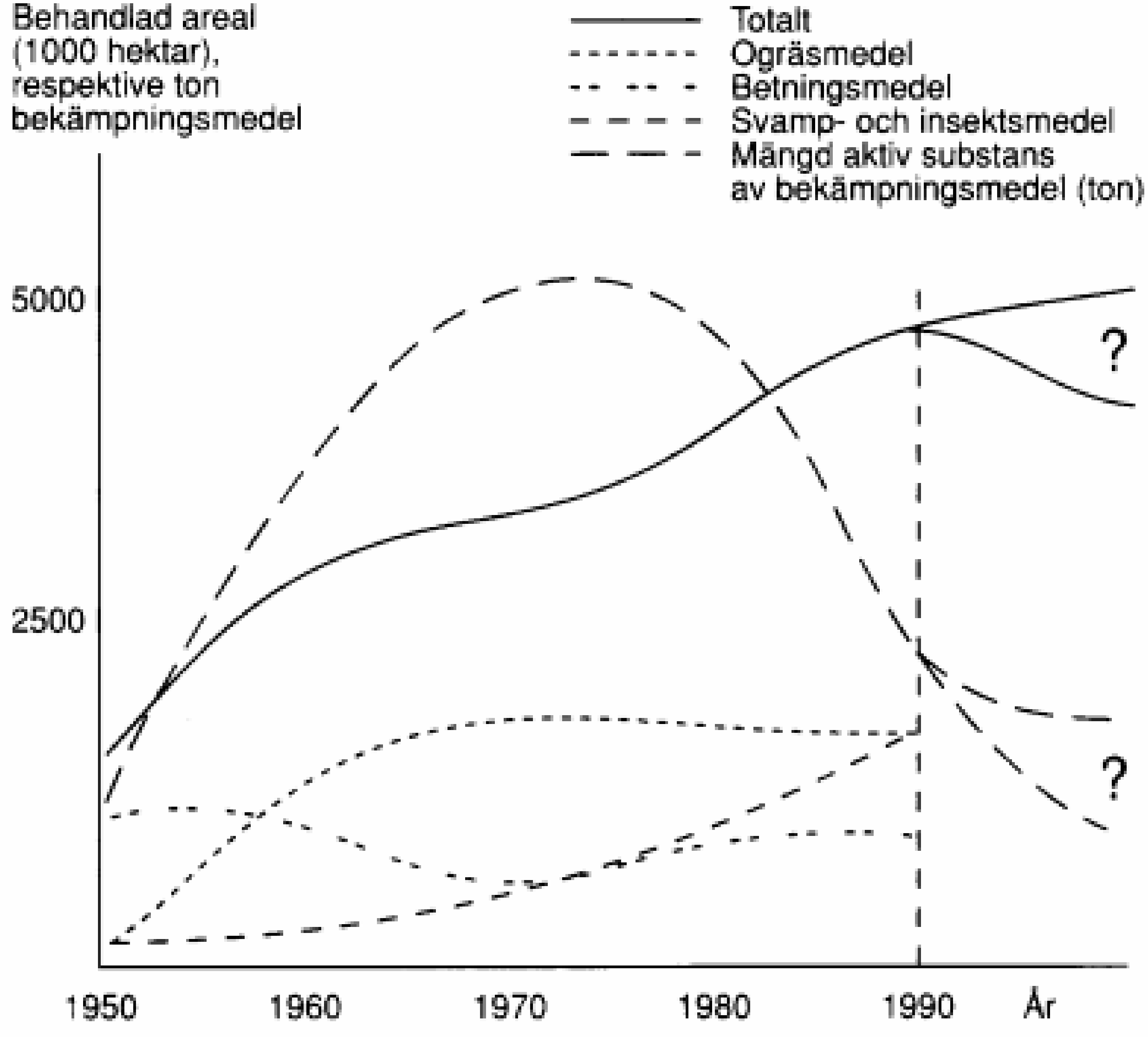


The amount of organic carbon in living organisms and in the soil, in tons/ha (World Resources Institute , 2000)

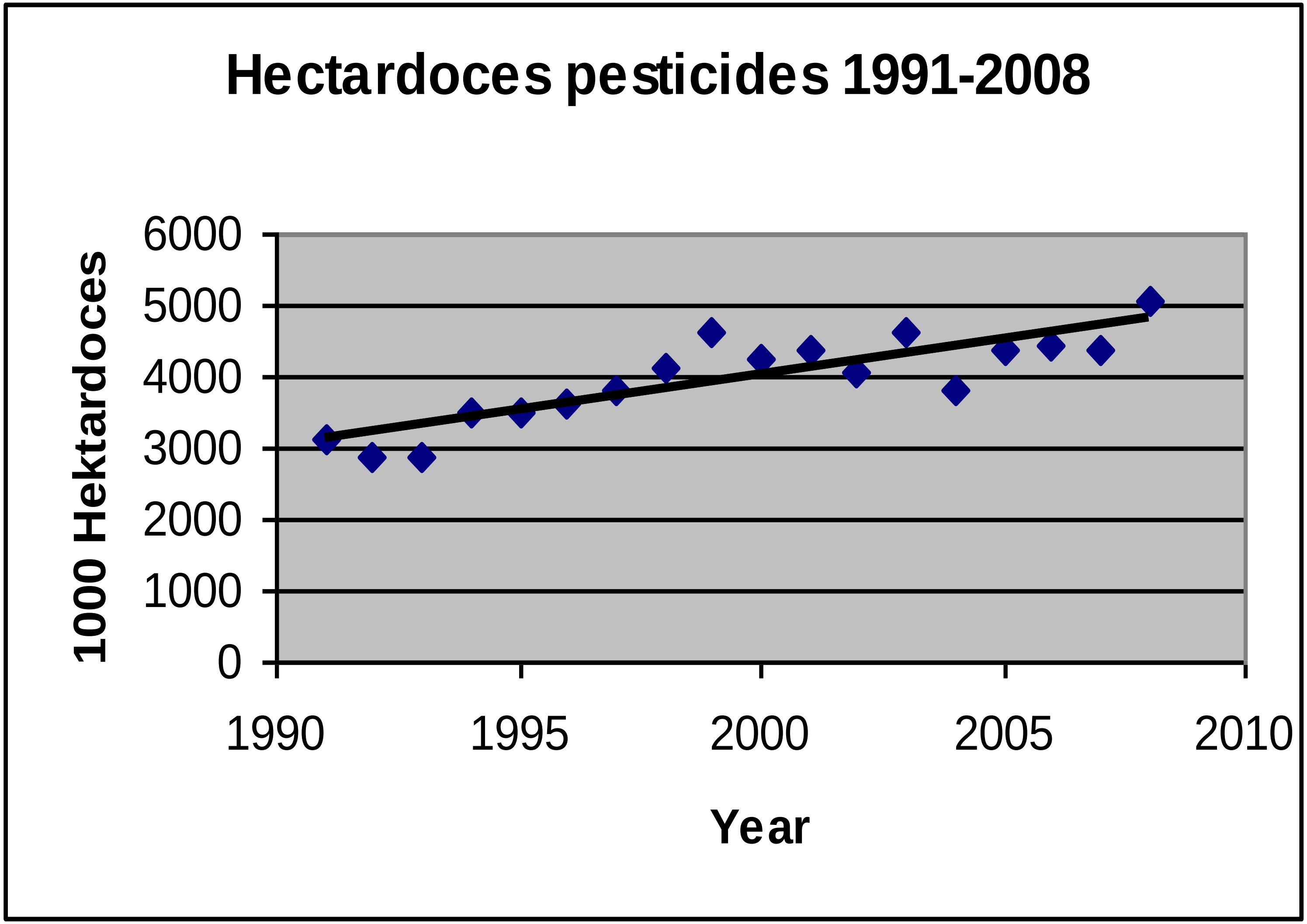
Cultivation



Many studies show how humus halt declines considerably already after the first 10 years of cultivation (Schlesinger, 1986). Cultivation can reduce organic carbon in soil by 20 – 30 % in the first few decades due to a lower production of detritus and a higher rate of decomposition.

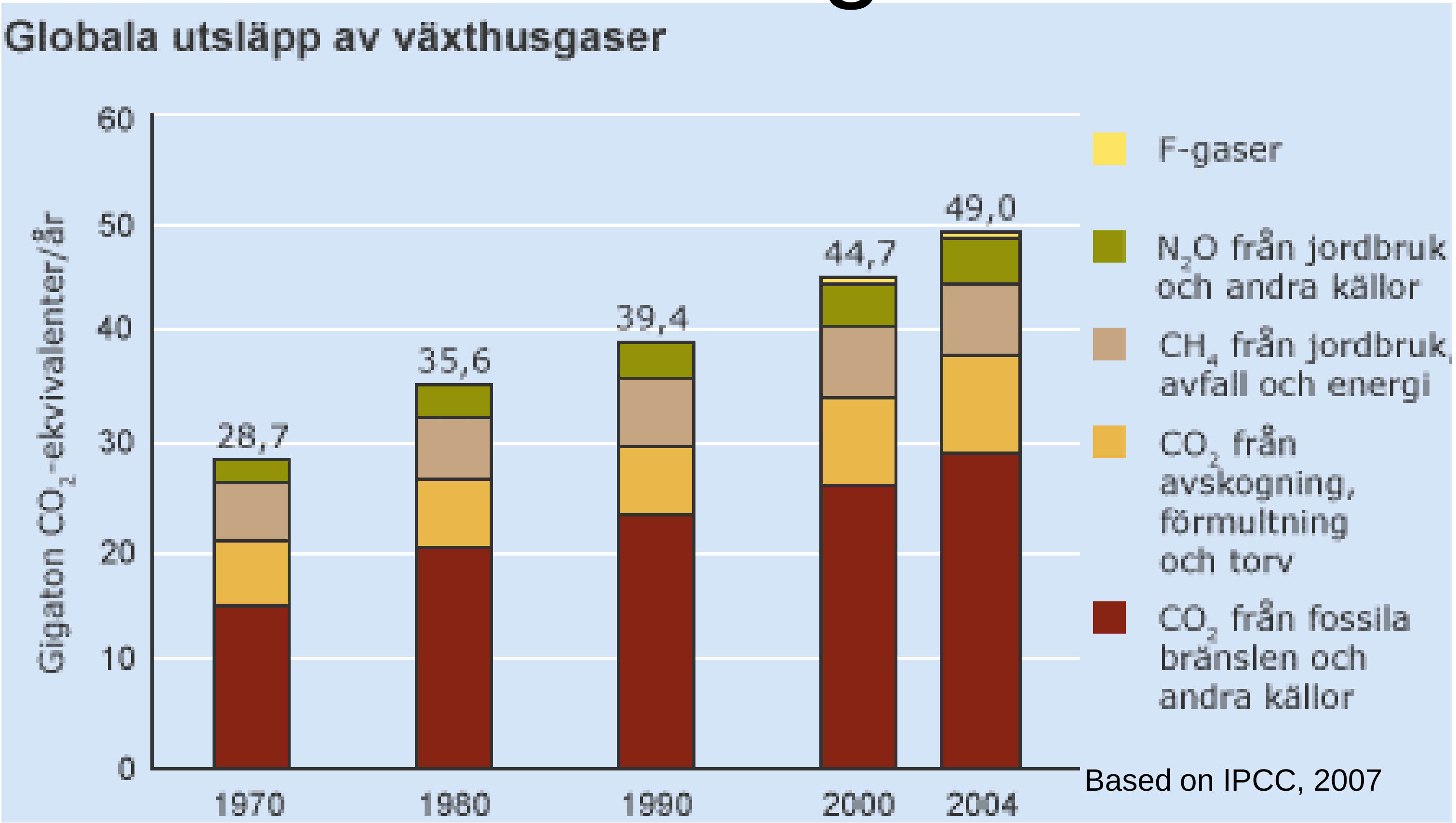


Användningen av bekämpningsmedel i jordbruket mätt som behandlad areal och som mängd aktiv substans. Uppskattningarna är mer osäkra i början av perioden. Källa: Kemikalieinspektionen och Olle Pettersson.



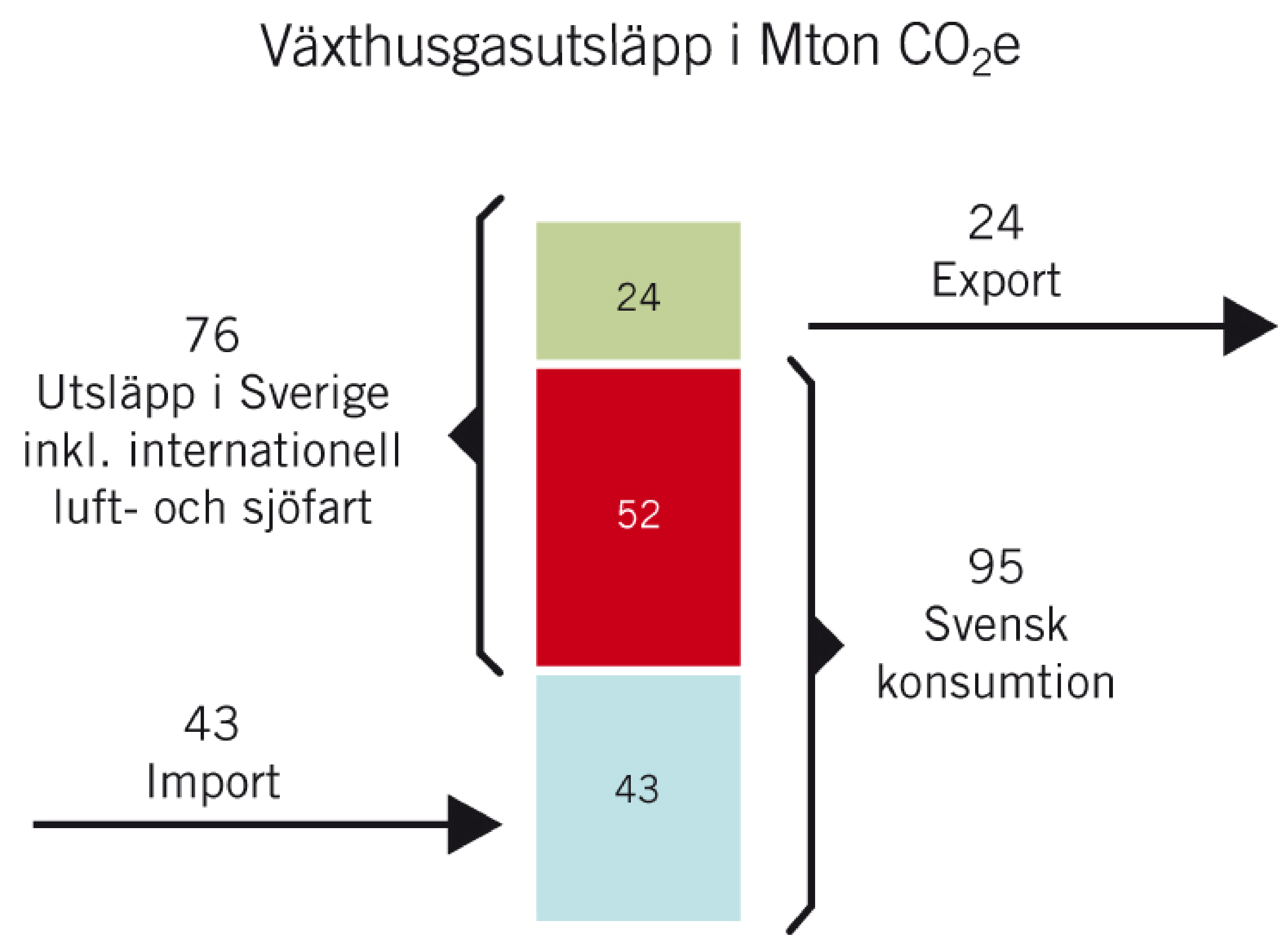
. Bekämpningsmedelsanvändningen har ökat med över 60 % sedan 1990. Källa: Jordbrukstatistisk årsbok, 2010. SCB. Sveriges officiella Statistik.

Globala utsläpp av växthusgaser

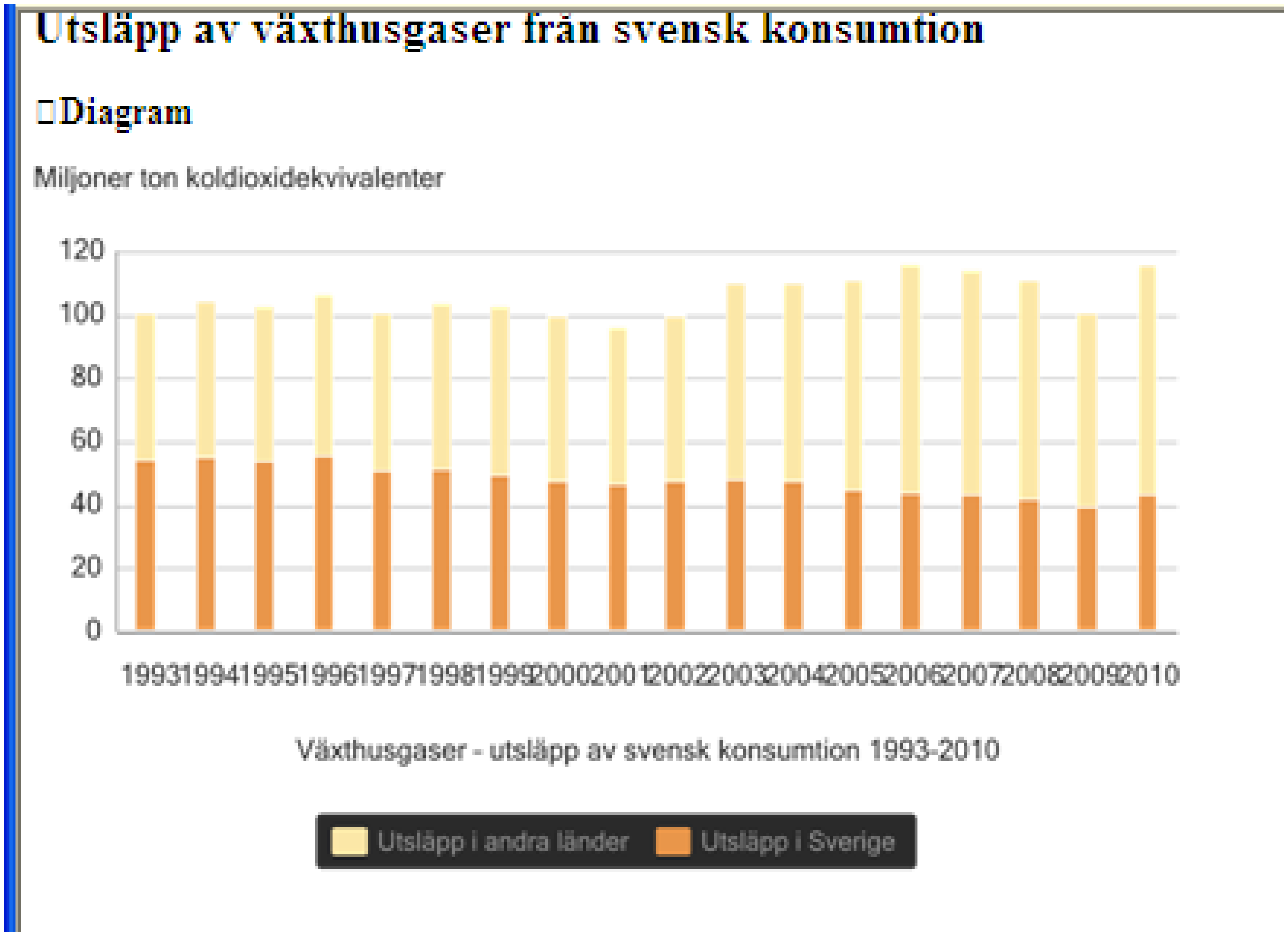


Växthusgas	GWP
CO_2	1
CH_4	21
N_20	310

Källa: Climate Change 2001: The Scientific Basis, IPCC


Växthusgasutsläpp i Mton CO_2e
24
Export
24
76
Utsläpp i Sverige
inkl. internationell
luft- och sjöfart
52
95
Svensk
konsumtion
43
Import
43

Utsläppen orsakade av svensk konsumtion har ökat med 17 procent 1993–2011

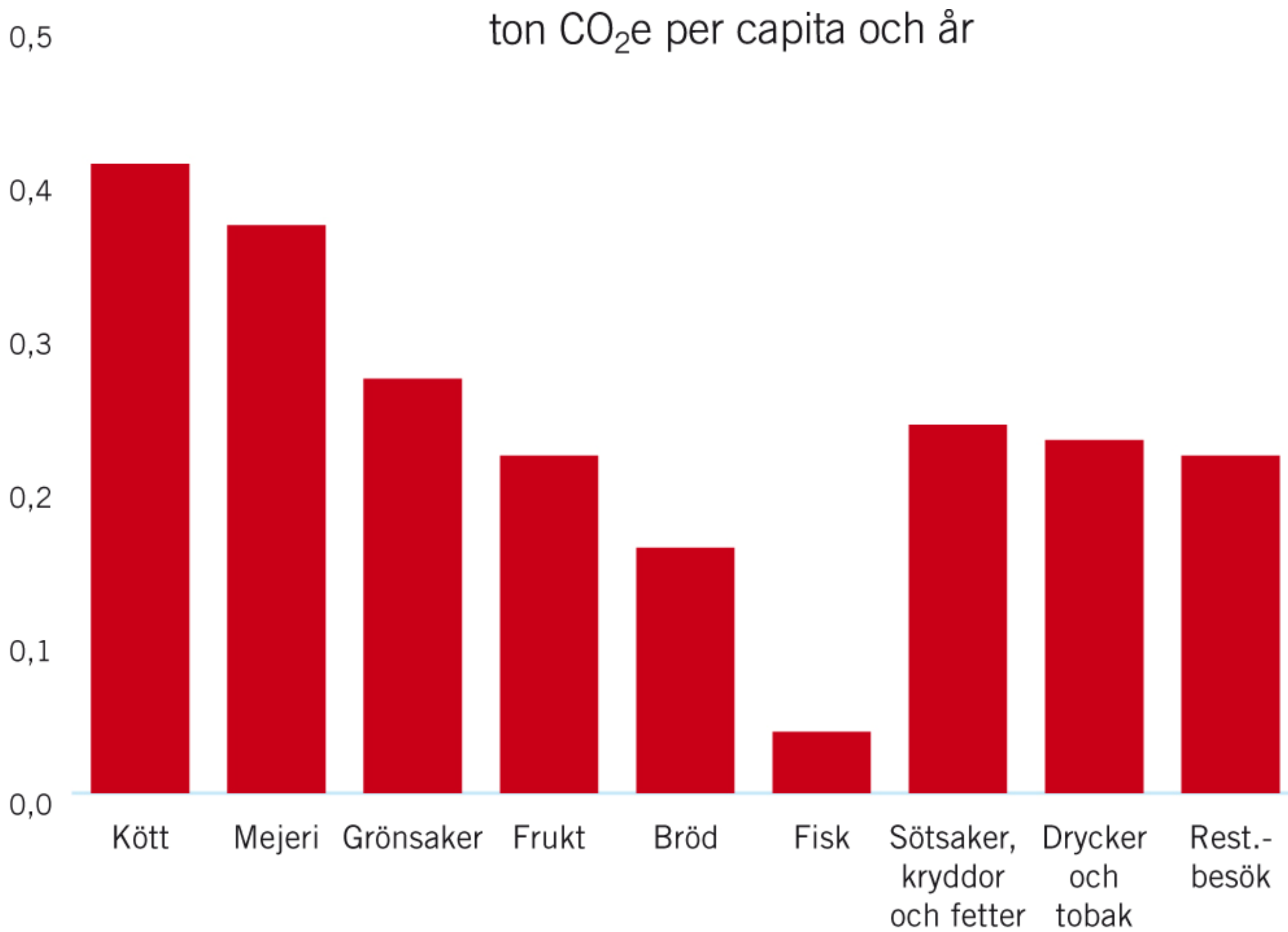


food

travel

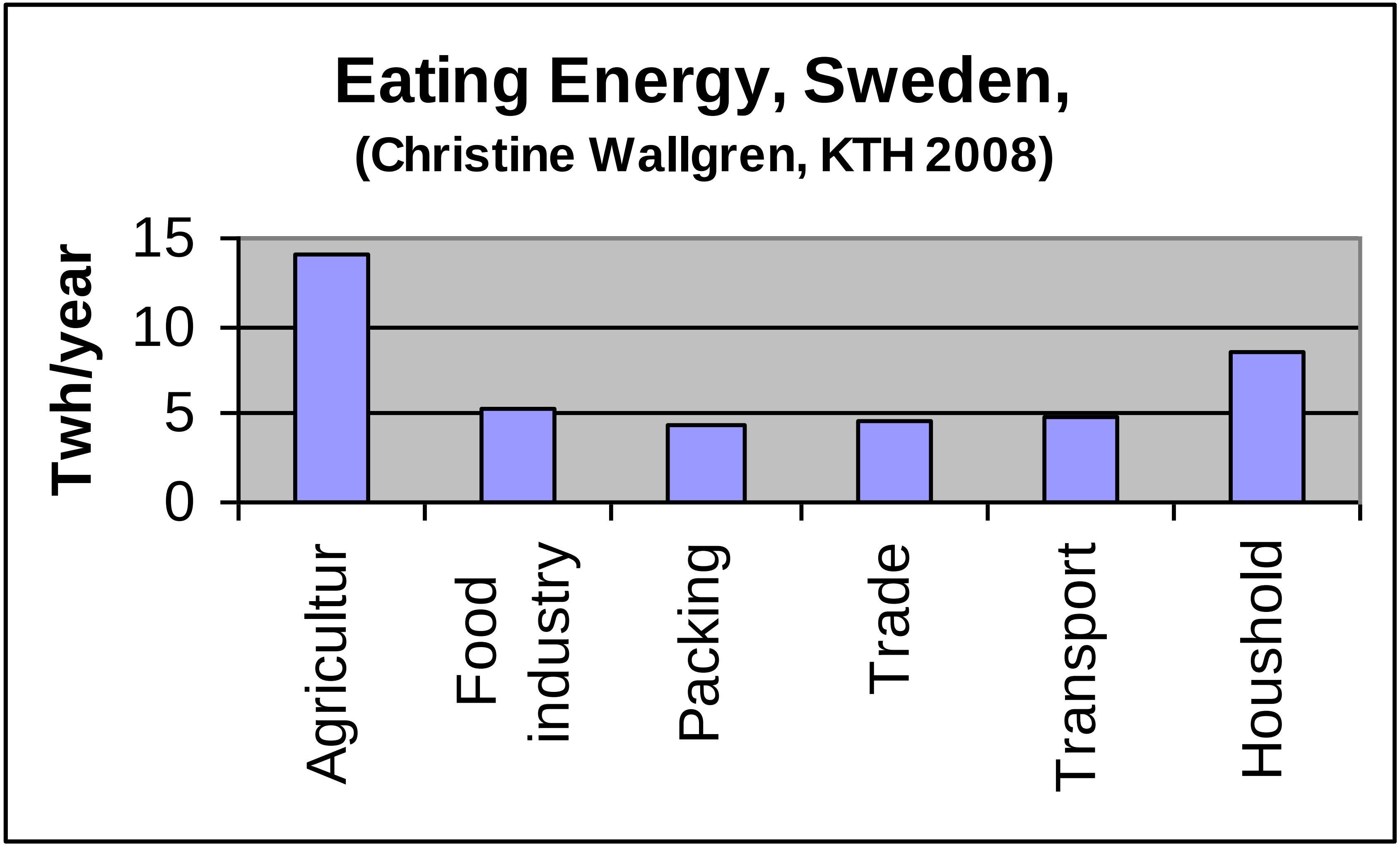
housing

Reducera 80 % -hur?



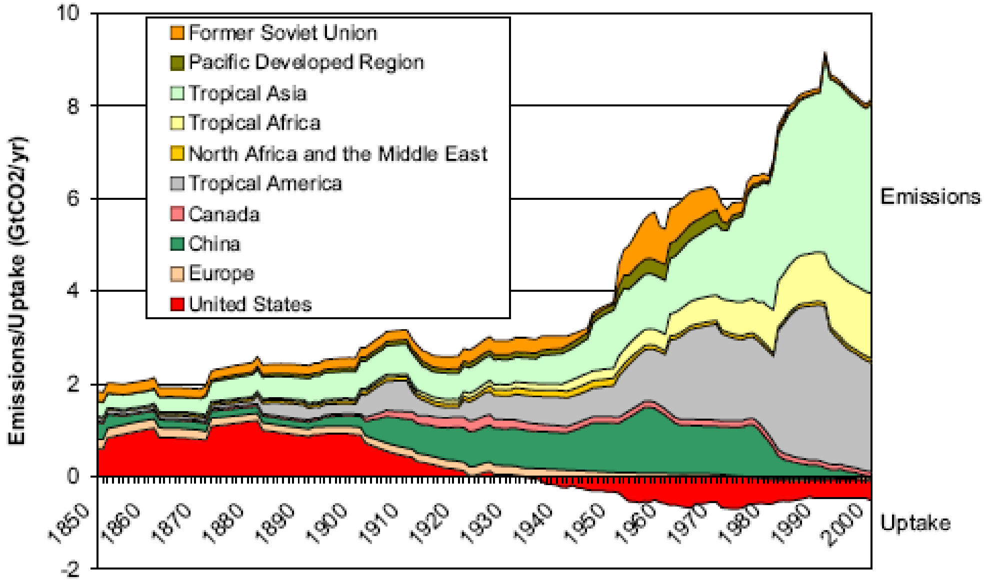
Av de totala växthusgasutsläppen på 10 ton CO2 ekvivalenter per capita utgör maten beräknat fram till butik en 28 % av den totala klimatbelastning av vår konsumtion (Naturvårdsverket, 2008). Inkluderas matens andel av hushållens övriga energiförbrukning, transporter och matproduktions bidrag till avskogningen och markförstöring så bidrar maten till närmare 40 % av den totala klimatbelastningen

35%, 50%



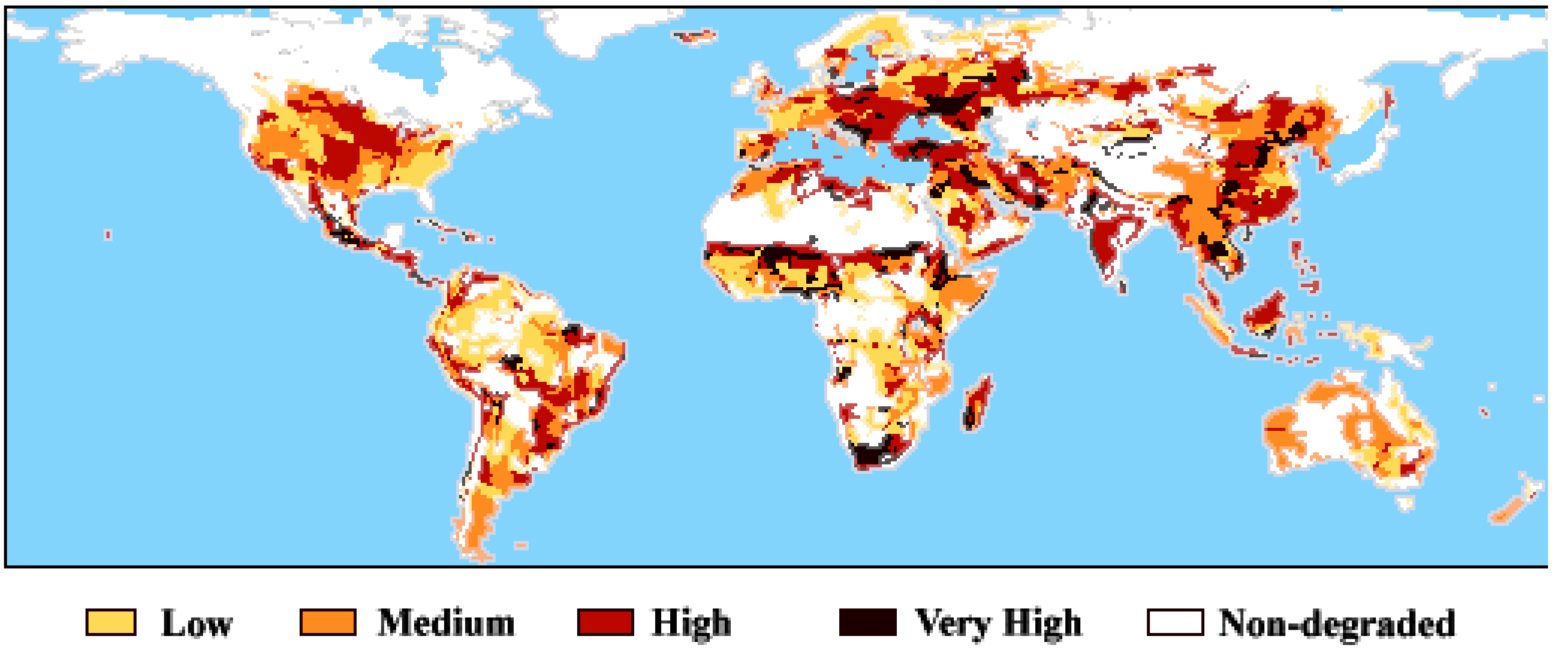
Analys av energianvändningen i livsmedelskedjan olika led jordbruk (34 % av totala energianvändningen), livsmedelsindustri (13 %), förpackningar (10 %), handel (11%), transporter(11), och hushållen (20), (Christine Wallgen 2008)

Figure 3[9] Uptake and emissions from land-use changes between 1850 and 2000. The negative emissions (uptake) post-1940 are largely due to increasing forest area in the US (0.4GtCO_2/yr in 2000) and Europe (0.07GtCO_2/yr in 2000). The peak in 1990 linked to forest fires in Indonesia.



Approximately 20 % of the yearly increase of carbon dioxide in the atmosphere is due to deforestation and land degradation. The global humus capital is decreasing and green areas are getting smaller. (Source: Carbon Dioxide Information Analysis Centre, CDIAC, 2002)

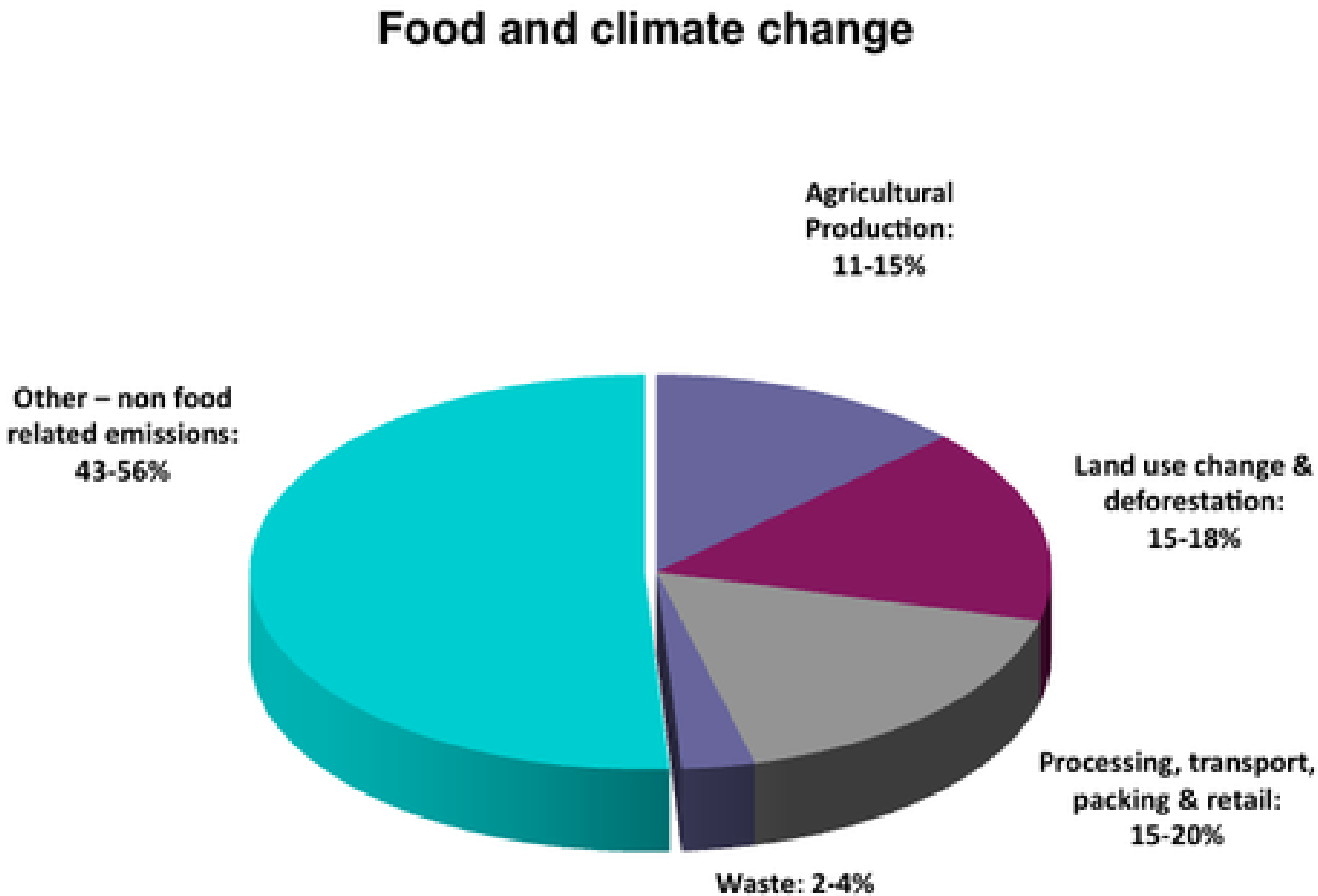
Soil Degradation Severity



PROJECTION: Geographic

SOURCES: UNEP/ISRIC

UNEP
EAD/GRID-Geneva

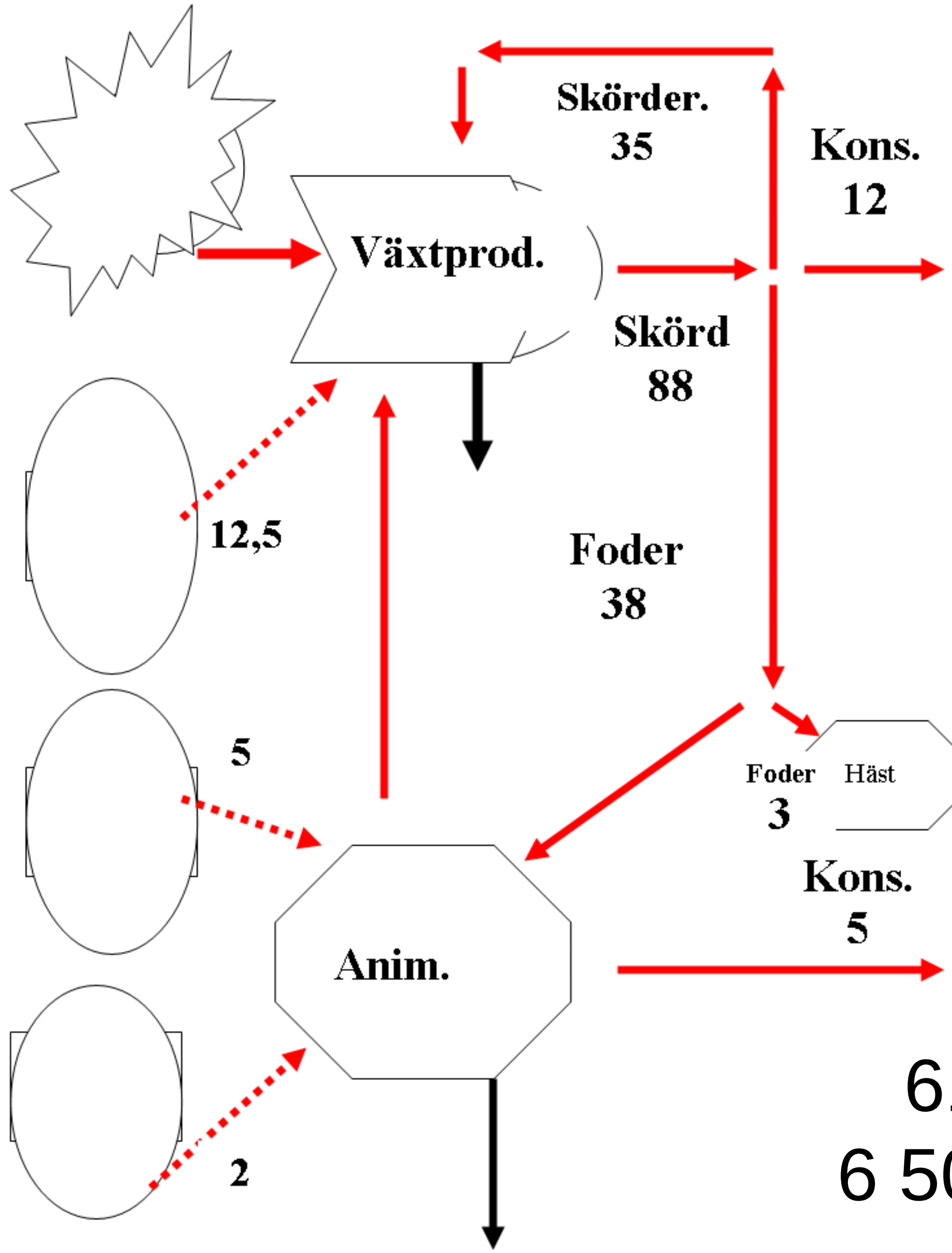


The United Nations Conference on Trade and Development (**UNCTAD**), 2011

Ulrich HOFFMANN,
Senior Trade Policy Advisor
UNCTAD secretariat

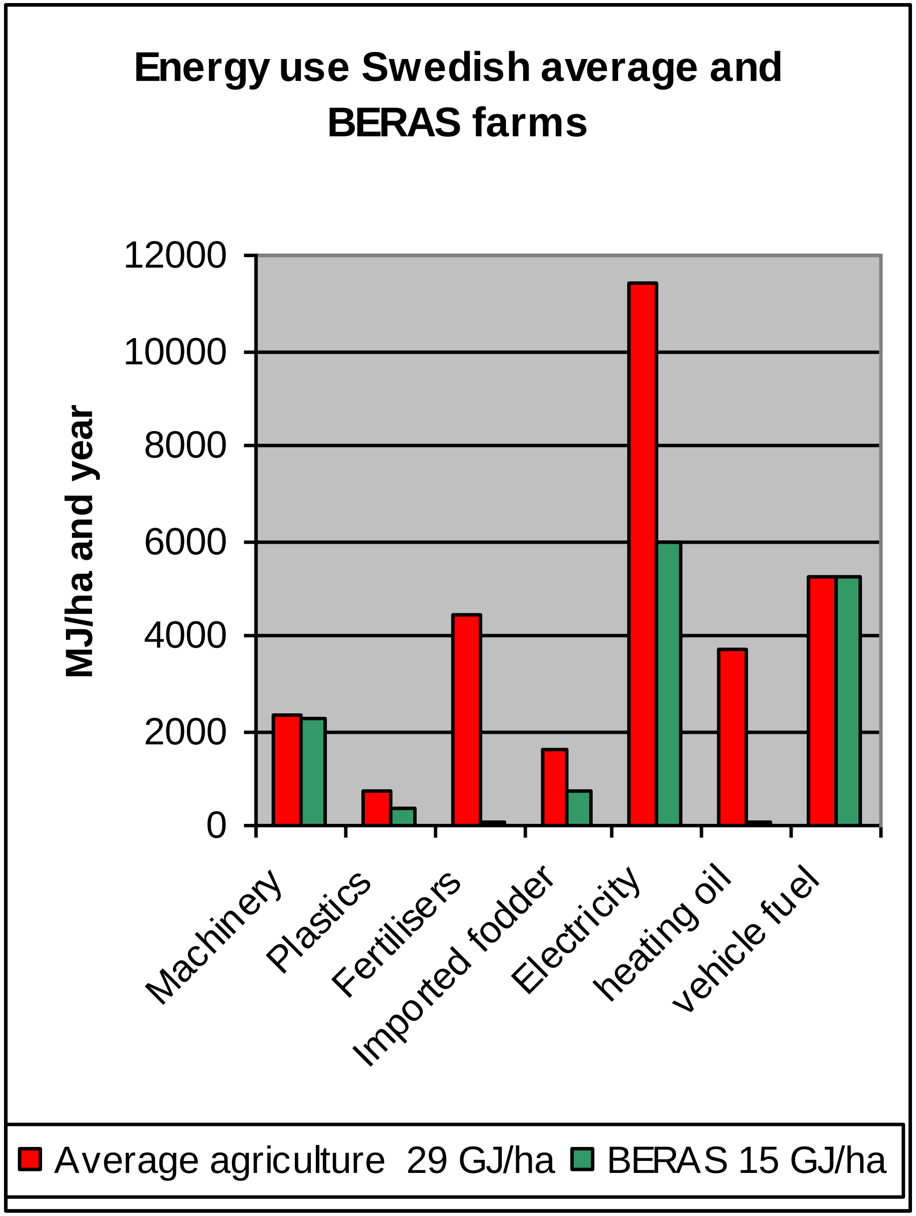
Hjälp-
energi

Foder-
import

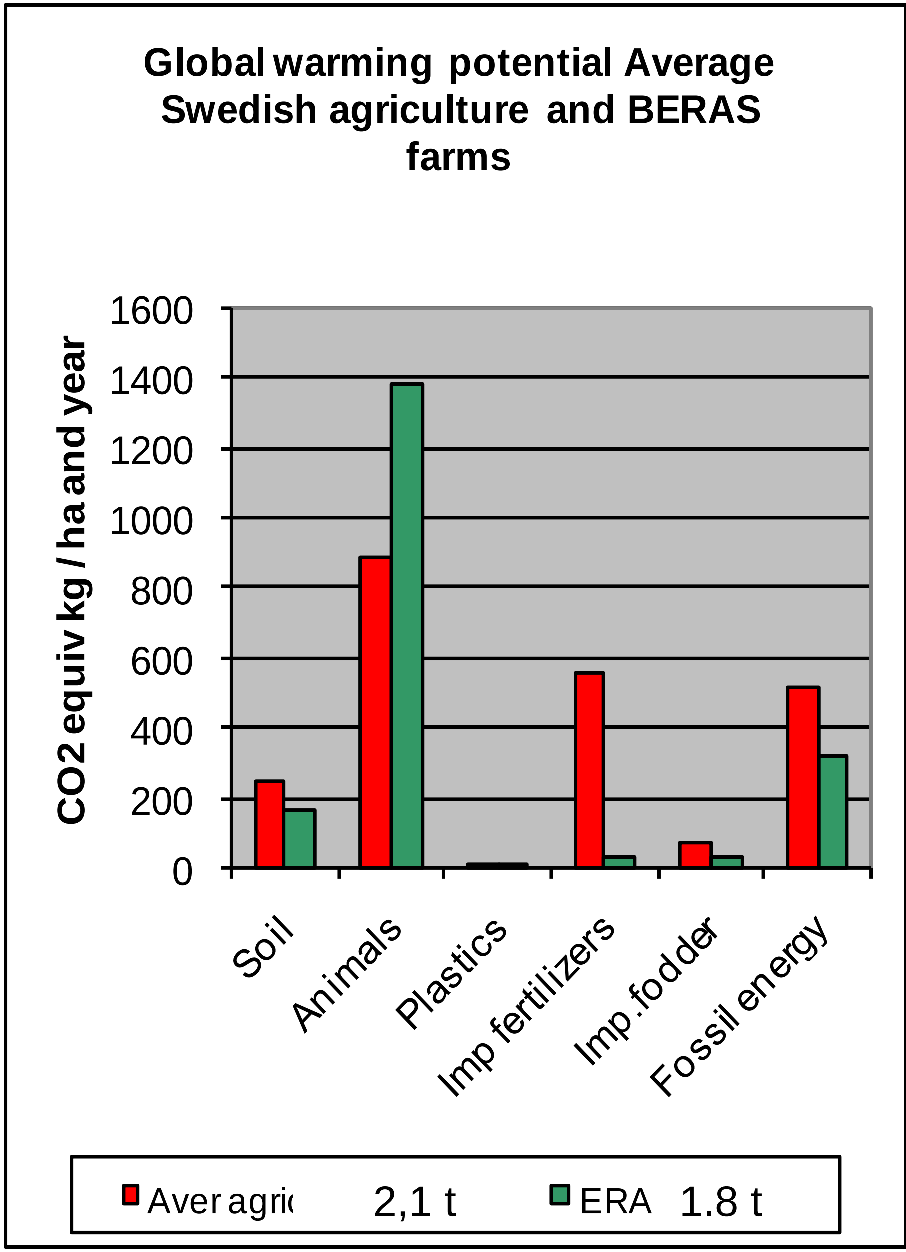


61 000 TJ
6 500 MJ/Cap

19, 5 TWh Sv Agr, Uhlin 1995, **21** TWh Thomsson, Granstedt 2005



Energy use Swedish average and BERAS farms
MJ/ha and year
12000
10000
8000
6000
4000
2000
0
Machinery
Plastics
Fertilisers
Imported fodder
Electricity
heating oil
vehicle fuel
Average agriculture 29 GJ/ha
BERAS 15 GJ/ha



Global warming potential Average Swedish agriculture and BERAS farms
CO2 equiv kg / ha and year
1600
1400
1200
1000
800
600
400
200
0
Soil
Animals
Plastics
Imp fertilizers
Imp.fodder
Fossil energy
2,1 t
1.8 t

Granstedt, A., L-Baeckström, G.(2000): Studies of the preceding crop effect of ley in ecological agriculture**.** American Journal of Alternative Agriculture, vol. 15, no. 2, pages 68–78. Washington University.

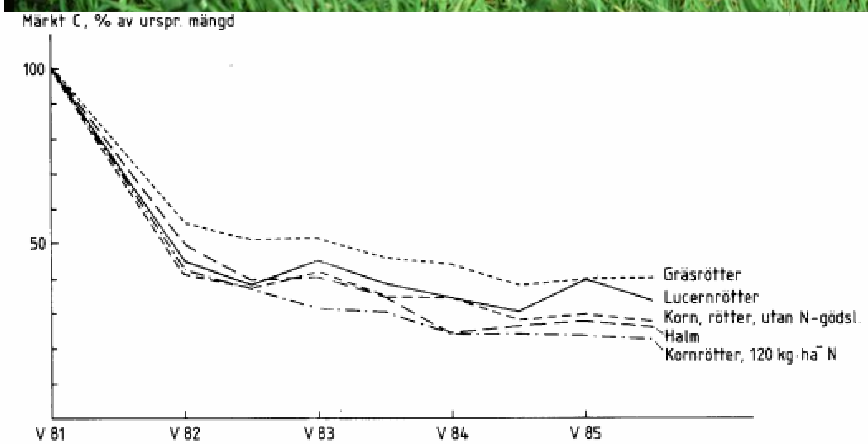
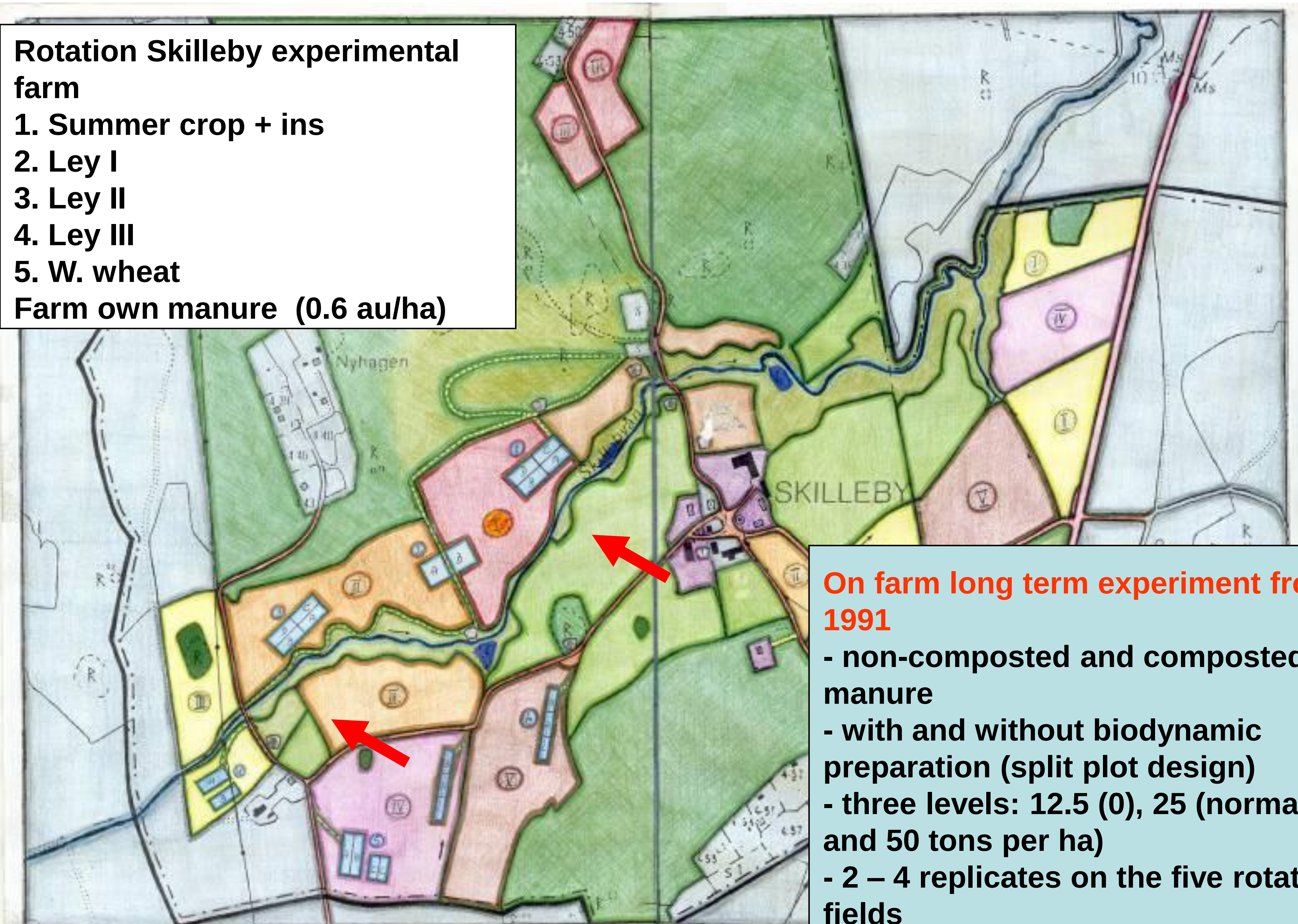


Fig. 4. Mineralisering av isotopmärkt organisk material. – *Mineralization of isotope-labeled organic material.*

Rotation Skilleby experimental farm
1. Summer crop + ins
2. Ley I
3. Ley II
4. Ley III
5. W. wheat
Farm own manure (0.6 au/ha)

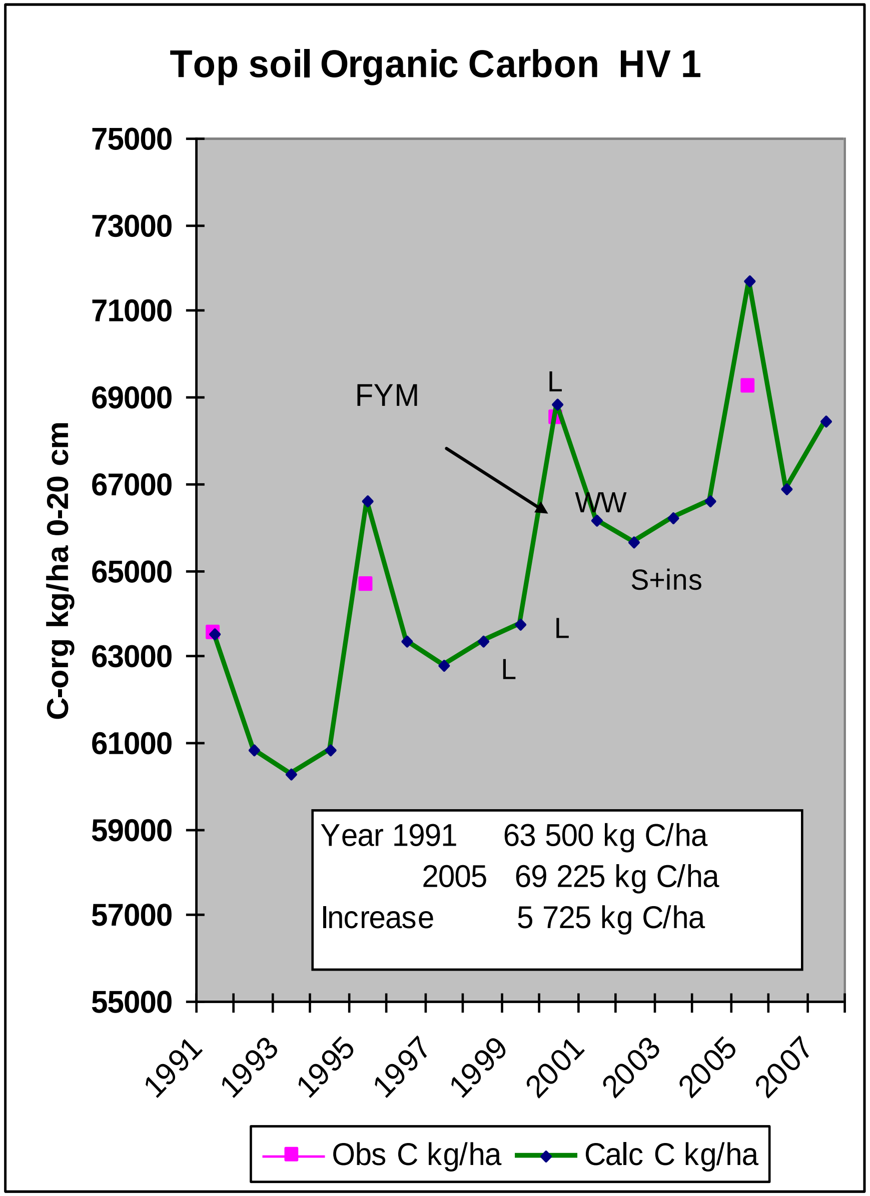


On farm long term experiment from 1991
- non-composted and composted manure
- with and without biodynamic preparation (split plot design)
- three levels: 12.5 (0), 25 (normal) and 50 tons per ha)
- 2 – 4 replicates on the five rotation fields

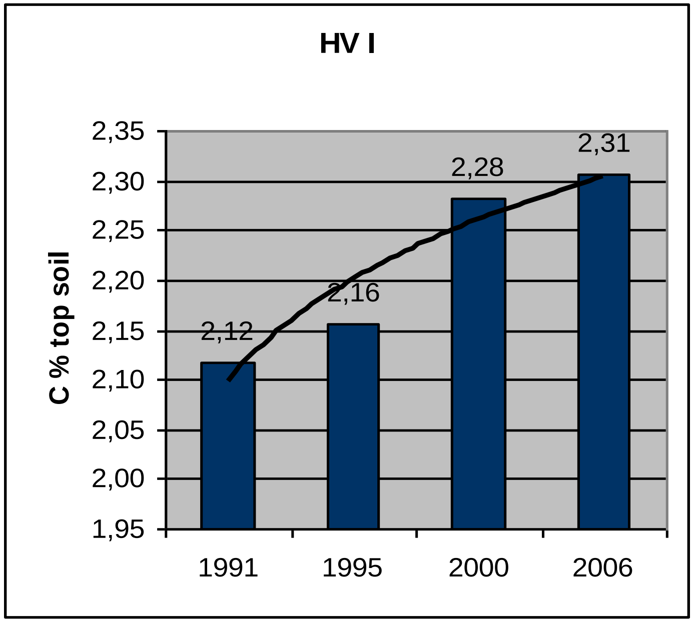
Long term manure experiment

Experimental plan from 1991

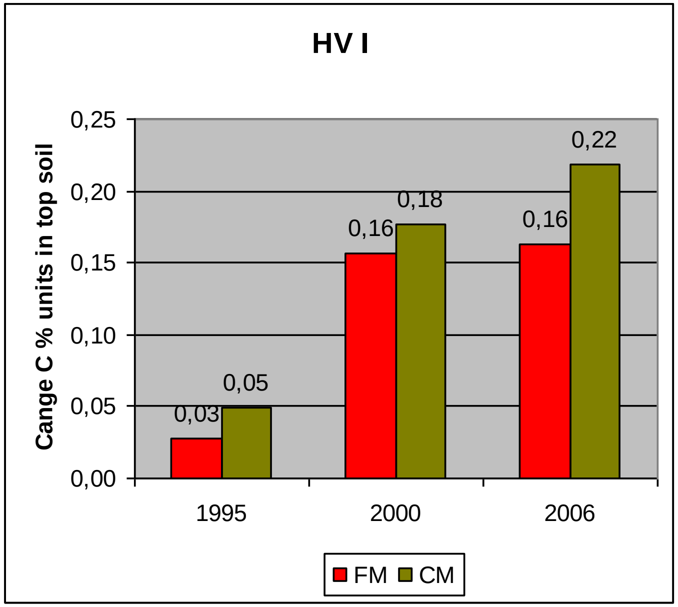
Main plot	Treatments winter wheat
F1	Not composted manure 12.5 ton (0 from 1995)
F2	25 ton
F3	50 ton
K1	Composted manure 12.5 ton (0 from 1995)
K2	25 ton
K3	50 ton
Subplot (split plot) +	BD preparation each plot each year
-	Without BD preparation



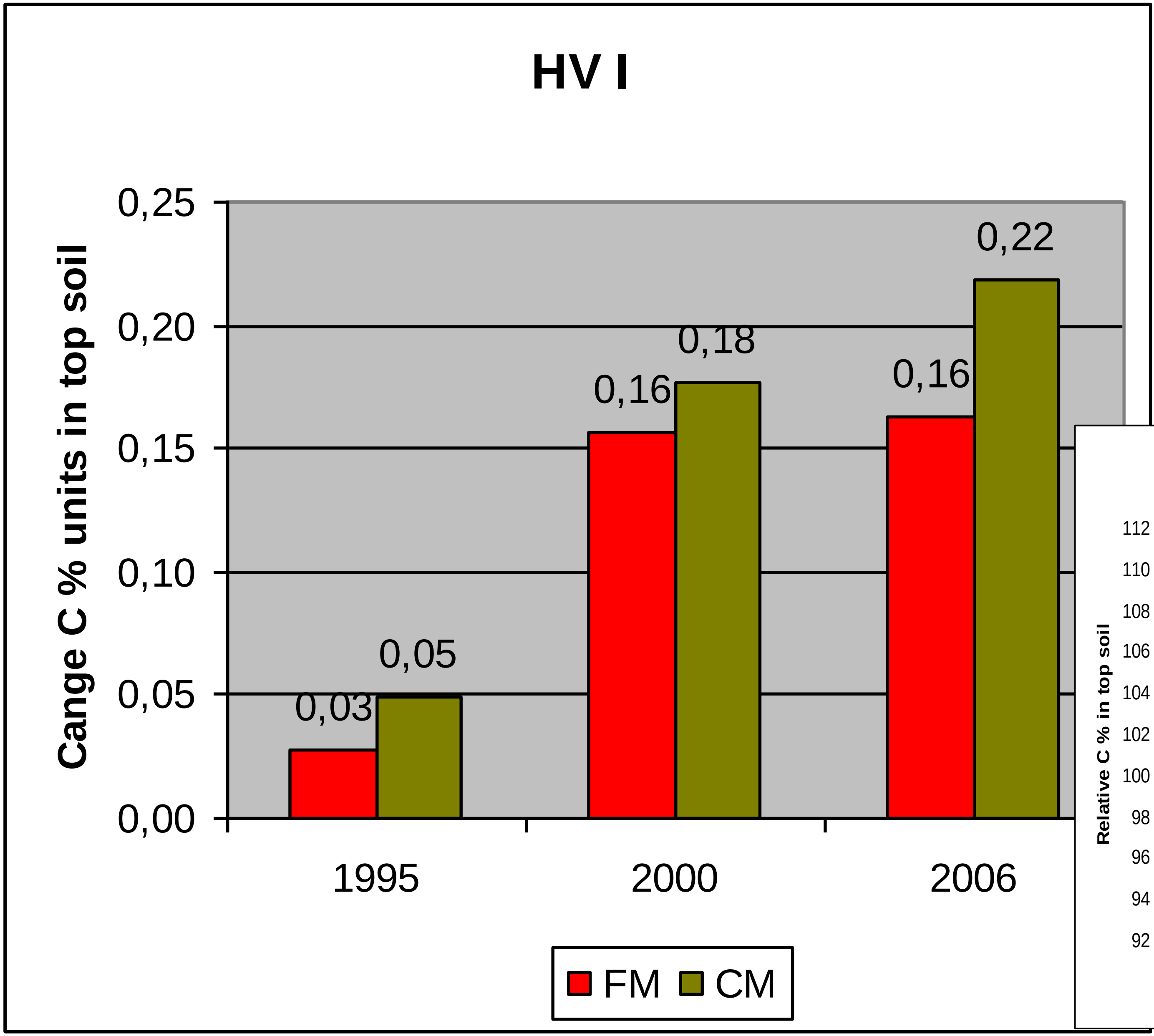
Top soil Organic Carbon HV 1
C-org kg/ha 0-20 cm
75000
73000
71000
69000
67000
65000
63000
61000
59000
57000
55000
FYM
L
WW
S+ins
L
L
Year 1991 63 500 kg C/ha
2005 69 225 kg C/ha
Increase 5 725 kg C/ha
1991
1993
1995
1997
1999
2001
2003
2005
2007
Obs C kg/ha
Calc C kg/ha

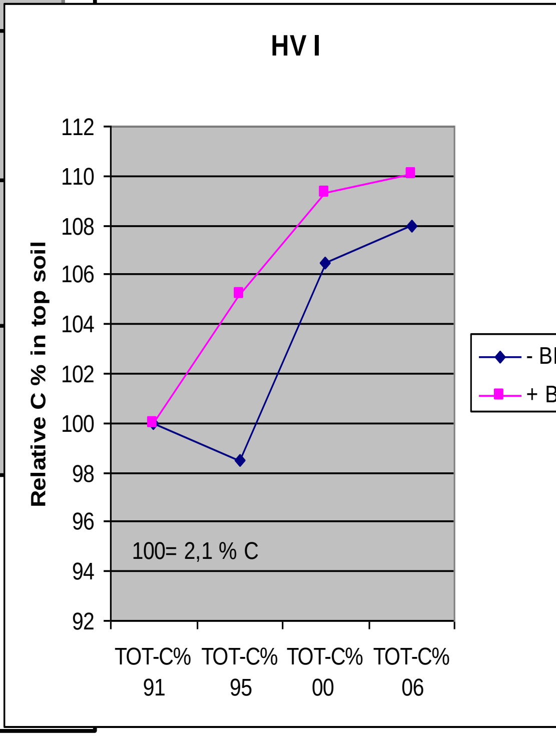


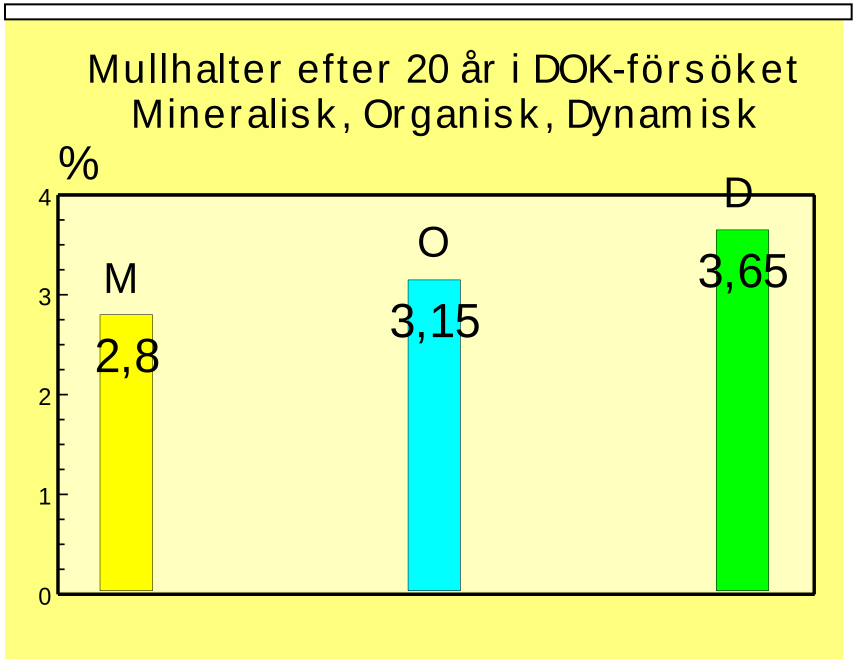
HV I
C % top soil
2,35
2,30
2,25
2,20
2,15
2,10
2,05
2,00
1,95
2,12
2,16
2,28
2,31
1991
1995
2000
2006



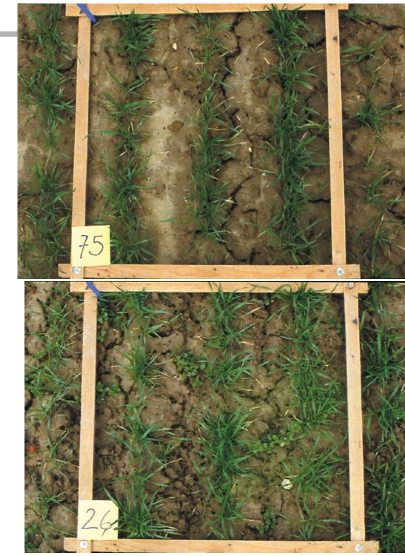
HV I
Cange C % units in top soil
0,25
0,20
0,15
0,10
0,05
0,00
0,03
0,05
0,16
0,18
0,16
0,22
1995
2000
2006
FM
CM


HV I
Cange C % units in top soil
0,25
0,20
0,15
0,10
0,05
0,00
0,03
0,05
0,16
0,18
0,16
0,22
1995
2000
2006
FM
CM


HV I
Relative C % in top soil
112
110
108
106
104
102
100
98
96
94
92
100= 2,1 % C
TOT-C% 91
TOT-C% 95
TOT-C% 00
TOT-C% 06



K



D

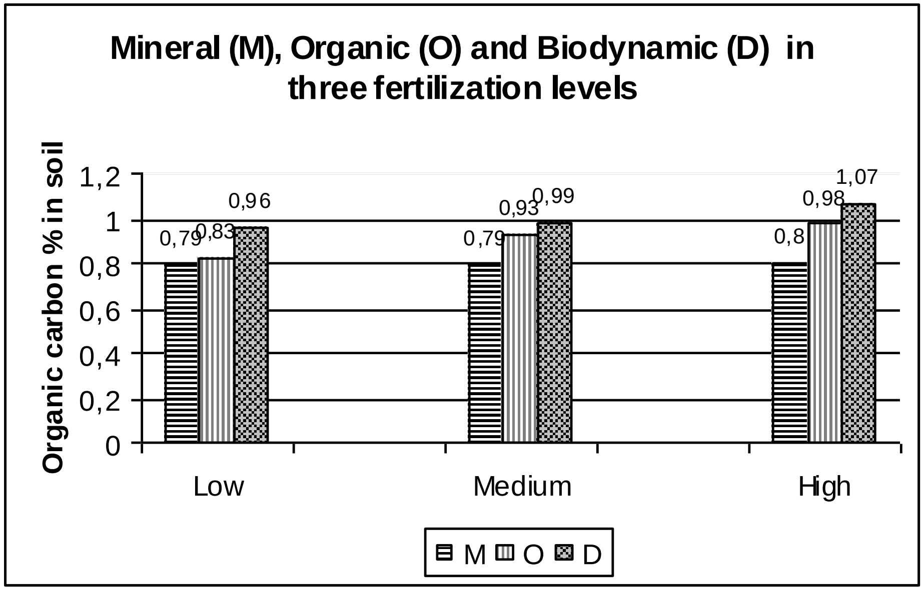
DOK-experiment

[1] Mäder, P., Fliessbach, A.,Dubois D., Gunst L., Fried P. & Niggli, U. 2002. Soil Fertility and Biodiversity in Organic Farming. Science VOL 296 pp 1592-1597.

Humus content after 20 years in DOK trials comparing conventional, organic and biodynamic treatments. In the Swiss DOK -trials comparing t biodynamic, organic and conventional treatments in FiBL the humus content was, after 20 years, in conventional farming 2,8 % (M), in organic farming with organic manure 3,15 % (O) and in biodynamic farming with biodynamic manure treatments and the use of biodynamic preparations 3,65 % (D). (Mäder, et al, 2002).

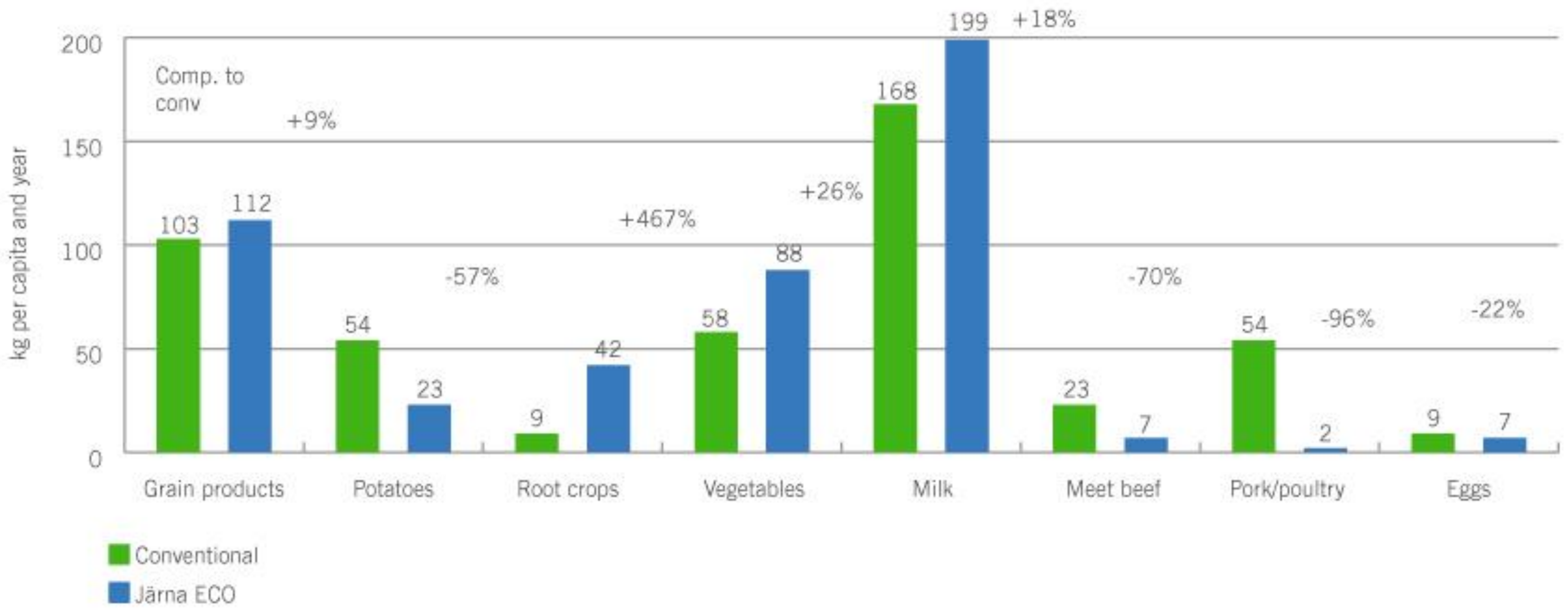
Mäder, P., Fliessbach, A.,Dubois D., Gunst L., Fried P. & Niggli, U. 2002. Soil Fertility and Biodiversity in Organic Farming. Science VOL 296 pp 1592-1597.

Humus content measured as carbon content



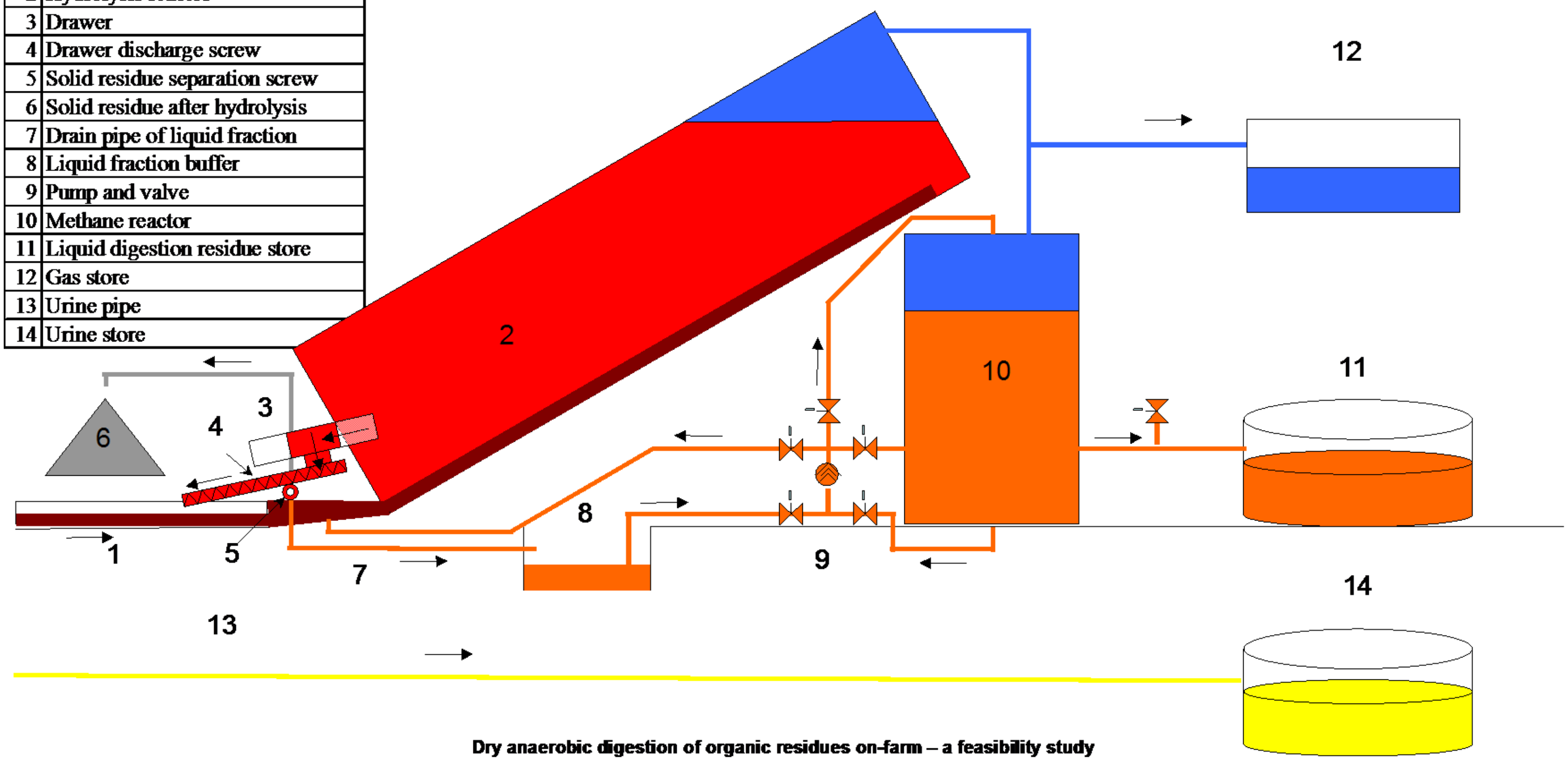
Humus content measured as carbon content in the soil. Mineral – Organic – Biodynamic. Fertilisation/ manure trial IBDF in Darmstadt. Fertilization levels 1-2-3 in M, O and D treatments. Comparative trials with four repetitions and three manure levels throughout. They showed the highest humus content (on average 13 percent higher) when all biodynamic preparations were used (D), compared to organic manure (O) under otherwise similar conditions. All organic manure has been composted and the experiments have been going since 1980 in humus-poor sandy-soil (Raupp, 2001).

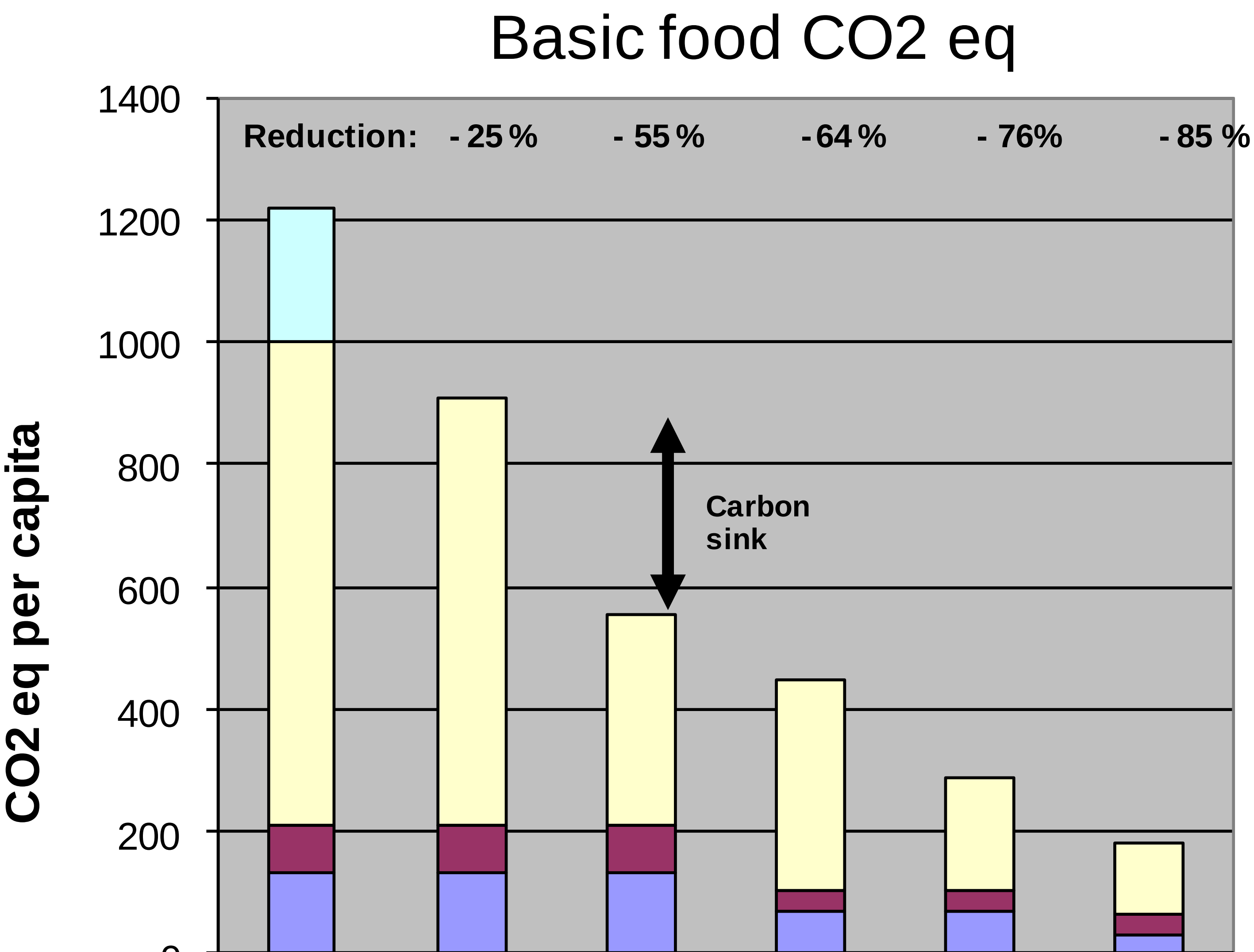
Conventional and ecological consumption BERAS – Järna survey (Granstedt and Thomson 2005)



Material flow chart of the biogas plant at Yttereneby, Järna, Sweden

1	Feeder channel
2	Hydrolysis reactor
3	Drawer
4	Drawer discharge screw
5	Solid residue separation screw
6	Solid residue after hydrolysis
7	Drain pipe of liquid fraction
8	Liquid fraction buffer
9	Pump and valve
10	Methane reactor
11	Liquid digestion residue store
12	Gas store
13	Urine pipe
14	Urine store



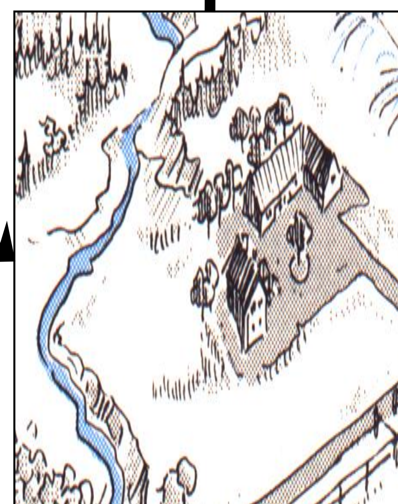


	CONV	ERA	ERA.SOM	ERA.SOM.LOC	ERA.SOM.LOC	ERA.SOM.LOC.BG.VEG
Land-use change	220					
Agriculture	790	699	344	344	188	120
Processing	80	80	80	35	35	30
Transports	130	130	130	66	66	31

Näringsbalans på gården

Emissioner till atmosfären

Näringsinput
- kvävefixering
- foder
- …

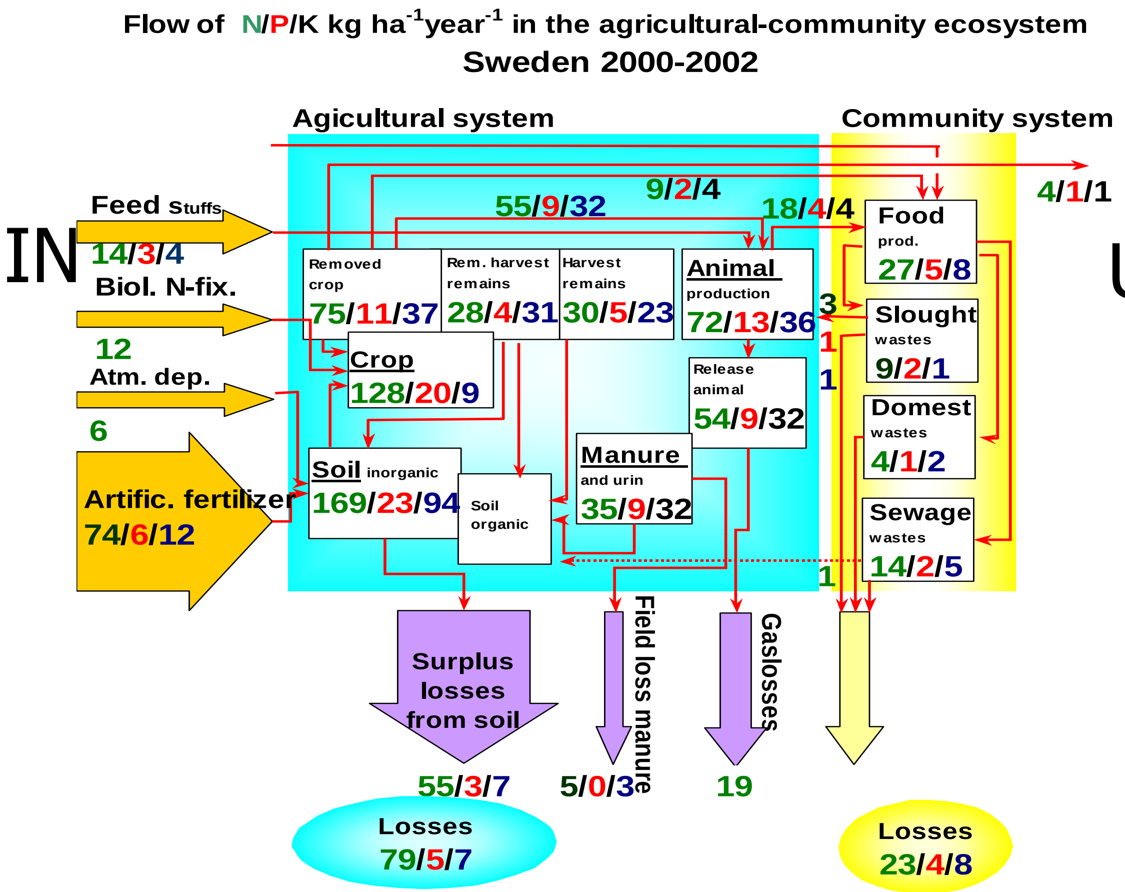


Näringsoutput
- växtproduktion
- djurproduktion
- …

Vattenemissioner

En analys av flöden av N, P och K i jordbruk och samhälle

visar att 3/4 av det N som tillförs går förlorat ut i miljön

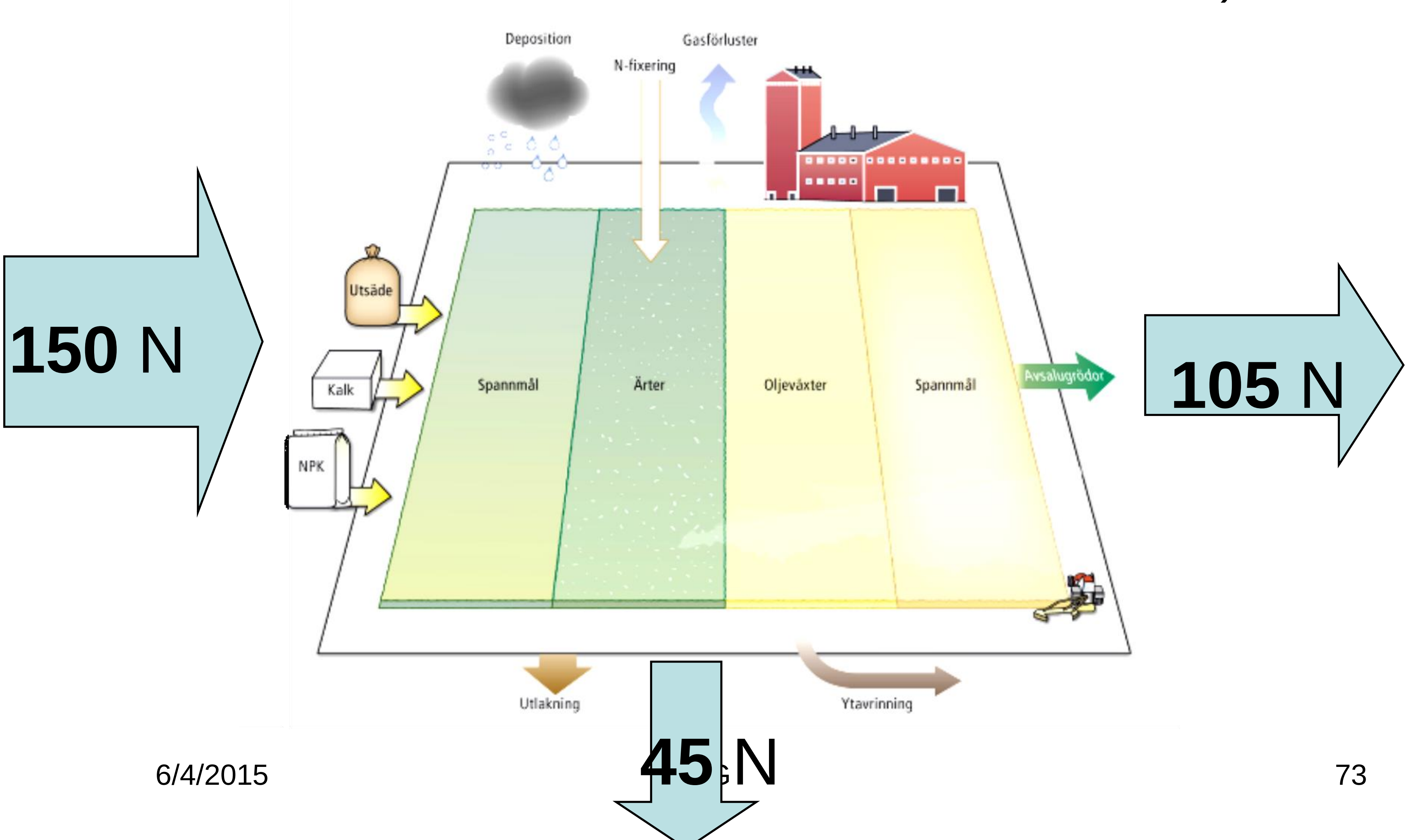


80 % av det som skördas från åkerarealen blir djurfoder och 75 % av det djuren äter blir till gödsel. Gödseln skall gå tillbaka och göda åkern och ej ut i havet.

Specialized crop farm

Input, output and surplus of Nitrogen kg/ha and year

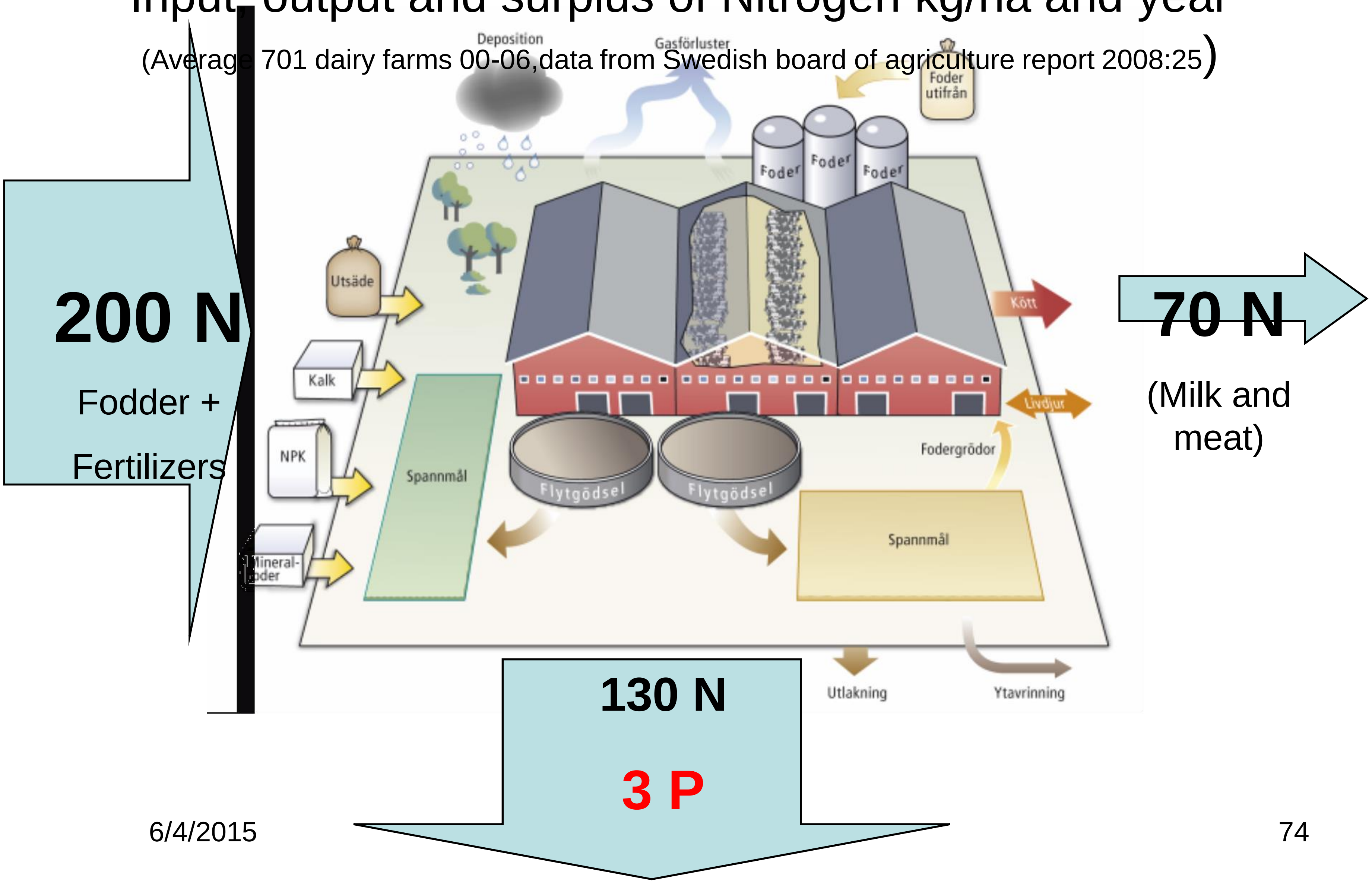
(Average 563 farms 01-06 data from Swedish board of agriculture report 2008:25)

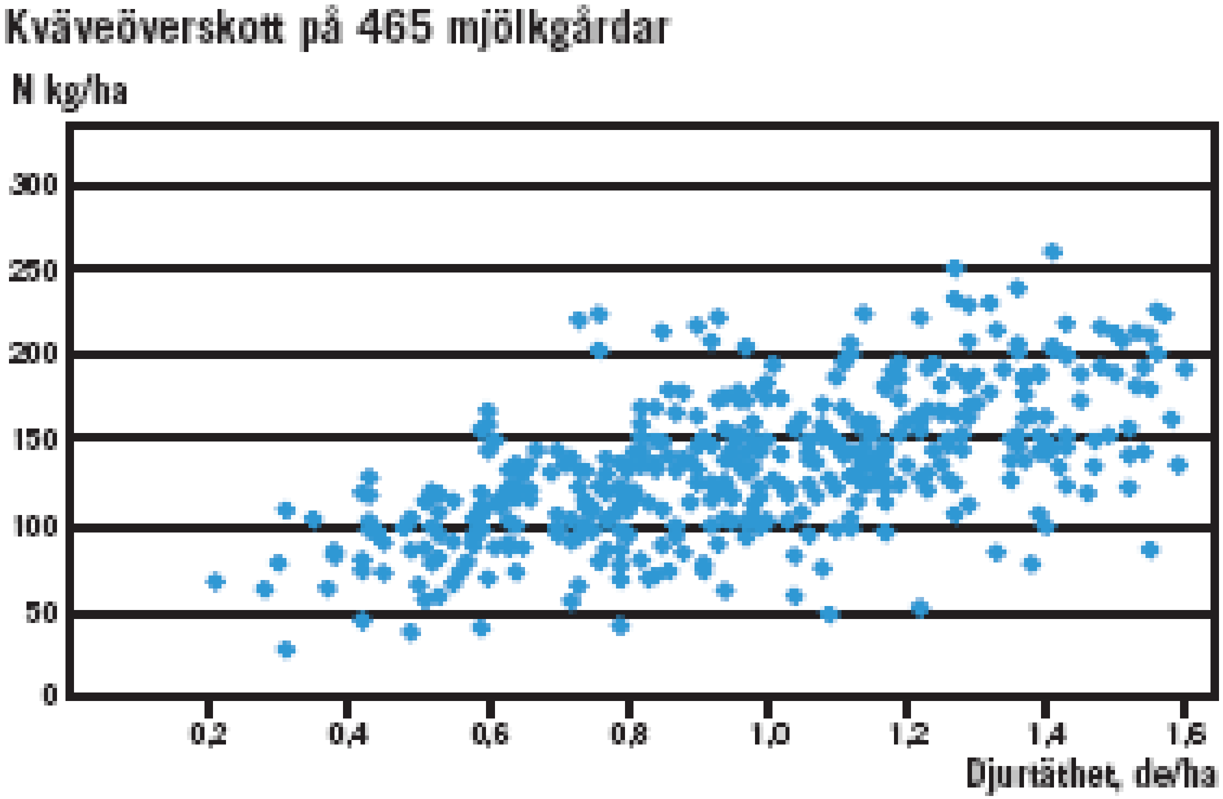


Specialized animal farm

Input, output and surplus of Nitrogen kg/ha and year

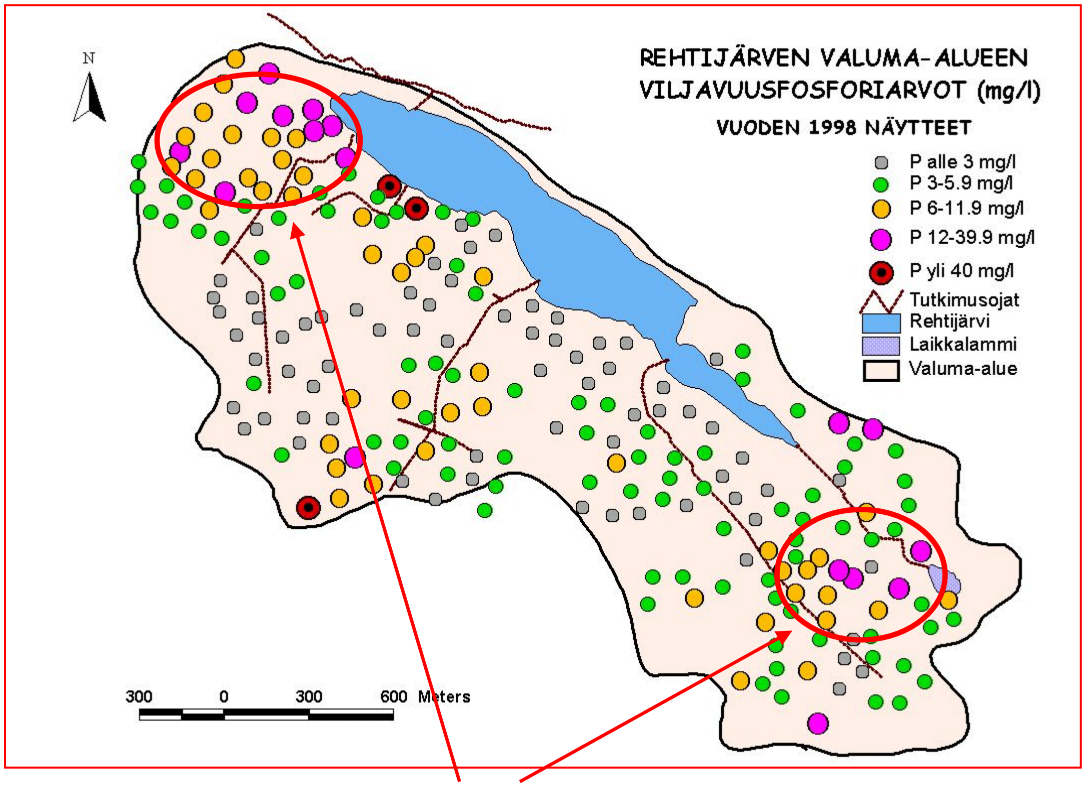
(Average 701 dairy farms 00-06,data from Swedish board of agriculture report 2008:25)





Nitrogen surplus N kg/ha in relation to animal units (de)/ha on 465 dairy farms in Sweden

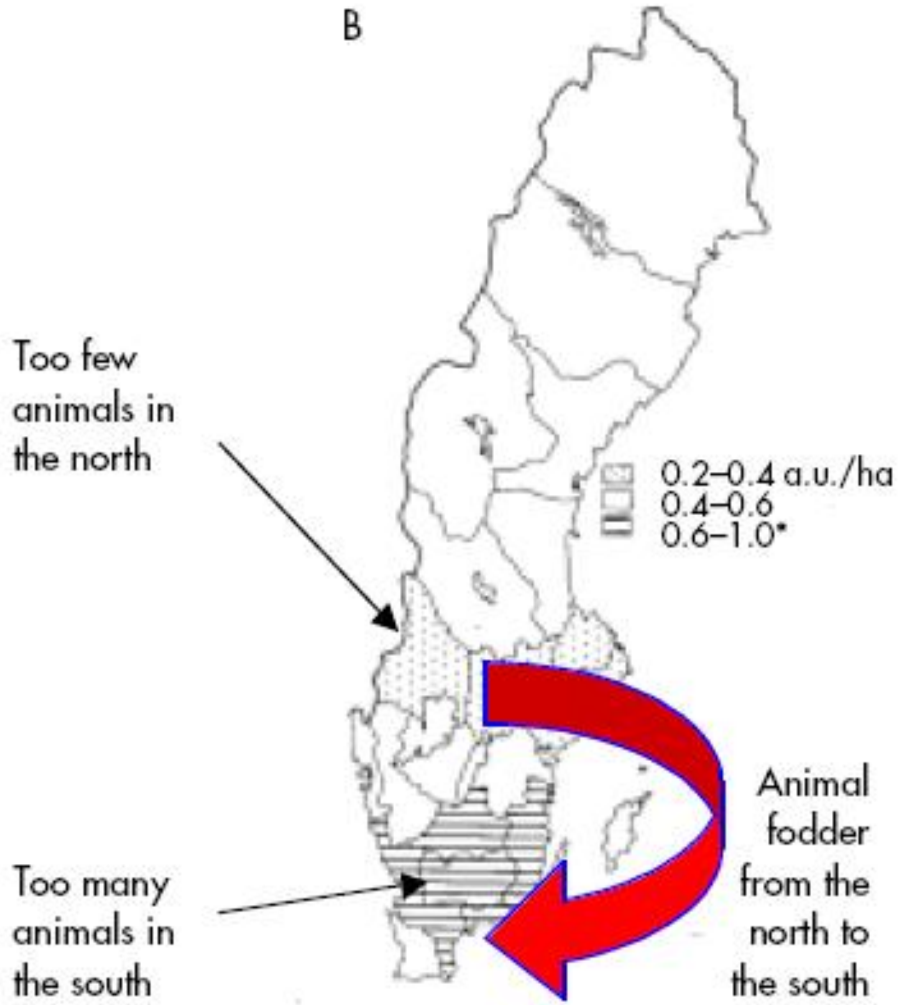
We know that in a catchment scale, a major part of P losses often come from a relatively small part of the catchment.



The hot-spots of P losses are typically areas where nutrients in manure is in surplus.

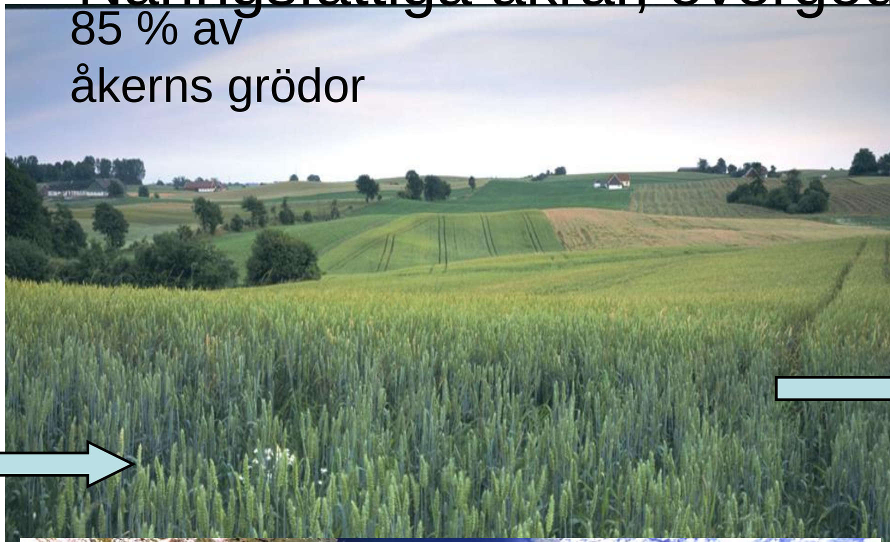
In the lake Rehtijärvi case, these two areas make up a half of the dissolved P losses to the lake, even through their share is less than 20% of the cathment land area.

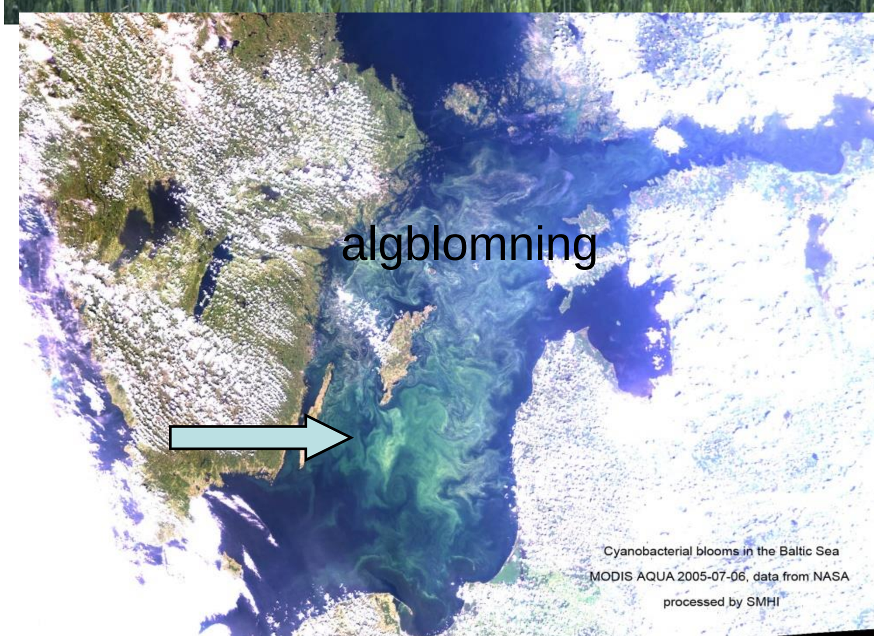
With regional – concentration

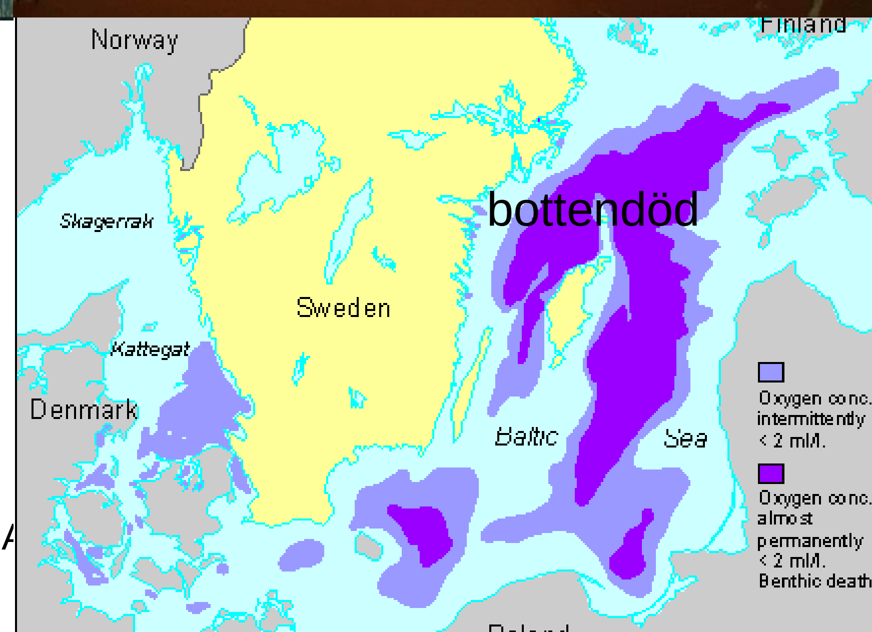


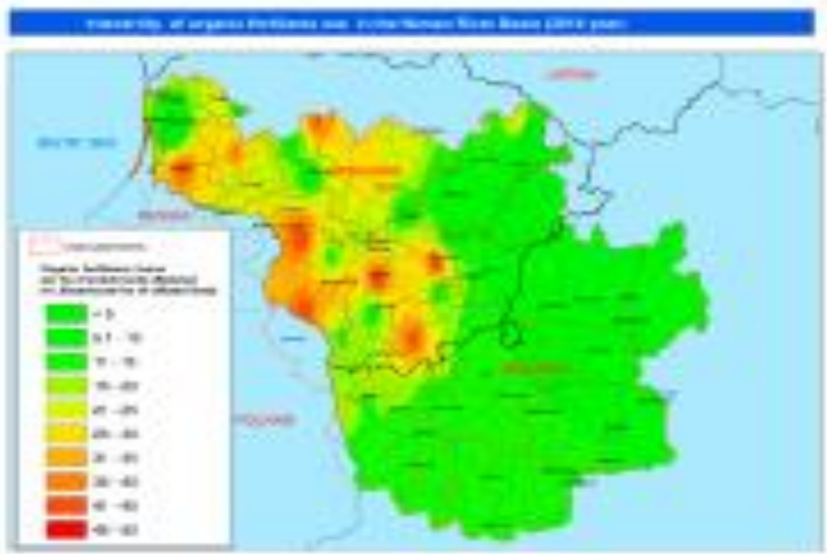
Depleted arable fields, eutropficated sea and climate warming

Näringsfattiga åkrar, övergödda hav och varmare klimat



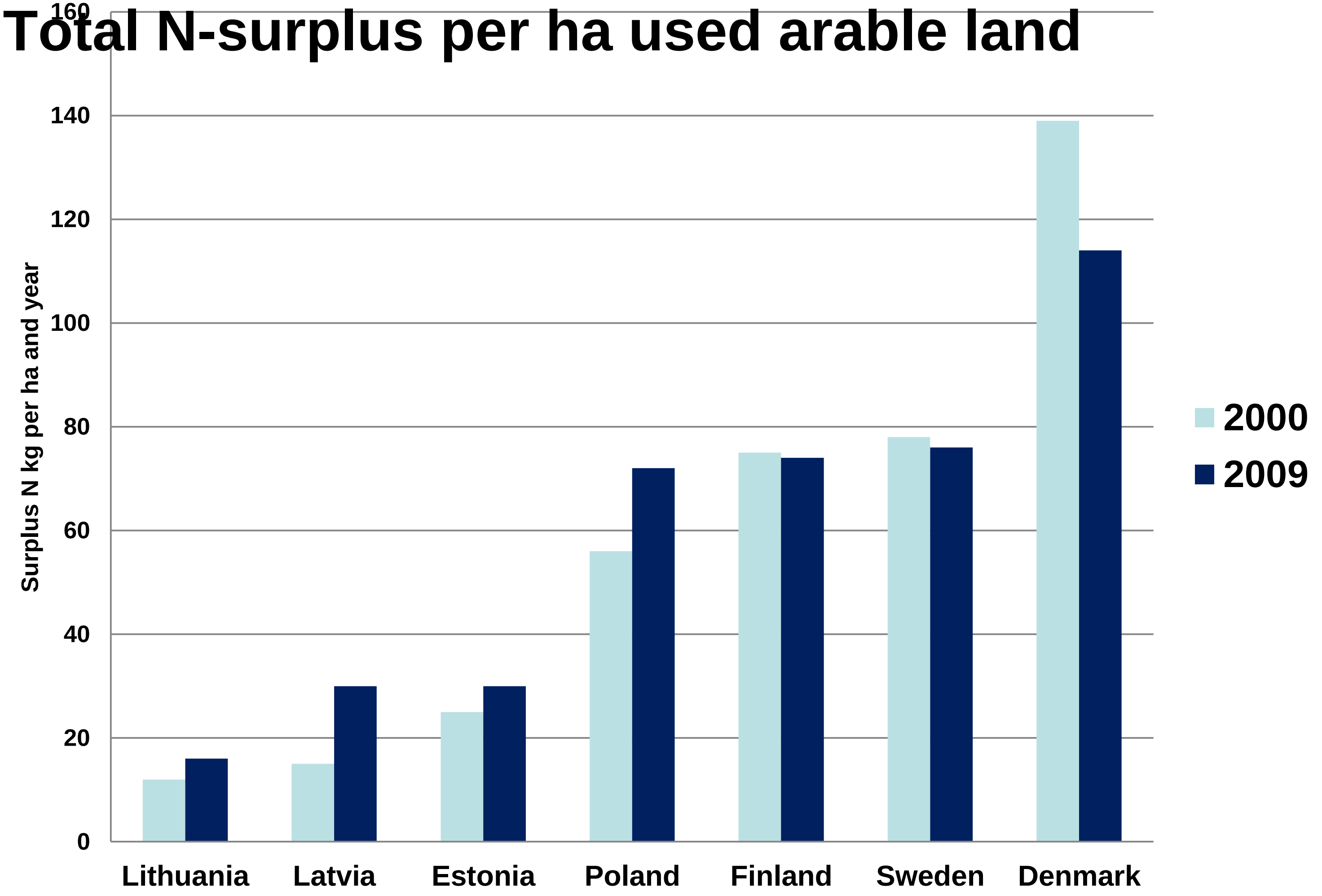


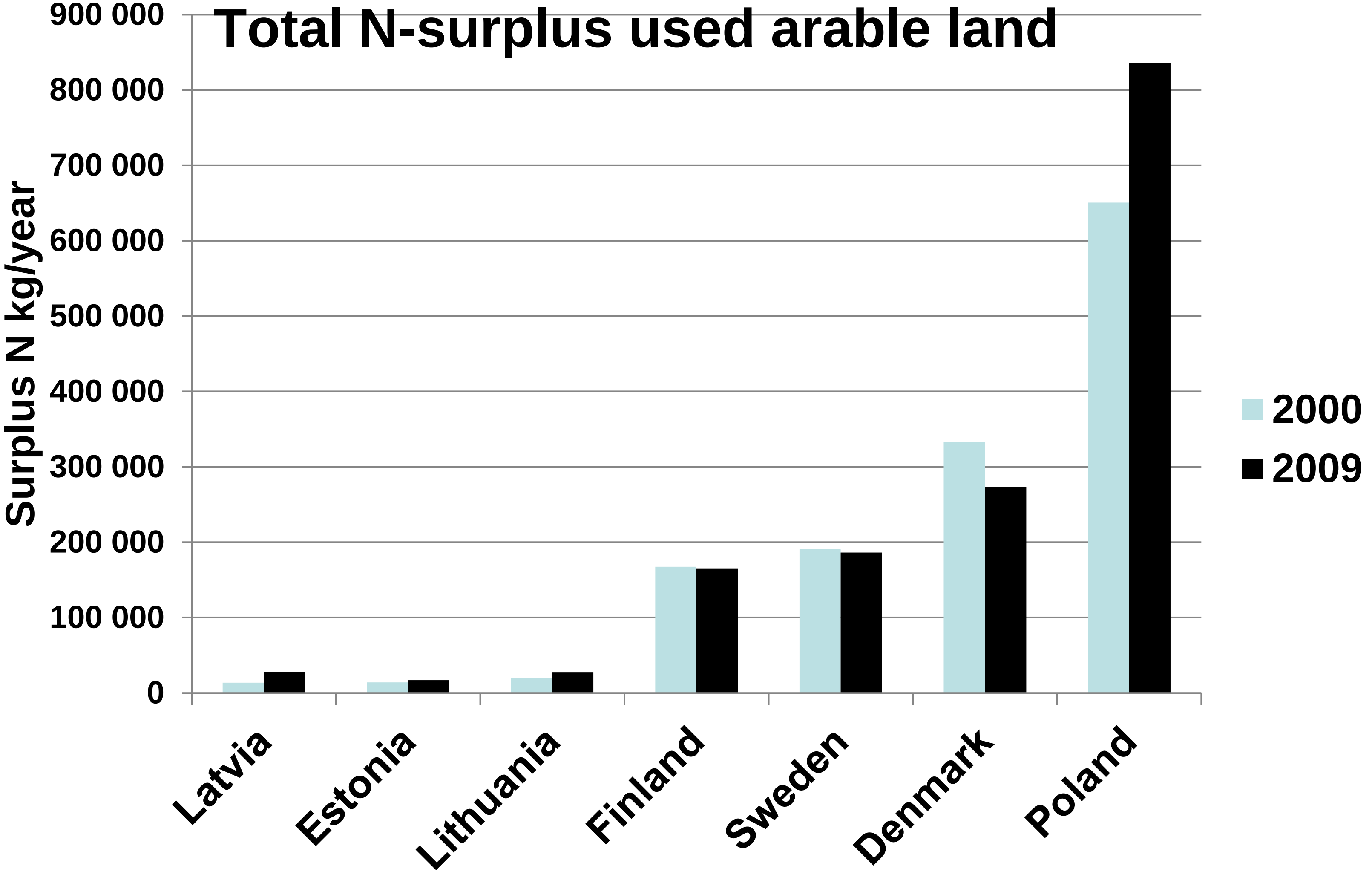




2015-06-04

Total N-surplus per ha used arable land





Total N-surplus used arable land
Surplus N kg/year
900 000
800 000
700 000
600 000
500 000
400 000
300 000
200 000
100 000
0
Latvia
Estonia
Lithuania
Finland
Sweden
Denmark
Poland
2000
2009

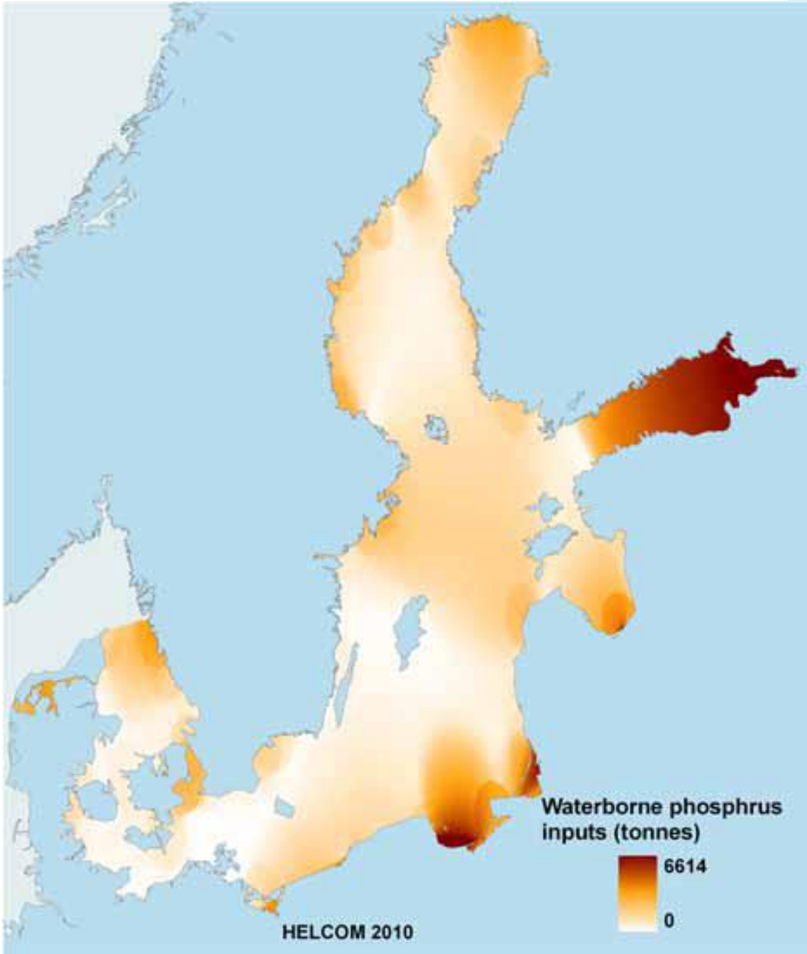
New EU states

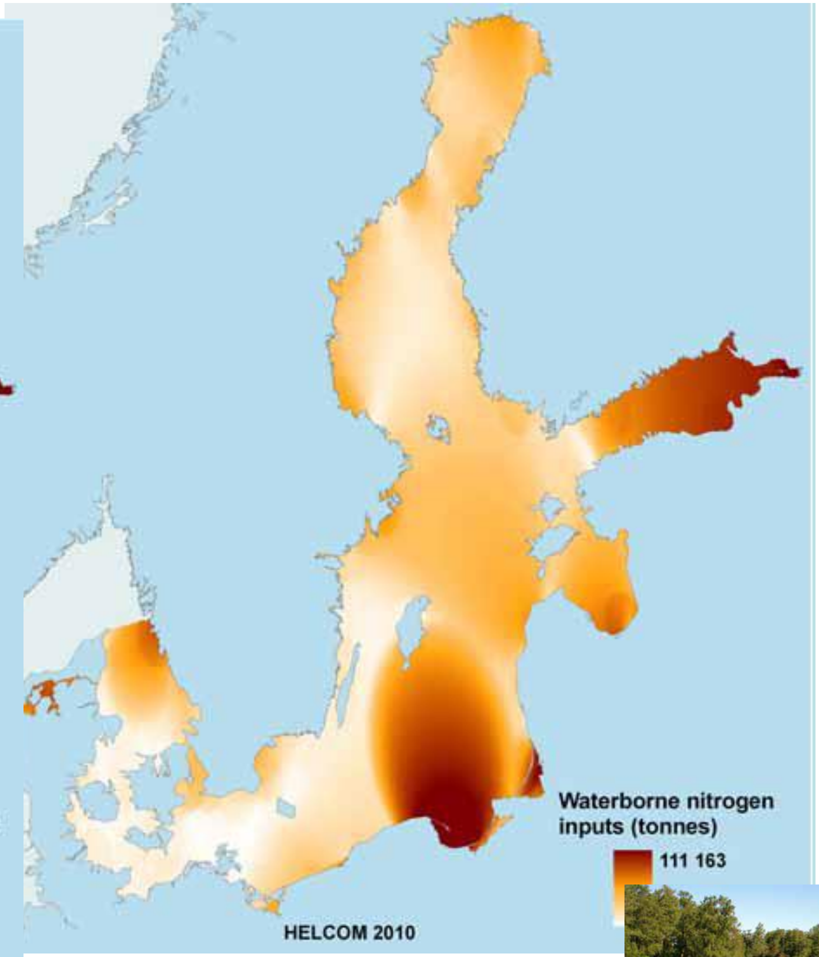
- Partly nutrient extensive agriculture today
- Small-scale diversified farms (Poland)
- Large unused areas (Latvia)

➢ Risk for separation, specialisation and intensification

➢ Higher nutrient leakage

Average annual waterborne inputs of nitrogen and phosphorus from rivers and coastal point sources in 2006. The visualization of the distribution
of the inputs to the sea area is based on a simple linear extrapolation of the inputs (tonnes) (Helcom proc 122 PLC 5 2010

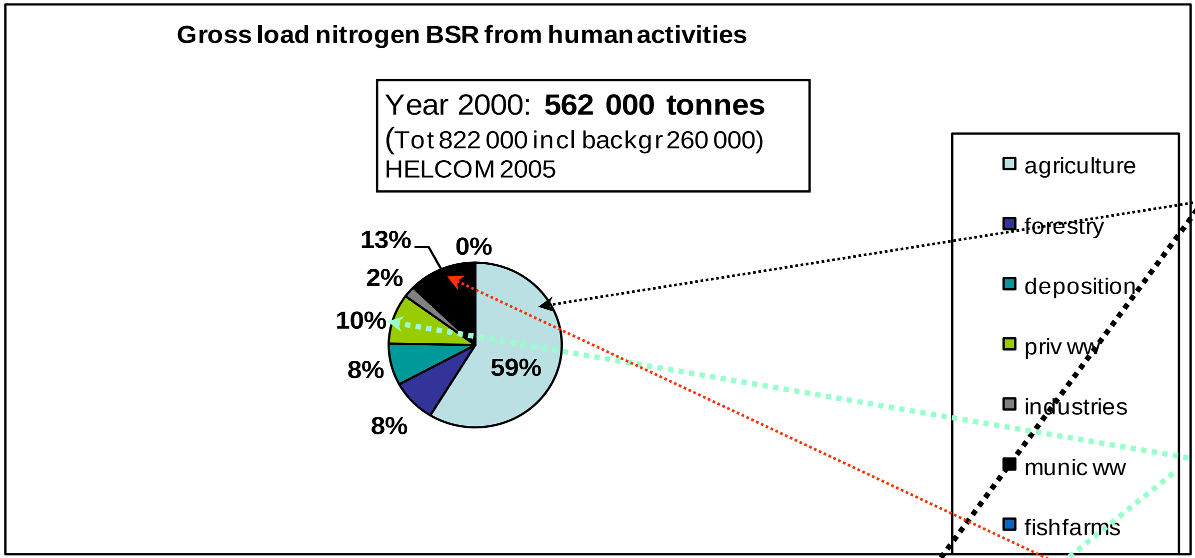




2001-2006

Aver. annual

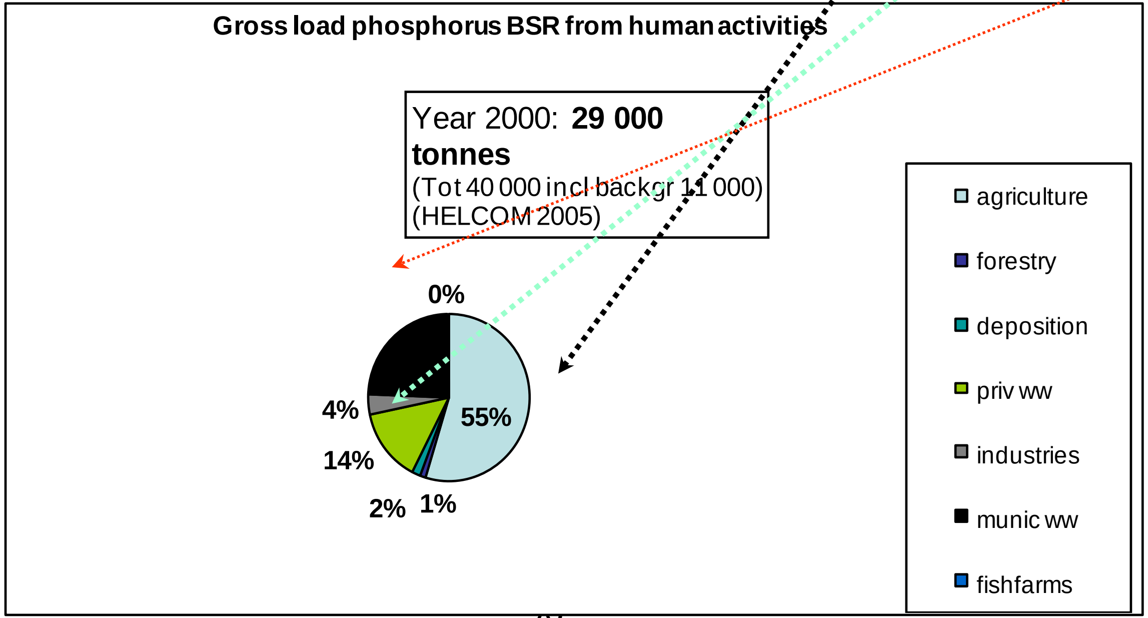
641 000 tonnes



2001-2006

Aver. annual

30 200 tonnes



N%/P%

- **Agricult.**

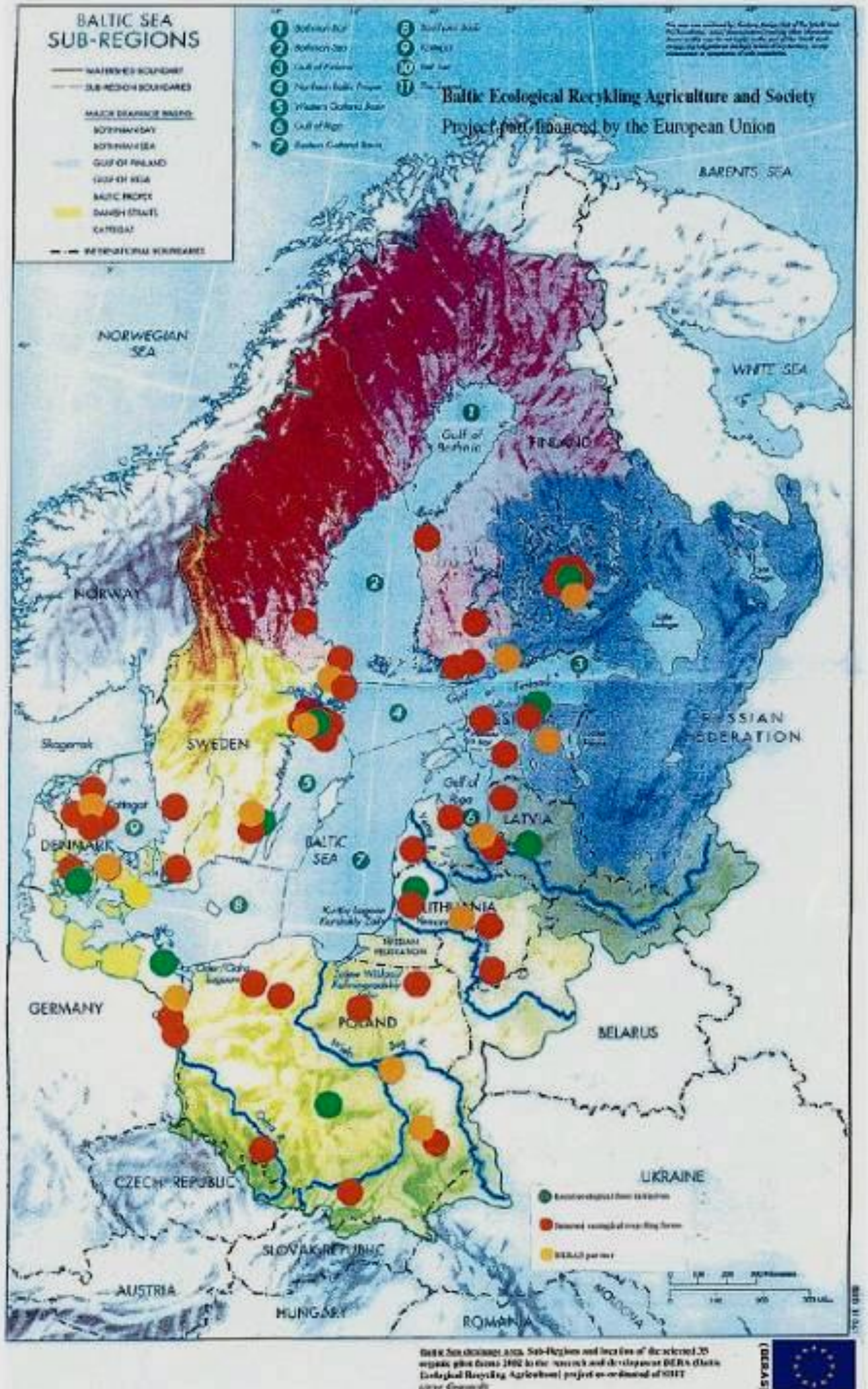
59/55

- **Privat waste**

10/14

- **Municipal waste**

13/24

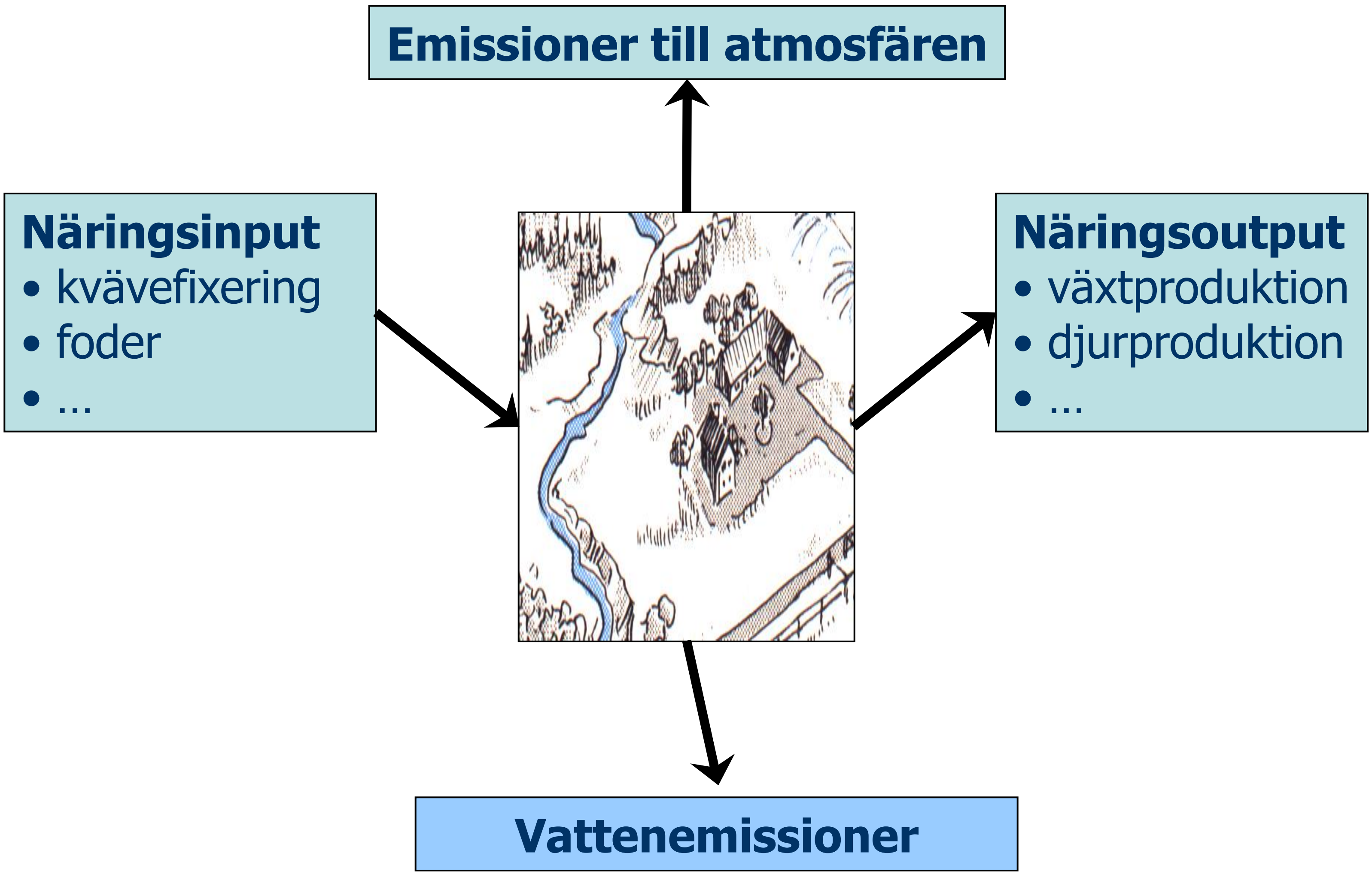


BERAS project 2003- 2006

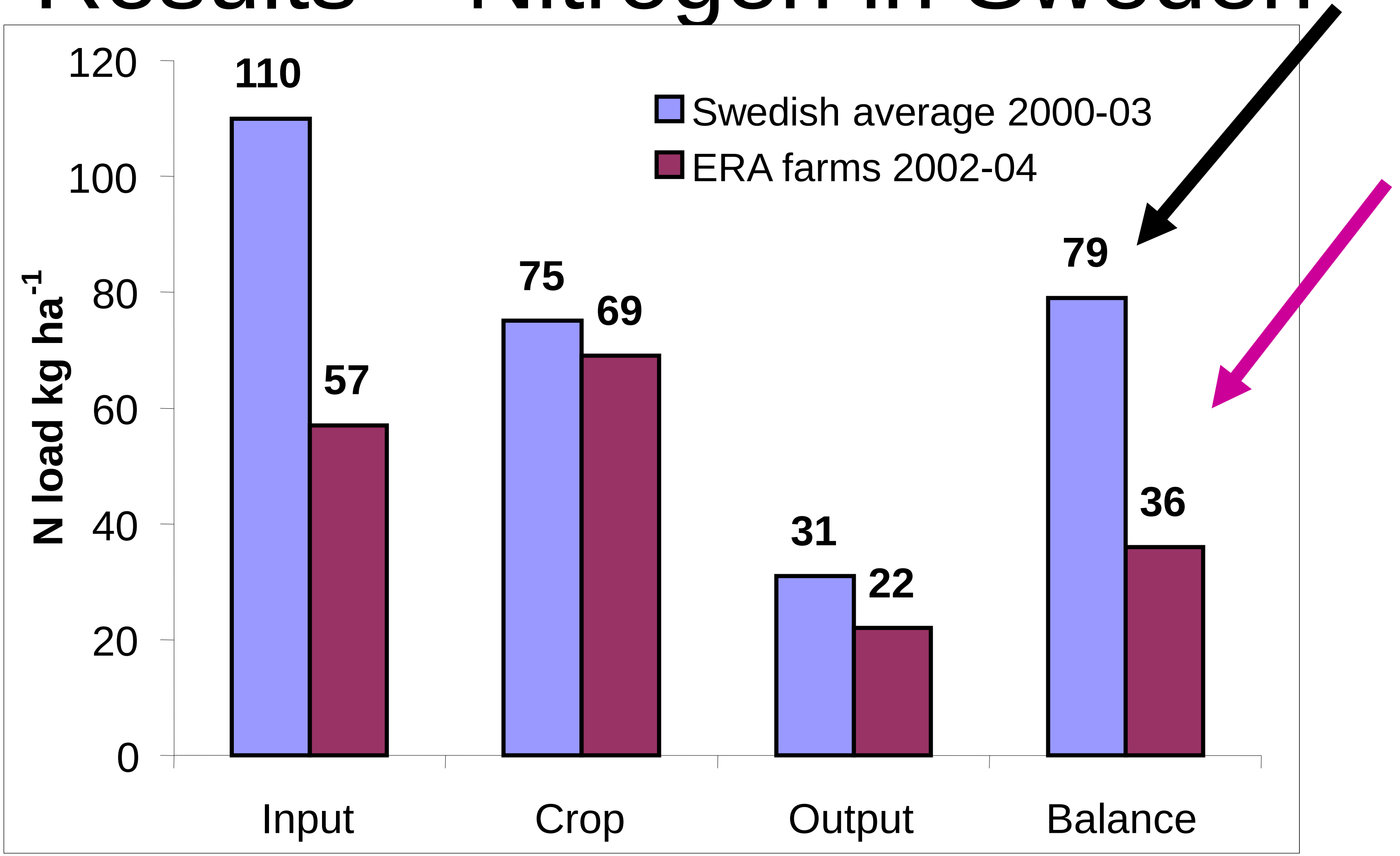
- 20 partners from 8 countries
- Pilot studies on 48 farms
  - Nutrient balances
  - Leakage measurements
  - Energy and global warming potential
  - Consumer surveys

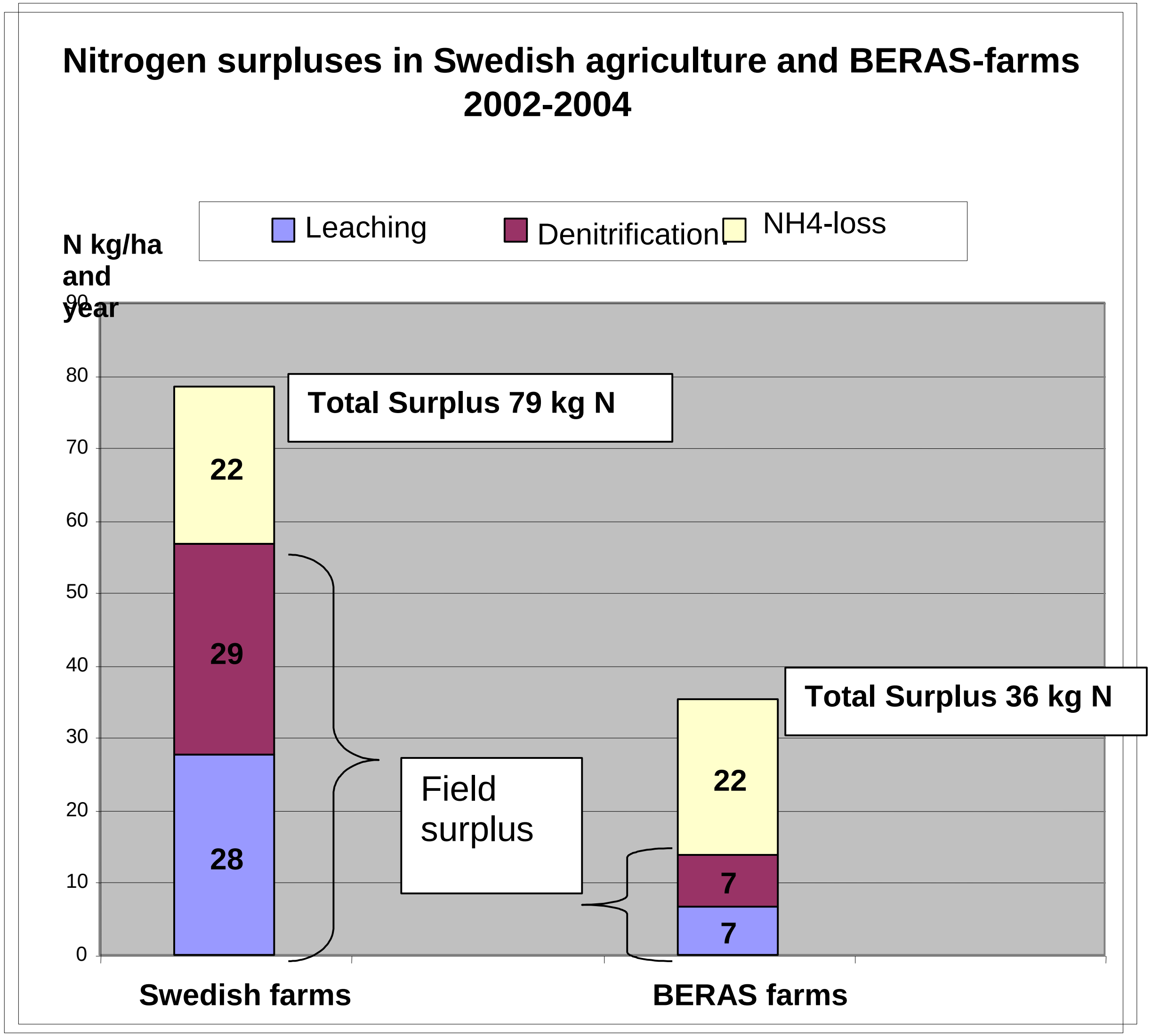
BERAS Implementation 2010 -2012 ????

Näringsbalans på gården

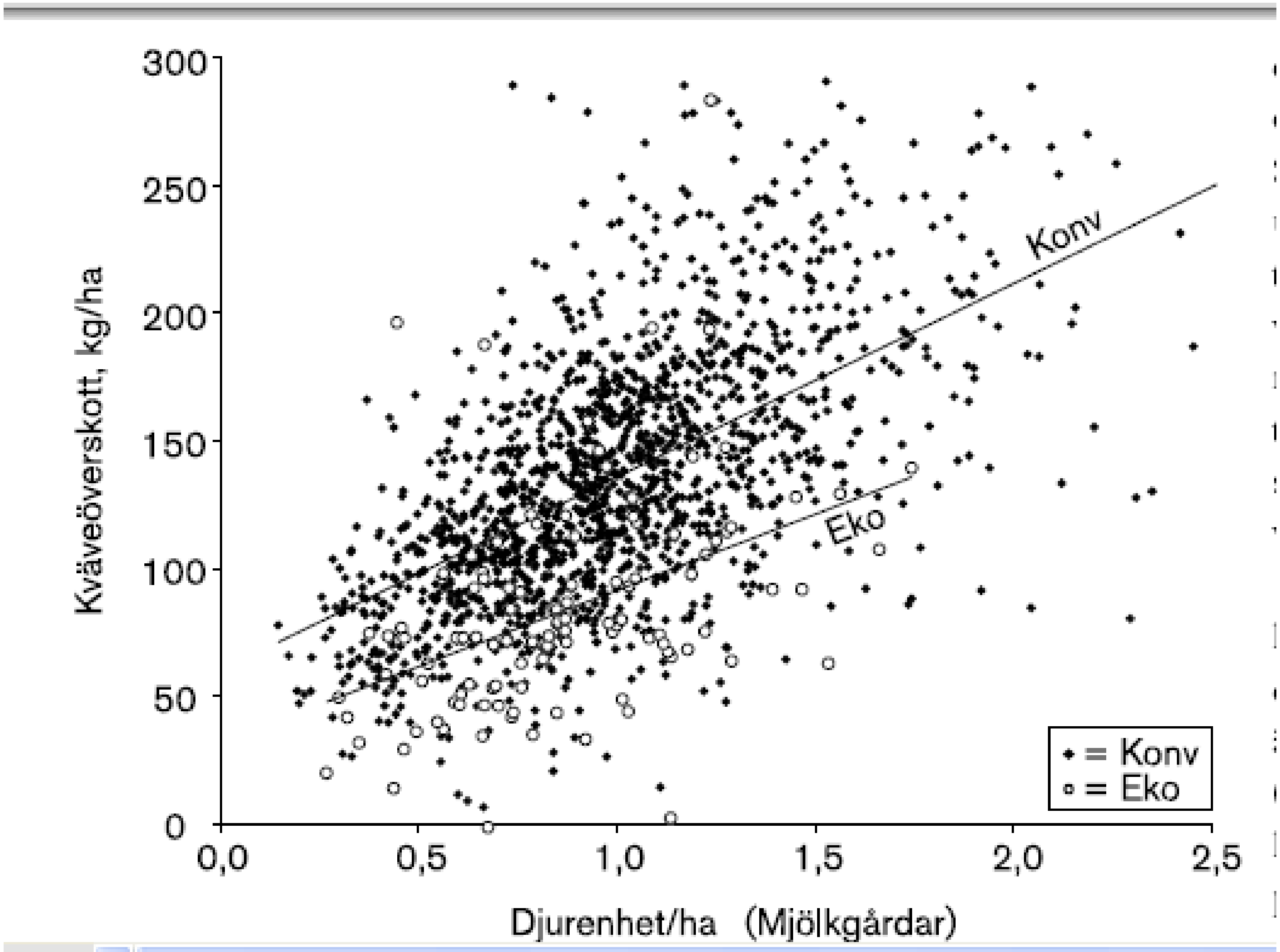


Results – Nitrogen in Sweden





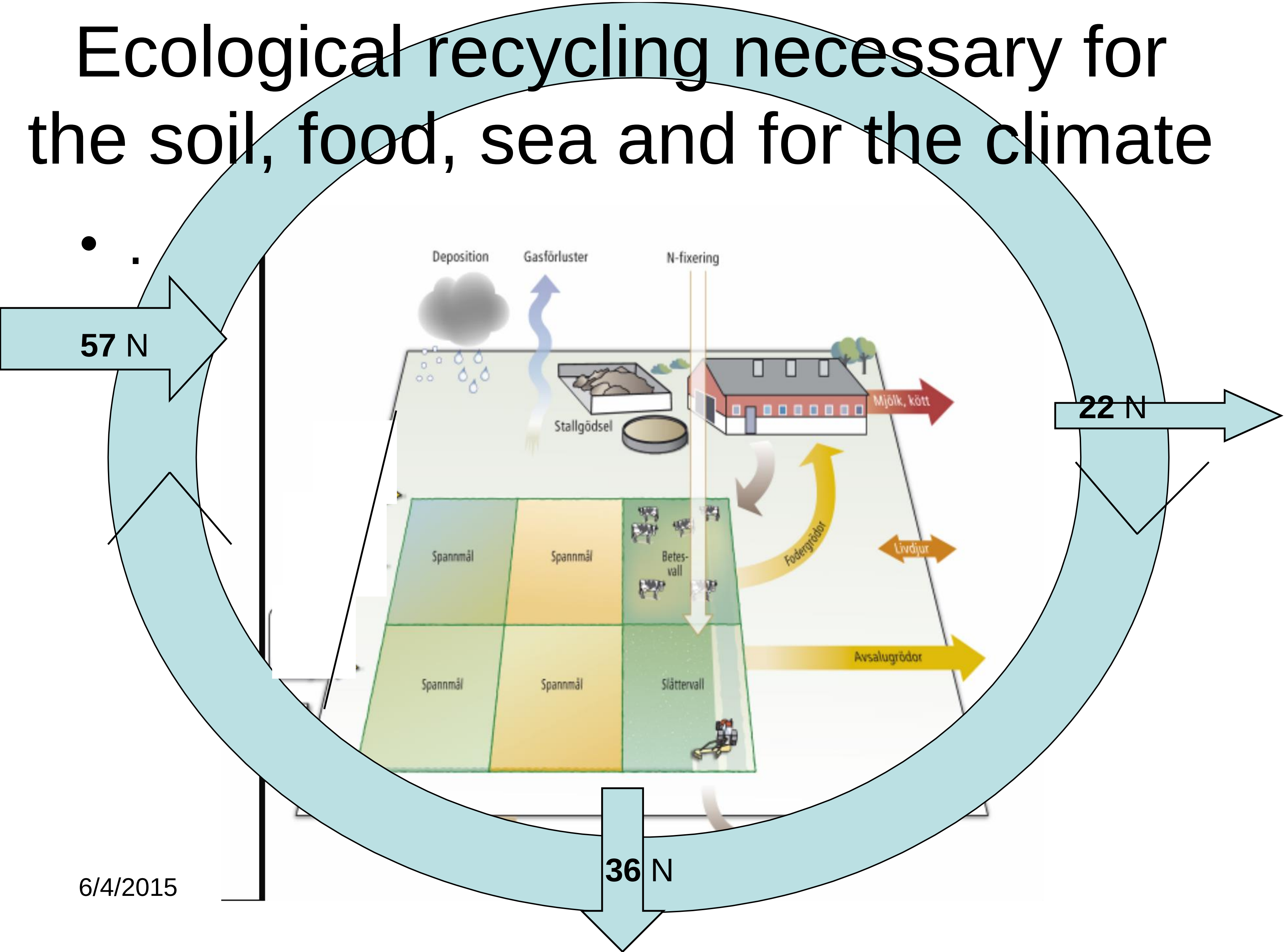
The results indicate 70 – 75 % lower leakage of nitrogen from BERAS-farms compared to the conventional agriculture.



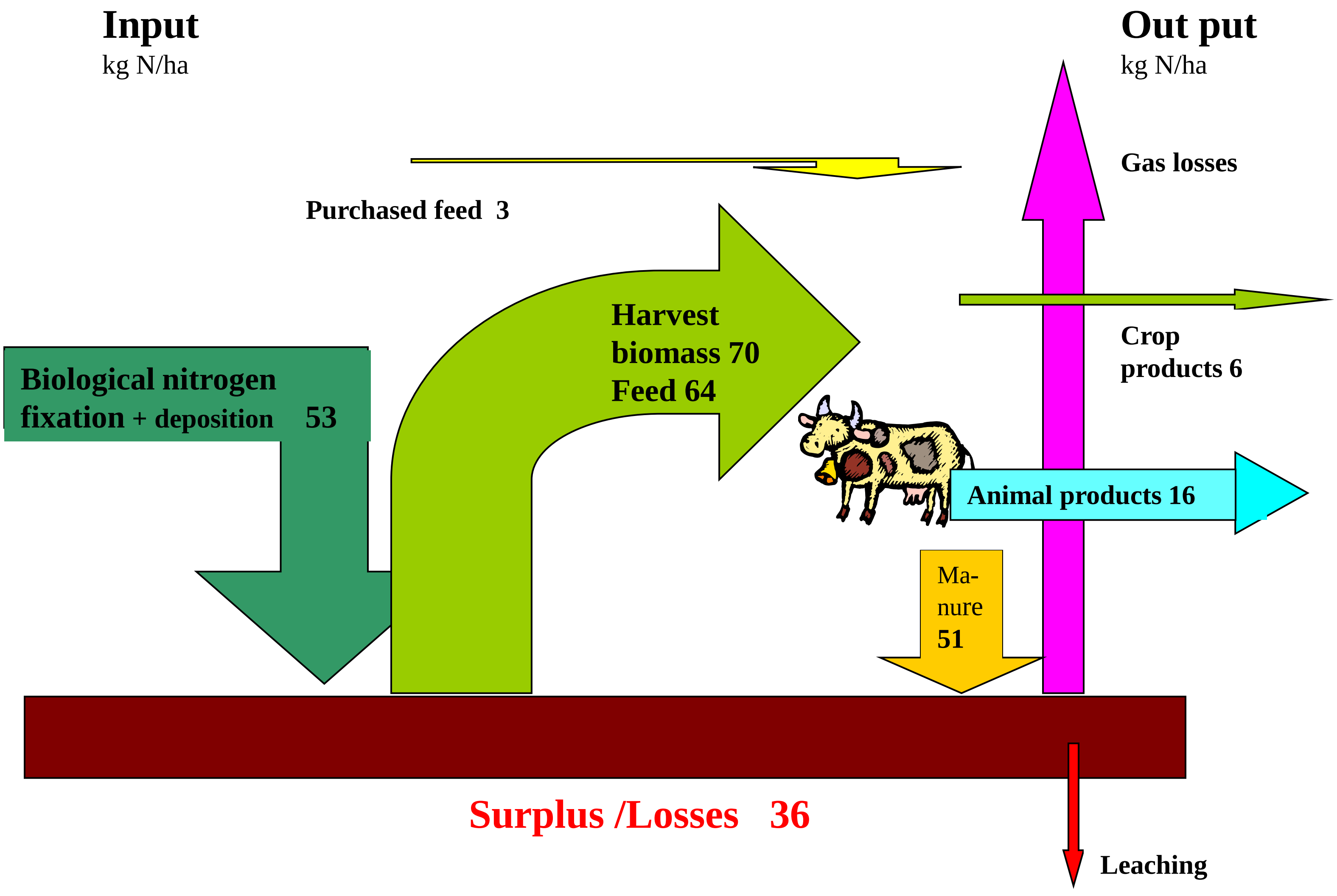
	Antal	N	P	K
Alla gårdar				
Ekologisk prod	107	84	2,3	8,3
Konventionell prod	1517	136	4,0	11,7

Ecological recycling necessary for the soil, food, sea and for the climate

- .

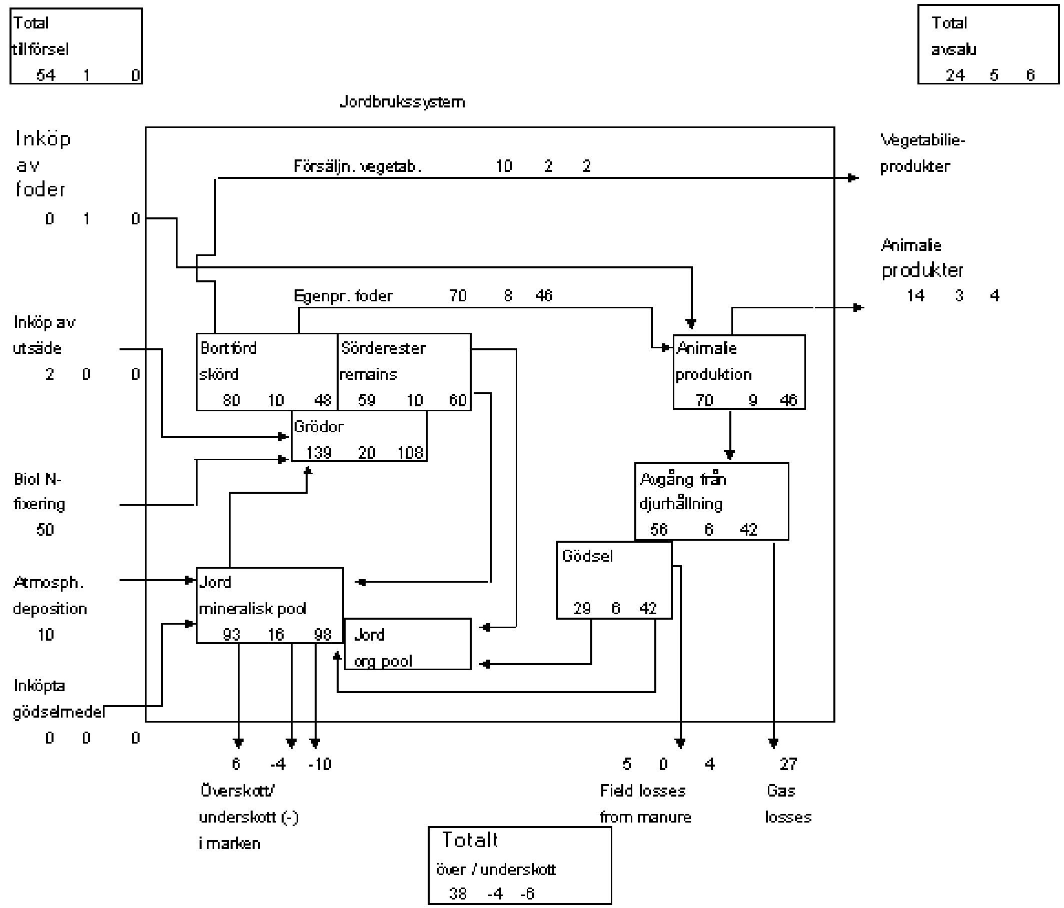


Integration of crop and animal production: Ecological Recycling Agriculture (ERA)



Nitrogen balance kg N/ha and year
Ytterreneby-Skilleby (an ERA-farm) 2002-2003

Flöden av N/P/K kg/ha och år i ekosystemet Skilleby gård



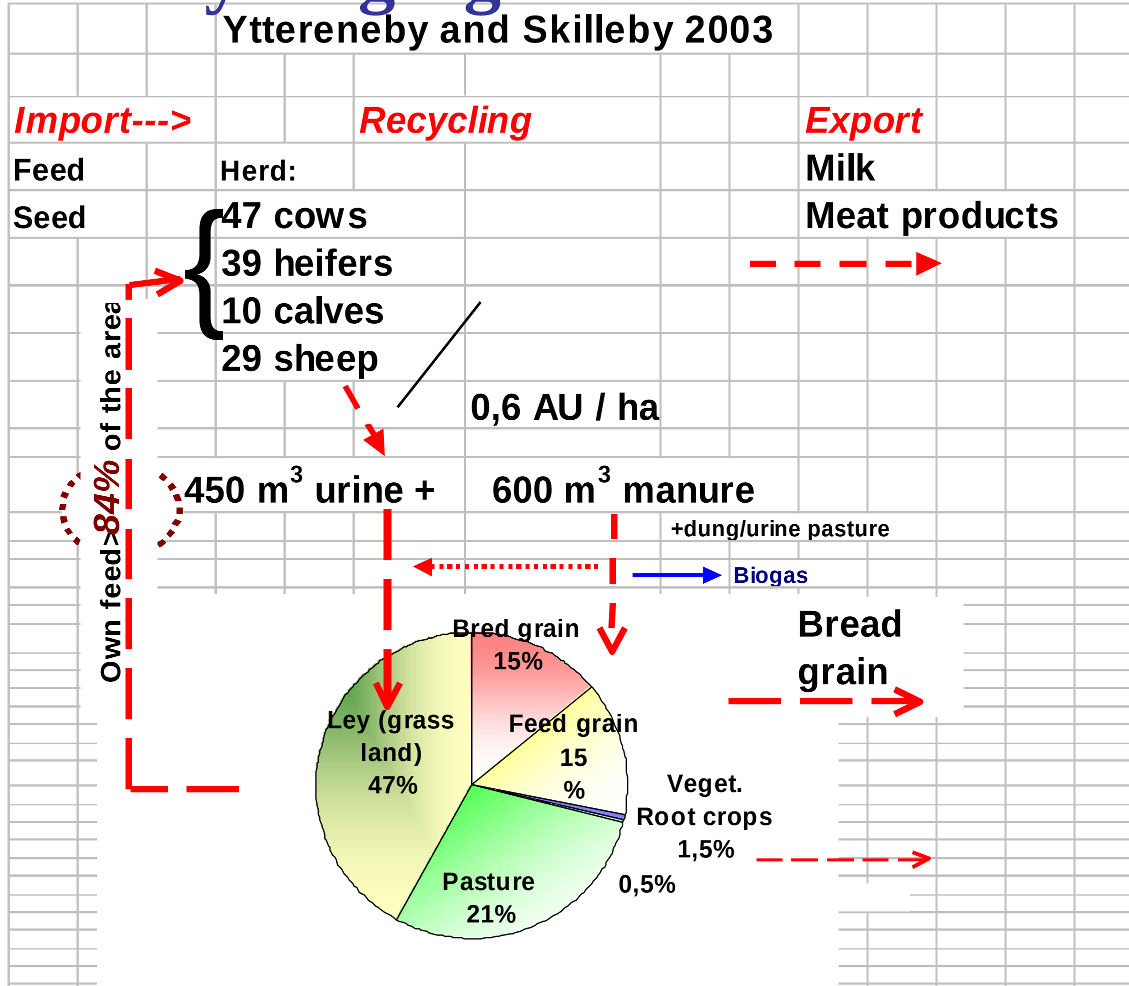
Kalkyl faktorer	N	P	K
Lagringsförl. från stallgödsel	0,5		
Fältförl. från stallgösel och urin	0,2		0,1

Gårdsdata	N	P	K
Inköpt foder		1	
Inköpt utsäde	2	0	0
Biol. N-fixering	50		
Atmosph. dep.	10		
Inköpta gödselmedel	0		
Försålda vegetabilieprod.	10	2	2
Egenproducerat foder	70	8	46
Återförda skörderester	59	10	60
Försålda animalieprod.	14	3	4

Example of Ecological Recycling Agriculture / ERA

The prototype farm Yttereneby – Skilleby in Järna)

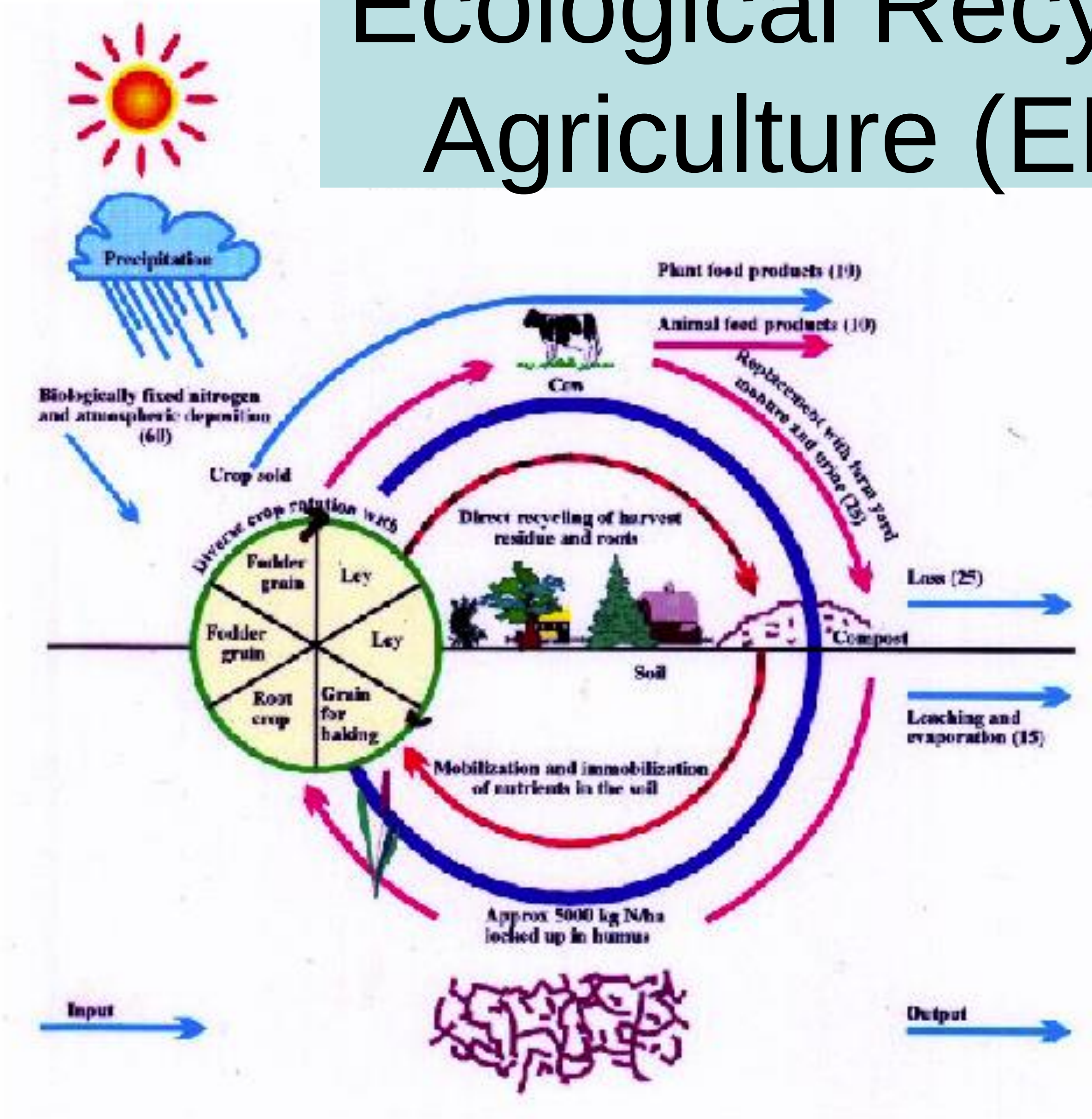
- The animal density is adjusted to the farm's feed production capacity. In this case fodder crops on 84 % and crops for sale on 16 % of the farm area and with a animal density of 0,6 AU/ha (= average for Sweden and European food consumption)



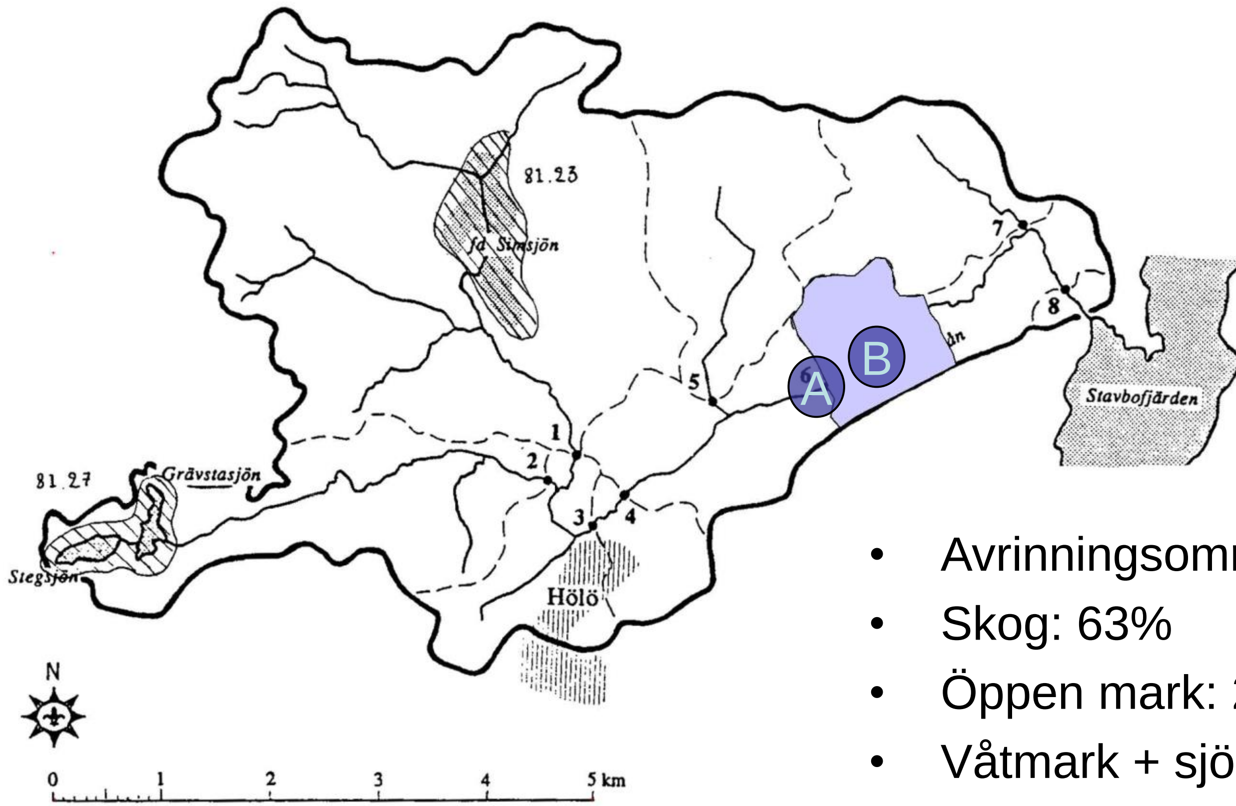
Arable land	ha		Crop rotation	
Crop rotation	106	Year	1	Spring cerals + insowing
Pasture	29		2	Ley I
Vegetable - root croops	2		3	Ley II
			4	Ley III
Total	**137**		5	Winter cerals
Natural pasture	25			

Ecological Recycling Agriculture (ERA)

The possible Solution

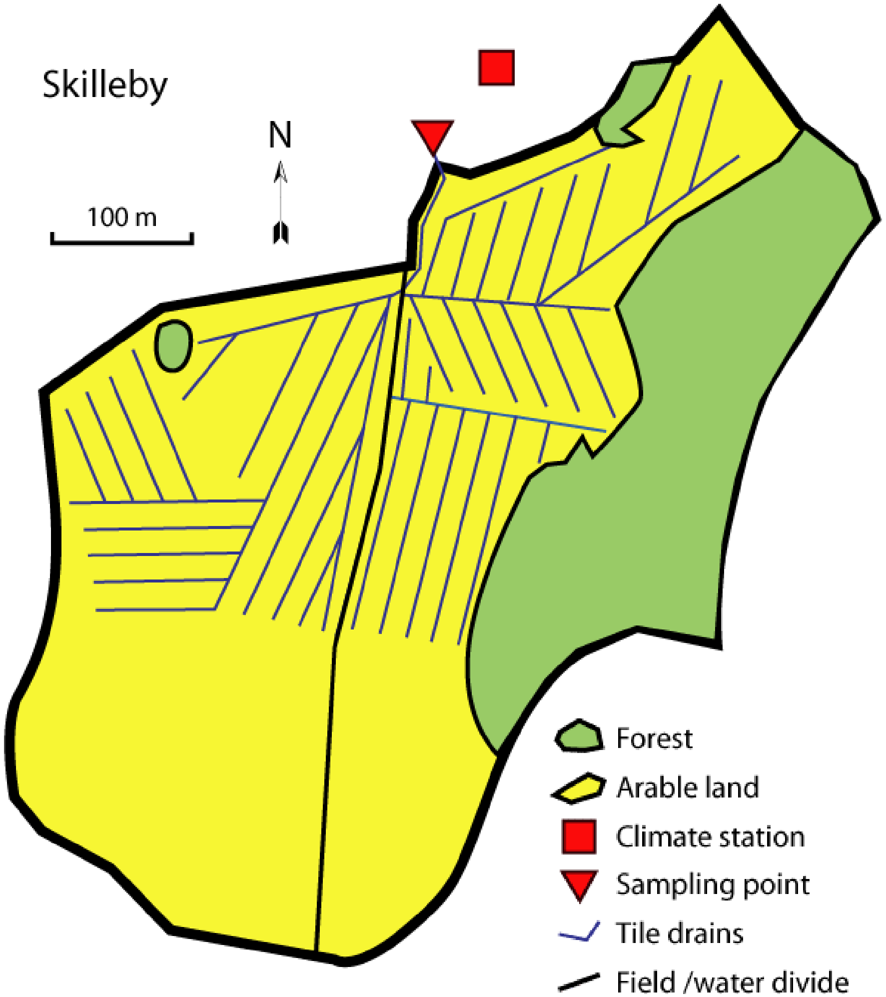


Skillebyåns avrinningsområde



- Avrinningsområde: ~33 km2
- Skog: 63%
- Öppen mark: 25%
- Våtmark + sjöar: 5%
- Djurtäthet: 21 DE/ha
- Hölö reningsverk: 750 PE

Länsstyrelsen 1994:12

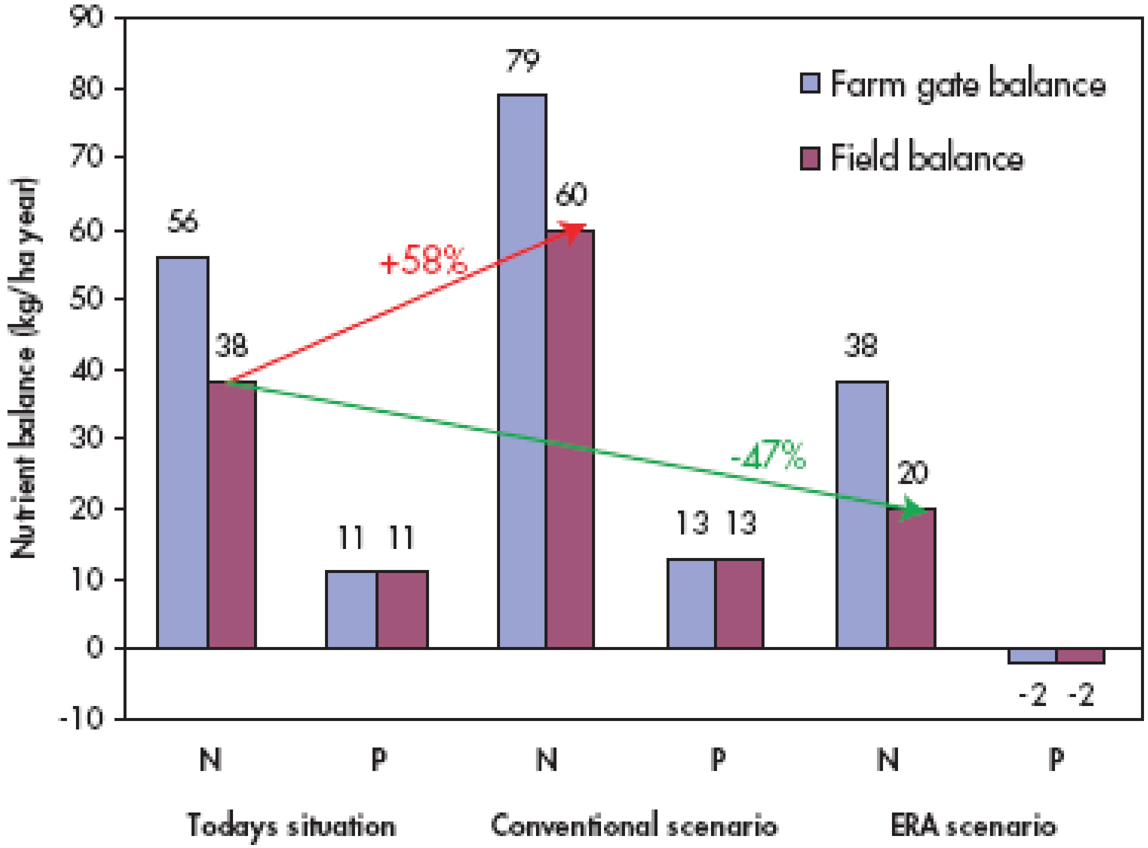


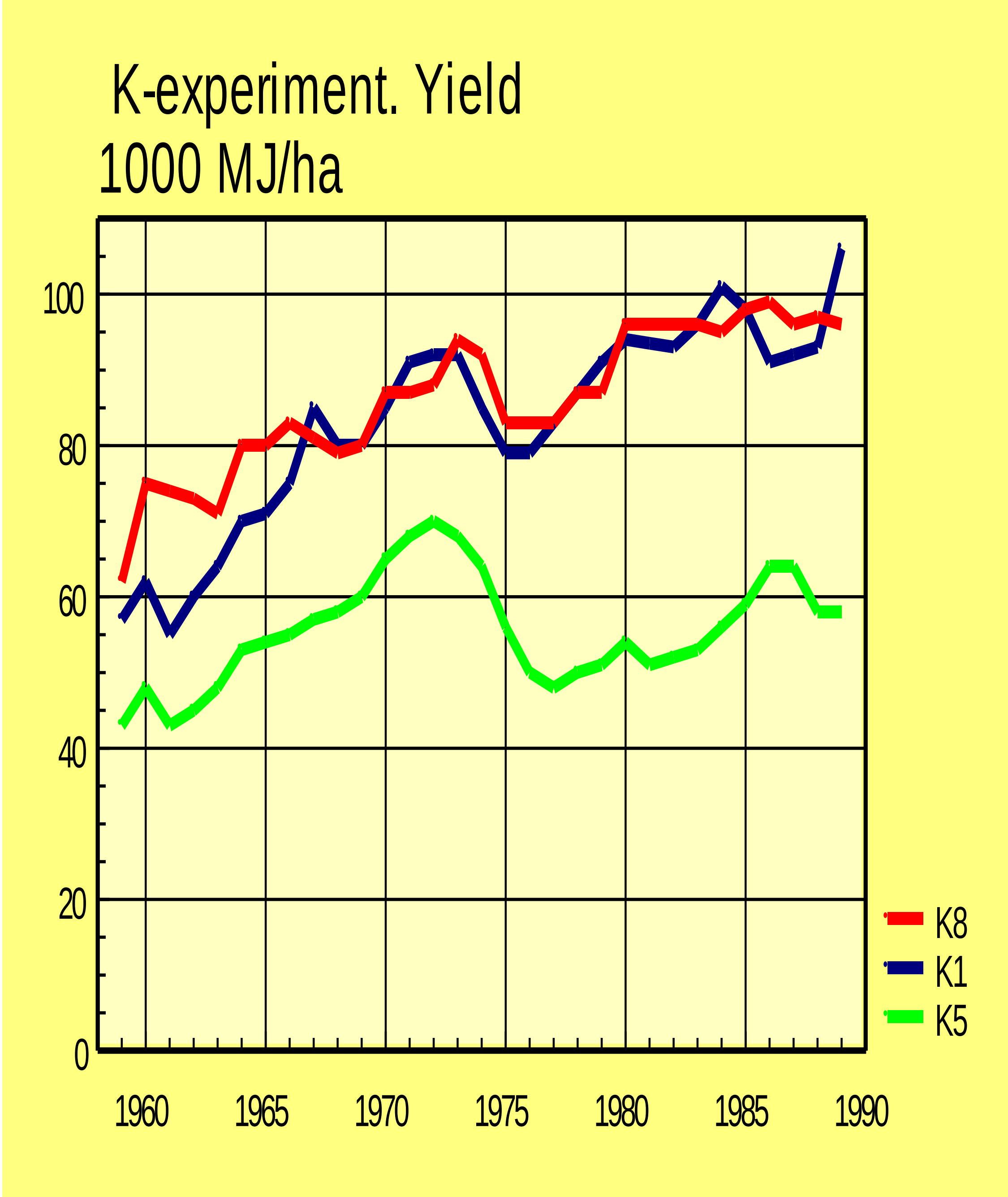
Skilleby

- Avrinningsområde: 22,6 ha
- Djurtäthet: 0,6 DE/ha
- Jordart: lera
- Fem-års-växtföljd:
  - Vall 1
  - Vall 2
  - Vall 3
  - Höstvete
  - Havre
- Skog 22%

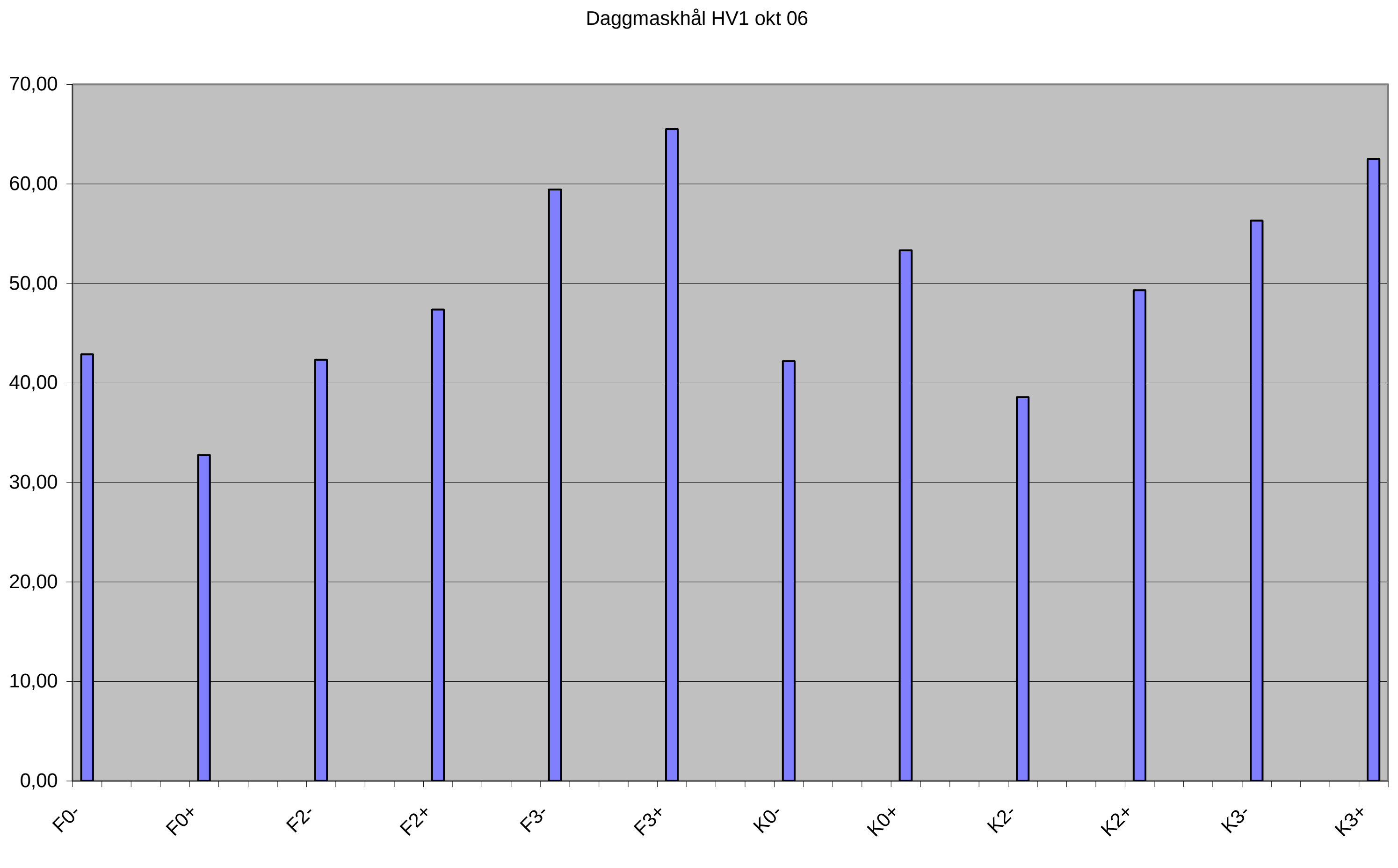
Three scenarios for the EU – countries around the baltic Sea

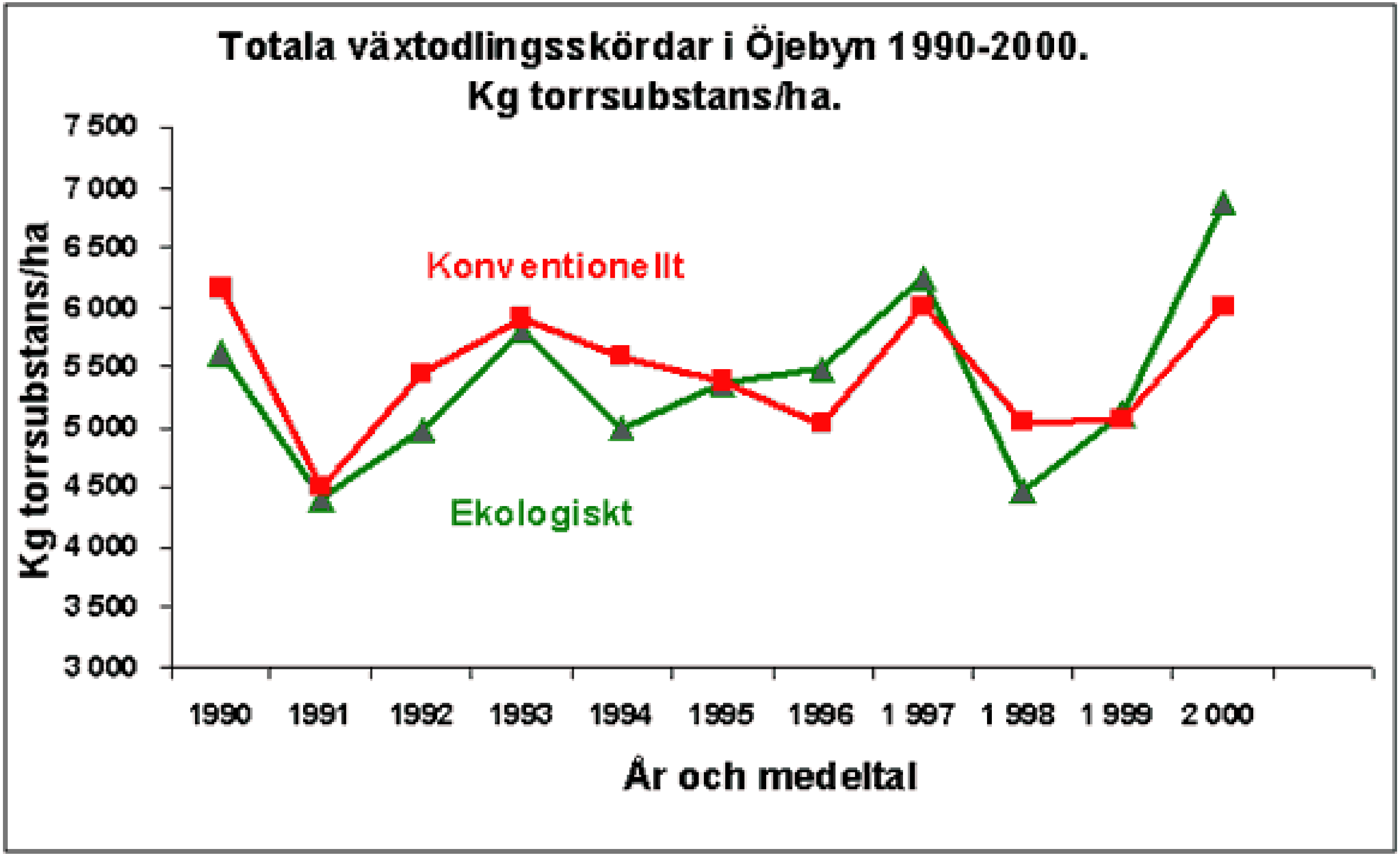
Nitrogen- och phosphurus surplus kg/ha and year



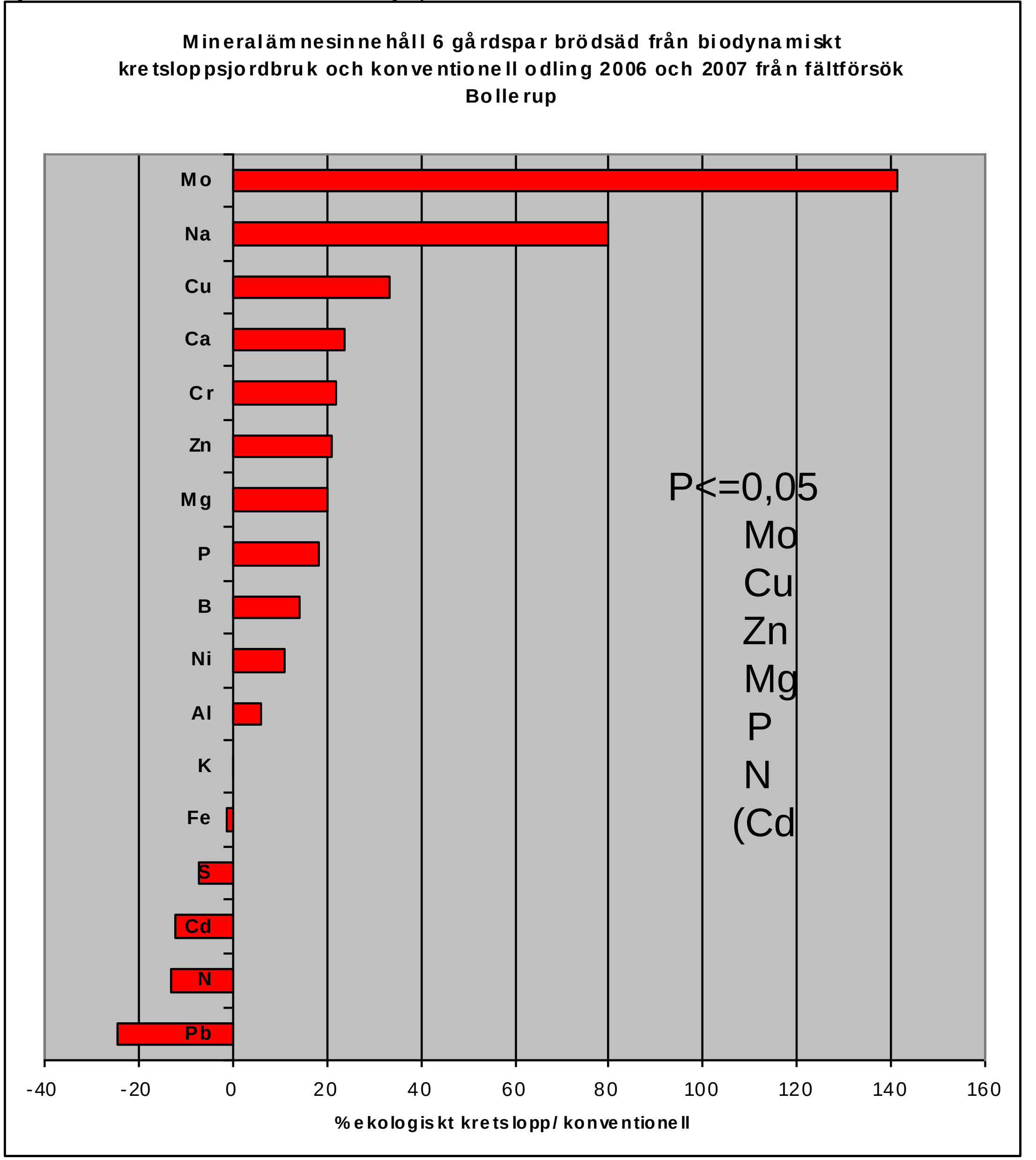

K-experiment. Yield
1000 MJ/ha
100
80
60
40
20
0
1960
1965
1970
1975
1980
1985
1990
K8
K1
K5

Daggmaskhål Skillebyförsöket




Totala växtodlingsskördar i Öjebyn 1990-2000.
Kg torrsubstans/ha.
Kg torrsubstans/ha
7 500
7 000
6 500
6 000
5 500
5 000
4 500
4 000
3 500
3 000
Konventionellt
Ekologiskt
1990
1991
1992
1993
1994
1995
1996
1 997
1 998
1 999
2 000
År och medeltal

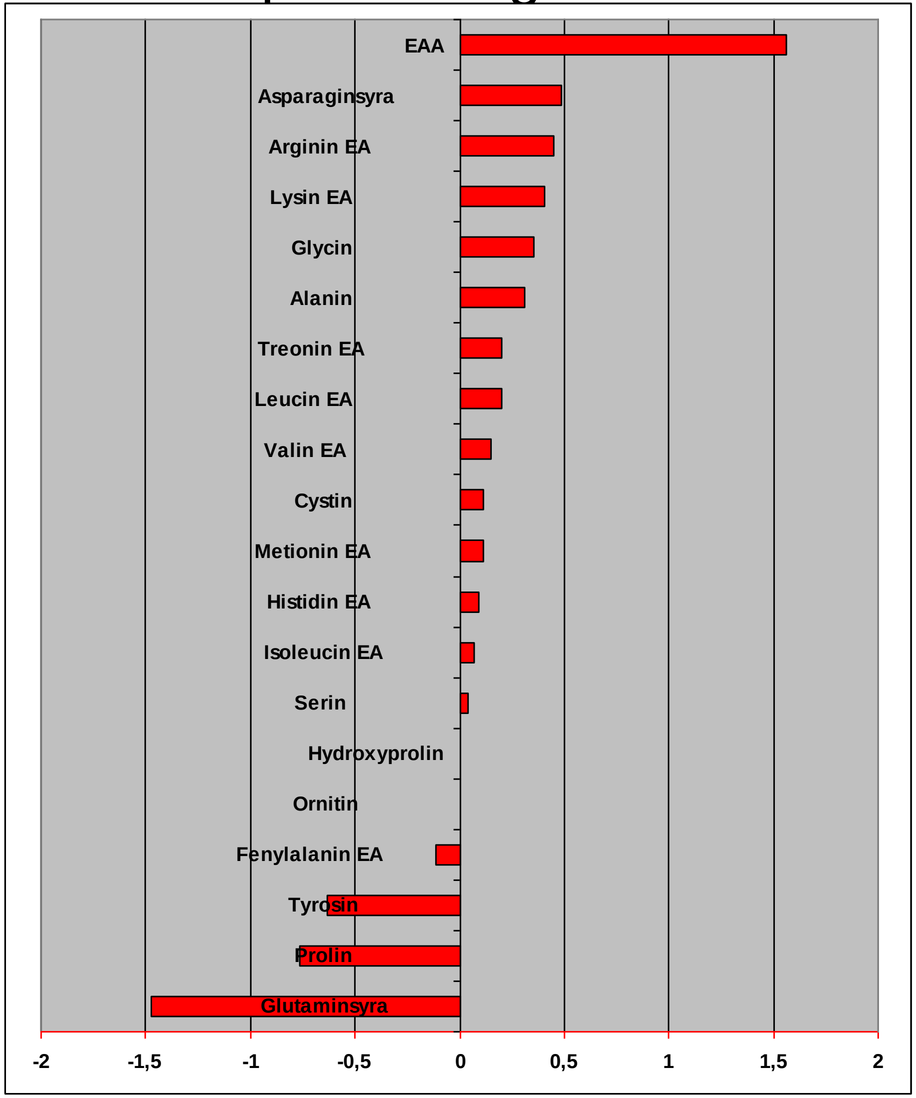
The ratio of the mineral content - biodynamically grown bread grain/conventionally grown bread grain. From a long term field experiment in Bollerup, Skåne Sweden 2006 och 2007



6/4/2015

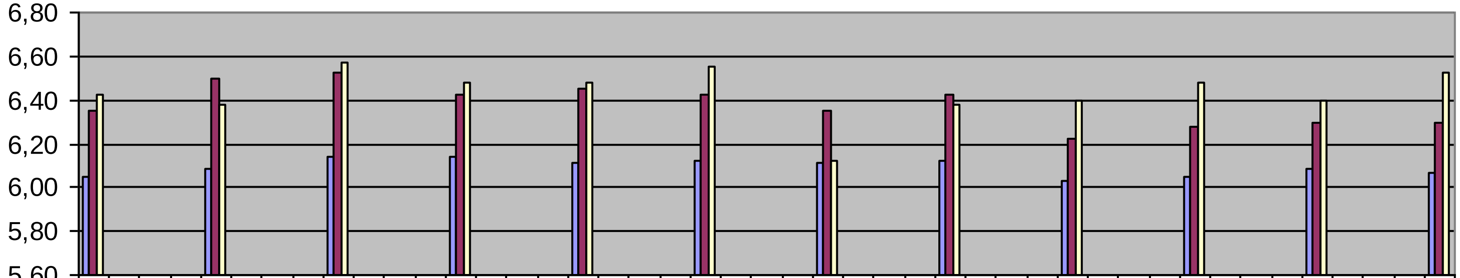
Aminosyror i procent av råprotein Bollerup försöksgård 2006

Protein med högre biologiskt värde



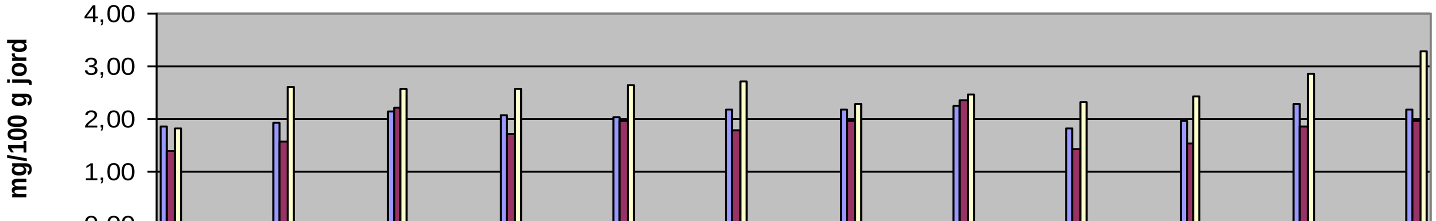
Differens Biodynamisk - Konventionell

pH top soil HV2



	f 0-	f 0+	f 2-	f 2+	f 3-	f 3+	k0-	k0+	k2-	k2+	k3-	k3+
pH-92	6,05	6,09	6,14	6,14	6,11	6,12	6,11	6,12	6,03	6,05	6,09	6,07
pH-95	6,35	6,50	6,53	6,43	6,45	6,43	6,35	6,43	6,23	6,28	6,30	6,30
pH 2007	6,43	6,38	6,58	6,48	6,48	6,55	6,13	6,38	6,40	6,48	6,40	6,53

P-AL top soil HV2



	f0-	f0 +	f2-	f2 +	f3-	f3 +	k0-	k0 +	k2-	k2 +	k3-	k3 +
P-AL 92	1,8	1,9	2,1	2,0	2,0	2,1	2,1	2,2	1,8	1,9	2,3	2,1
P-95	1,4	1,5	2,2	1,7	1,9	1,7	1,9	2,3	1,4	1,5	1,8	1,9
P-AL 2007	1,8	2,6	2,5	2,5	2,6	2,7	2,2	2,4	2,3	2,4	2,8	3,2

- **An ecological recycling agriculture based on integrated crop and animal production with effective recycling of nutrients and organic biomass and crop rotations with legume - grassland can:**
  1. **conserve basic natural resources**
  2. **rebuild fertile soils**
  3. **protect the Sea from N, P and pesticides**
  4. **reduce the global warming**
  5. **Improve the food nutritional quality**

Referenser:

Bai ZG, Dent DL, Olsson L and Schaepman ME 2008. Global assessment of land degradation and improvement 1: identification by remote sensing. Report 2008/01, FAO/ISRIC – Rome/Wageningen (http://www.fao.org/newsroom/

Granstedt, A. 1992. Case studies on the flow and supply of nitrogen in alternative farming in Sweden. Biological Agriculture and Horticulture, vol. 9, 15–63.

Granstedt, A. 1992. The potential for Swedish farms to eliminate the use of artificial fertilizers. American Journal of Alternative Agriculture, vol. 6, no. 3, 122–131. Washington University

Granstedt, A., L-Baeckström, G. 2000. Studies of the preceding crop effect of leys in ecological agriculture**.** American Journal of Alternative Agriculture, vol. 15, no. 2, 68–78. Washington University.

Granstedt, A. 2000. Increasing the efficiency of plant nutrient recycling within the agricultural system as a way of reducing the load to the environment – experience from Sweden and Finland. Agriculture, Ecosystems & Environment 1570 (2000) 1–17. Elsevier Science B.V. Amsterdam.

Granstedt, A. & Kjellenberg, L. 2008. Organic and biodynamic cultvation – a possible way of increasing humus capital, improving soil fertility and be a significant carbon sink in Nordic conditions. *Accepted* for oral presentation at the Second Scientific ISOFAR Conference in Modena 18-20 June 2008.

Granstedt, A., Seuri, P & Thomsson, O. 2008. Ecological Recycling Agriculture to Reduce Nutrient Pollution to the Baltic Sea. Journal Biological Agriculture and Horticulture, *Accepted October 2008.*

Kjellenberg, L. & Granstedt, A. 2005. The K-trial. A 33-years study of the connections between manuring, soils and crops. Biodynamic Research Institute, Järna, Sweden. (http://www.jdb.se/sbfi/publ/k-trial.pdf)

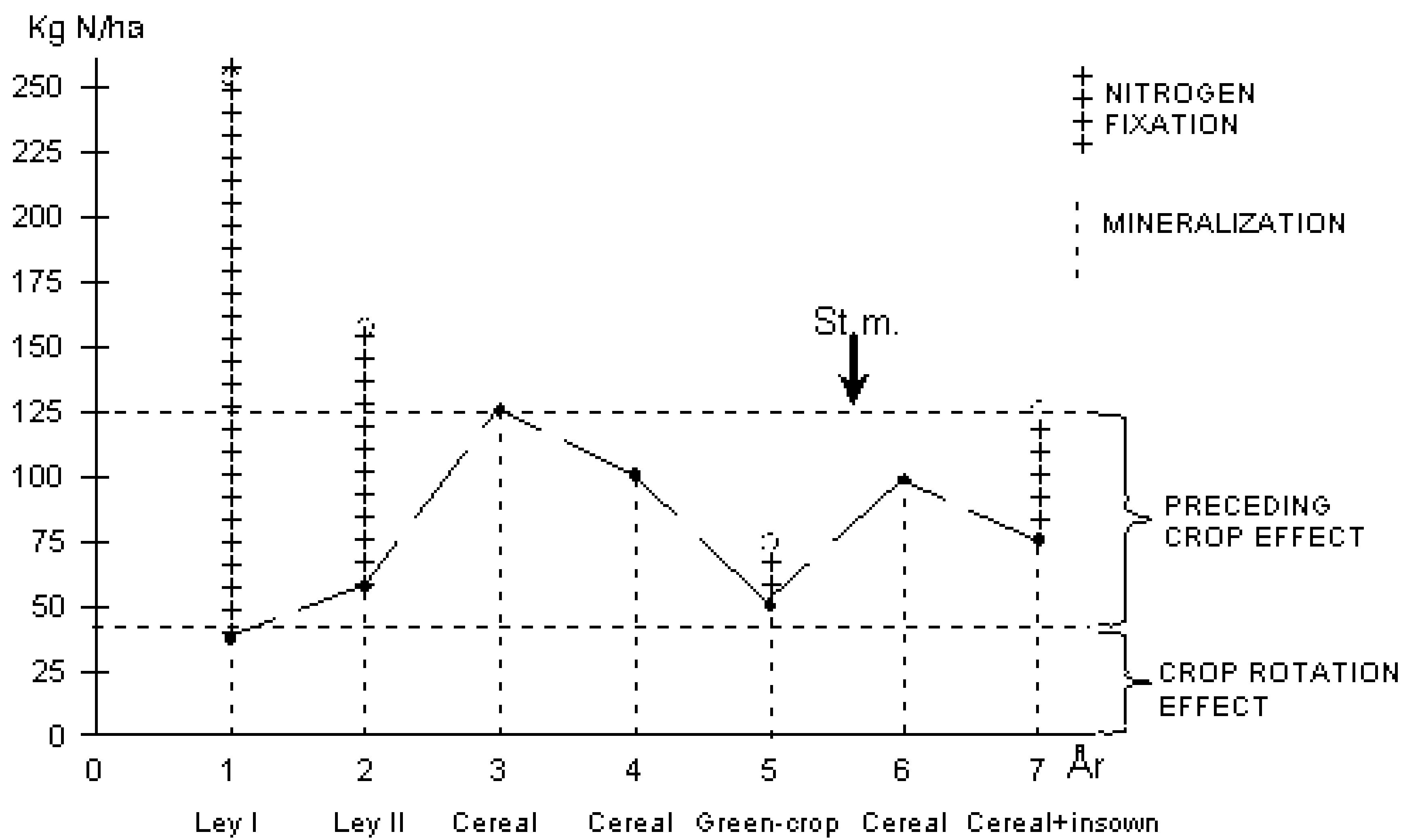
.

Mäder, P., Fliessbach, A.,Dubois D., Gunst L., Fried P. & Niggli, U. 2002. Soil Fertility and Biodiversity in Organic.

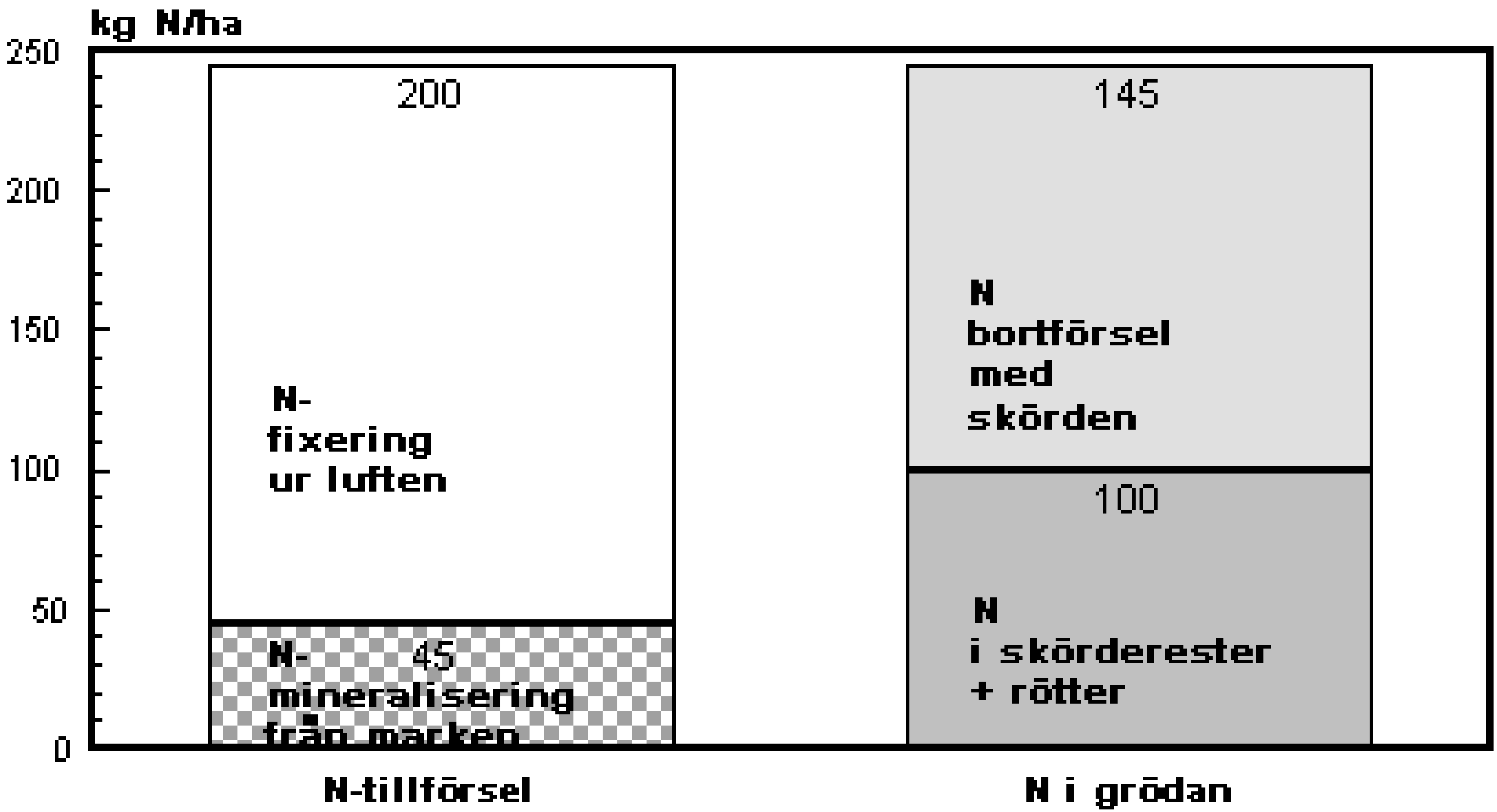
Farming. Science VOL 296 pp 1592-1597.

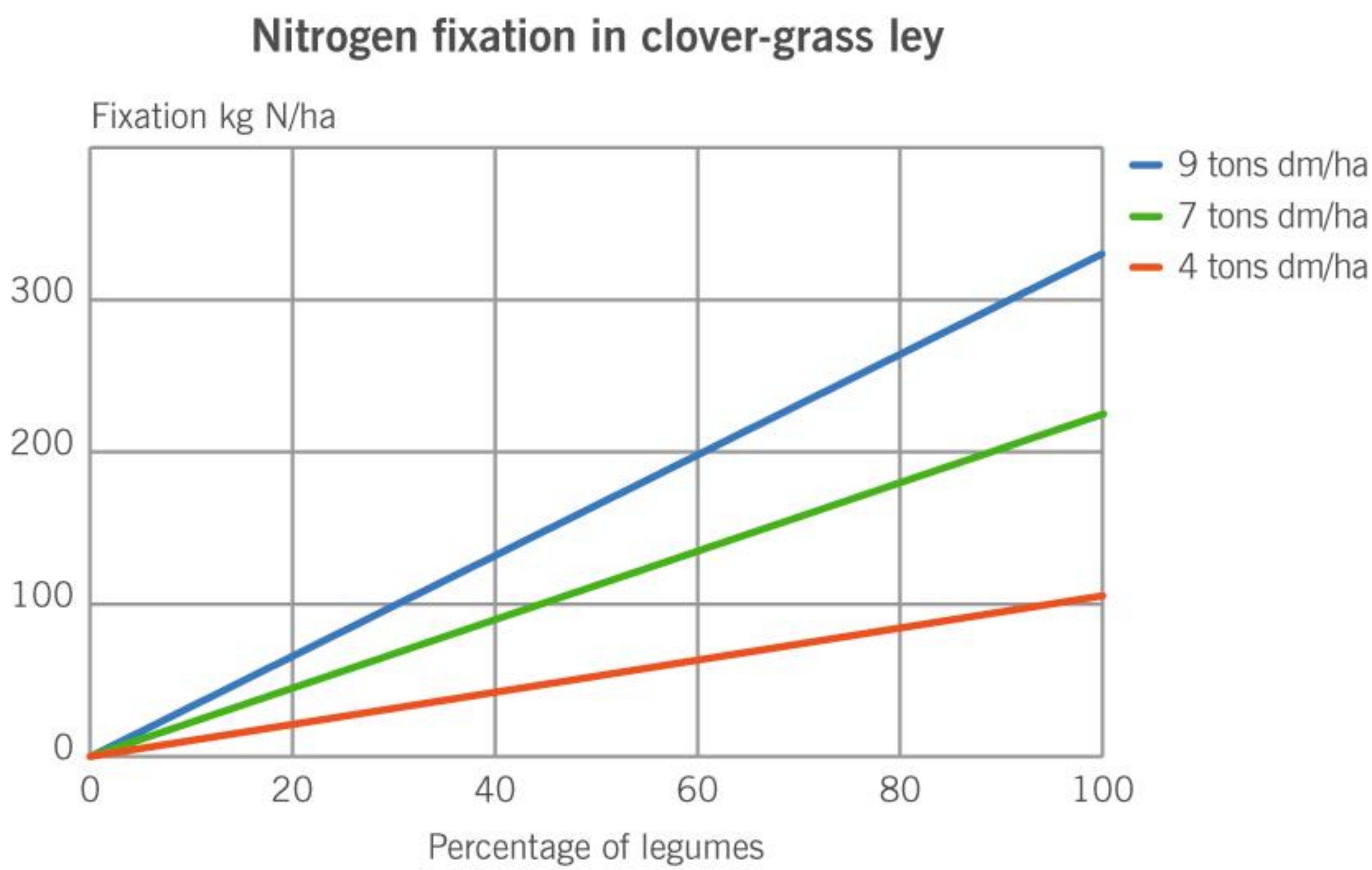
Extra för diskussion
Vallens förfruktsvärde i ekologisk odling

Granstedt, A., L-Baeckström, G. 2000. Studies of the preceding crop effect of leys in ecological agriculture**.** American Journal of Alternative Agriculture, vol. 15, no. 2, 68–78. Washington University.


Kg N/ha
250
225
200
175
150
125
100
75
50
25
0
NITROGEN
FIXATION
MINERALIZATION
St.m.
PRECEDING
CROP EFFECT
CROP ROTATION
EFFECT
0
1
2
3
4
5
6
7
År
Ley I
Ley II
Cereal
Cereal
Green-crop
Cereal
Cereal+insown




kg N/ha
250
200
150
100
50
0
200
N-
fixering
ur luften
N-
45
mineralisering
från marken
145
N
bortförsel
med
skörden
100
N
i skörderester
+ rötter
N-tillförsel
N i grödan


Nitrogen fixation in clover-grass ley
Fixation kg N/ha
9 tons dm/ha
7 tons dm/ha
4 tons dm/ha
300
200
100
0
0
20
40
60
80
100
Percentage of legumes

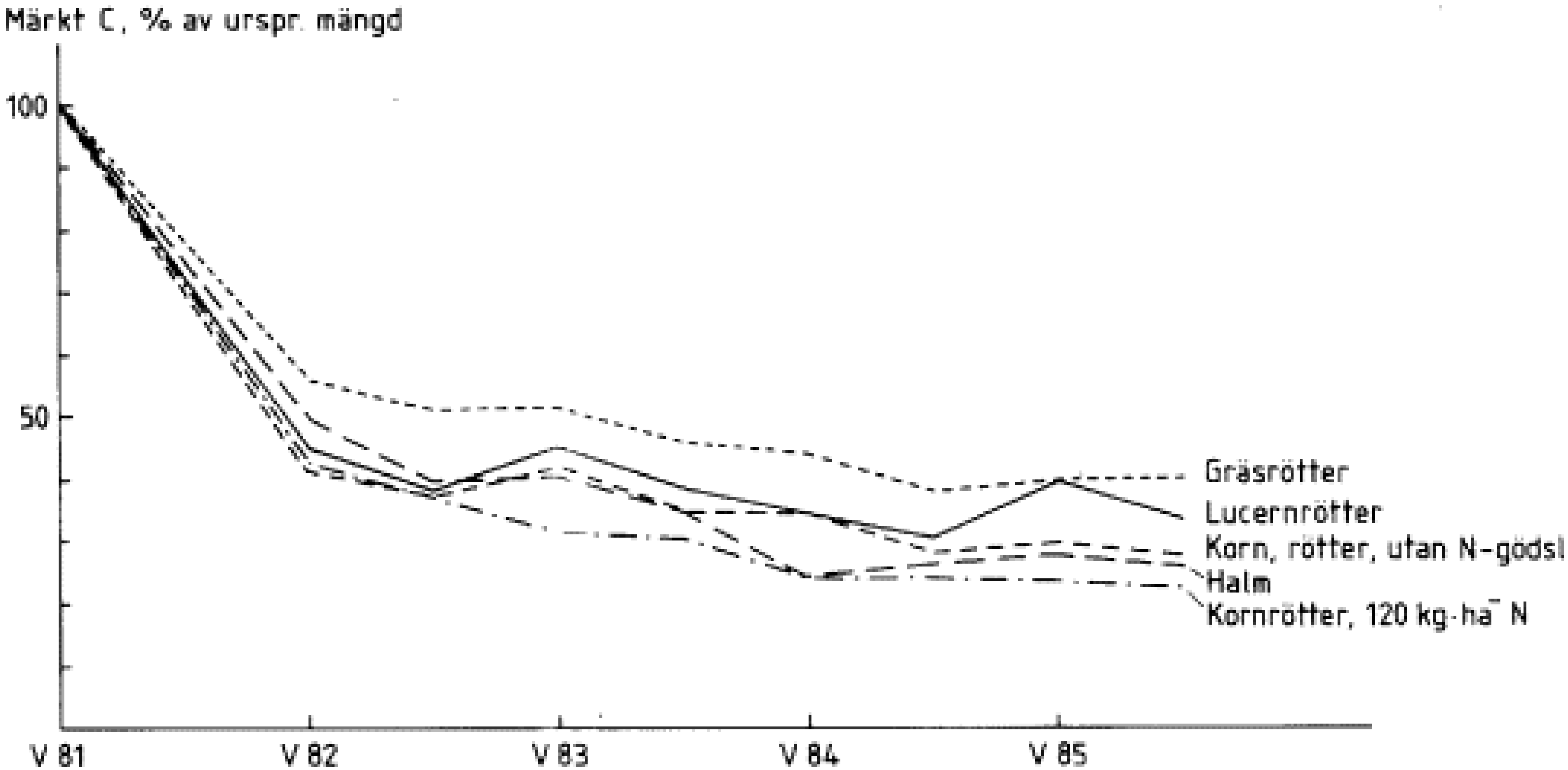
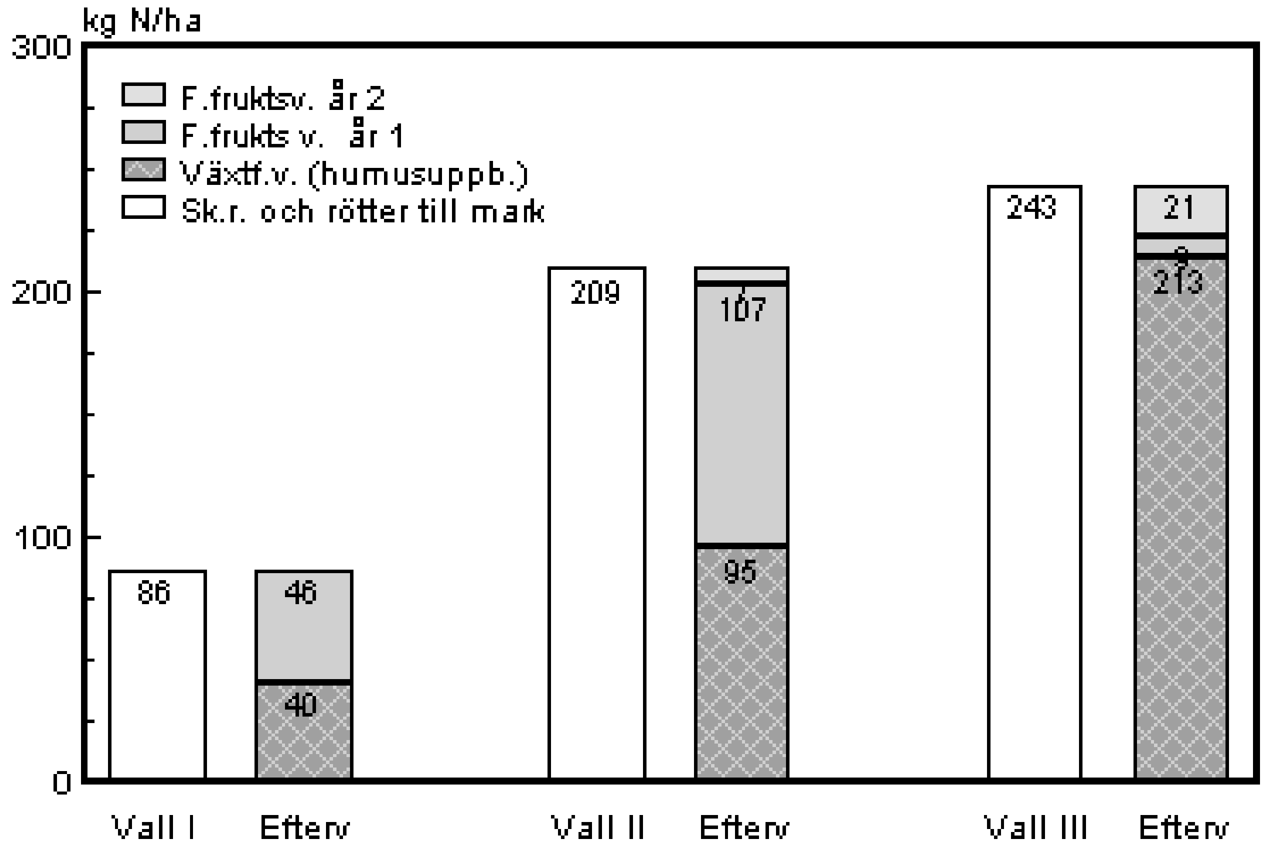
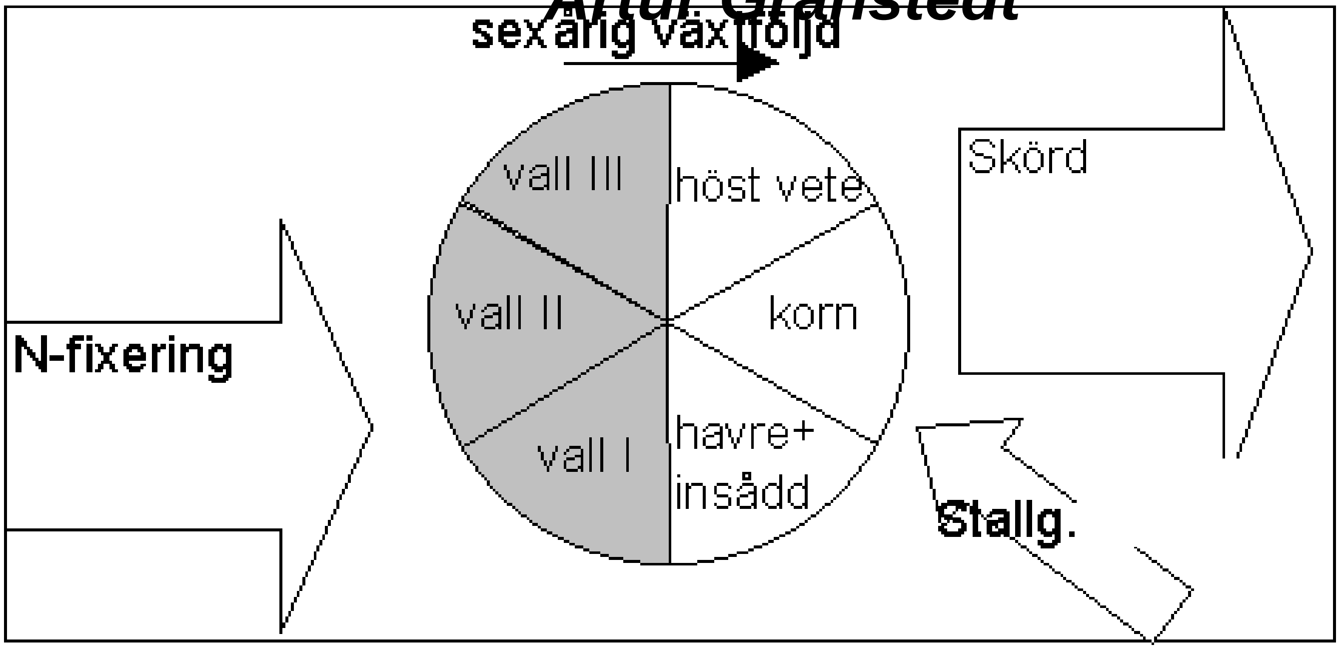


Fig. 4. Mineralisering av isotopmärkt organisk material. – *Mineralization of isotope-labeled organic material.*



Tillförd mängd kväve (N kg/ha) i skörderester och rötter (första stapeln), kväve i form av mineraliserat kväve (förfruktsverkan) år 1 och år 2 samt kväve införlivat i markens humus (andra stapeln) efter tidig

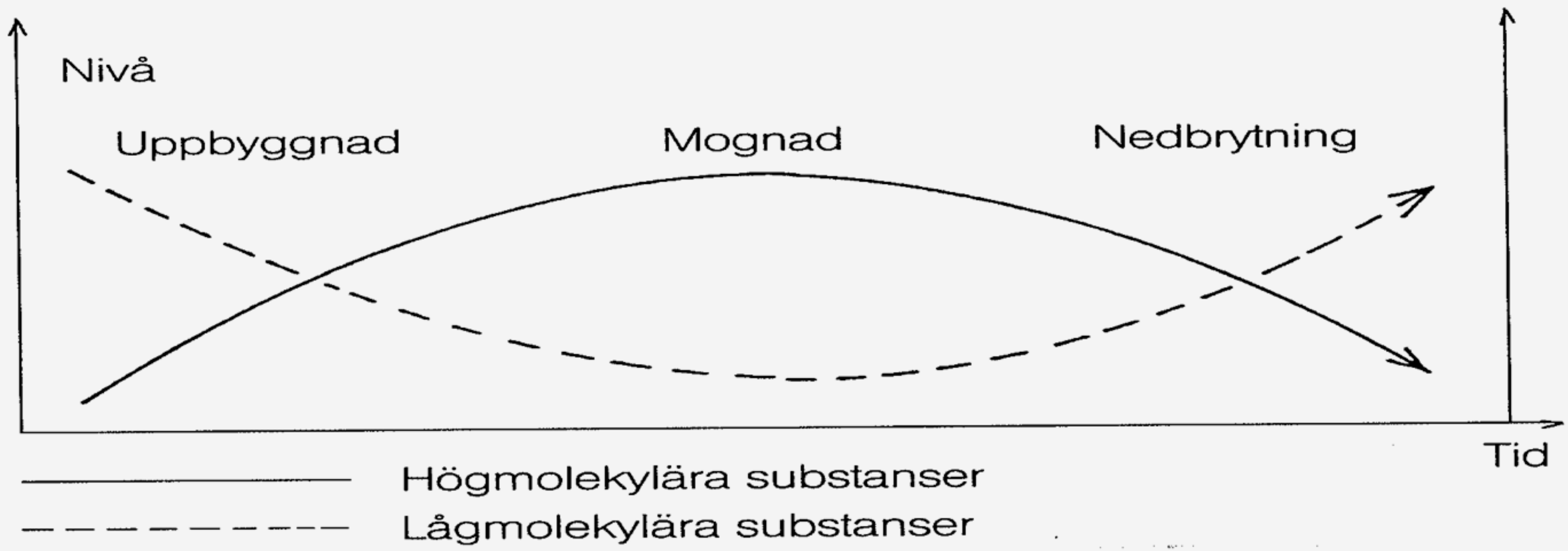
Vallens förfruktsvärde i ekologisk odling
- vallen både nödvändig resurs och riskfaktor
Artur Granstedt



. Genomsnittlig tillförsel av kväve genom kvävefixering och bortförsel med skörd samt återförsel med stallgödsel i en sexårig växtföljd (kg N/ha och år) enligt gjorda mätningar på en ekologisk gård i Mellansverige. Vallgrödorna är närande tack vare den biologiska kvävefixeringen som här sker av baljväxterna, medan stråsädesgrödorna är tärande. (Källa: Granstedt, 1990).

Extra för diskussion
Biodynamisk odling i forskning och försök

Granstedt, A., 1993. Telleby bokförlag, <järna


Nivå
Uppbyggnad
Mognad
Nedbrytning
Tid
Högmolekylära substanser
Lågmolekylära substanser

Figur 2 a 2 b)

Ren kopparkloridlösning (1,5 g $CuCl_2$) utkristalliserad utan tillsats (Selawry, 1957, Die Kupferchloridkristallisation), b) kopparkloridlösning med tillsats av extrakt från växten Veronica officinalis, blad (Granstedt, A. 1960, tidskriften Natura).

Figur 4. Kristallisationsbilder som illustrerar ordnade (till vänster) respektive oordnade kristallstrukturer (till höger).
Källa: Andersen, J.O. 2006. Är äppelsaft äppelsaft eller? Biodynamisk Forskningsforening, Danmark

Looking after the sea border for 5 000 years ago, Skilleby farm 2006.

Ekologi -definitioner

- Ekologi: Kunskap om huset, de levande organismerna och deras samverkan med varandra och den oorganiska miljön
- Ekosystem. Naturliga och människostyrda .
- Systemgränser –från det lilla till det globala.
- Organisationsnivåer: Cell, vävnad, organ, organsystem, individ, population , Samfund, Ekosystem, Biosfär.
- Biosfären kan delas upp i biotiska och abiotiska system; Atmosfären, Hydrosfären, Pedosfären, Litosfären.

Fråga. Hur stor del av växtens TS består av ämnen från atmosfären, hydrosfären, litosfären

Ämnessammansättning i växten makro och mikronäringsämne % av TS

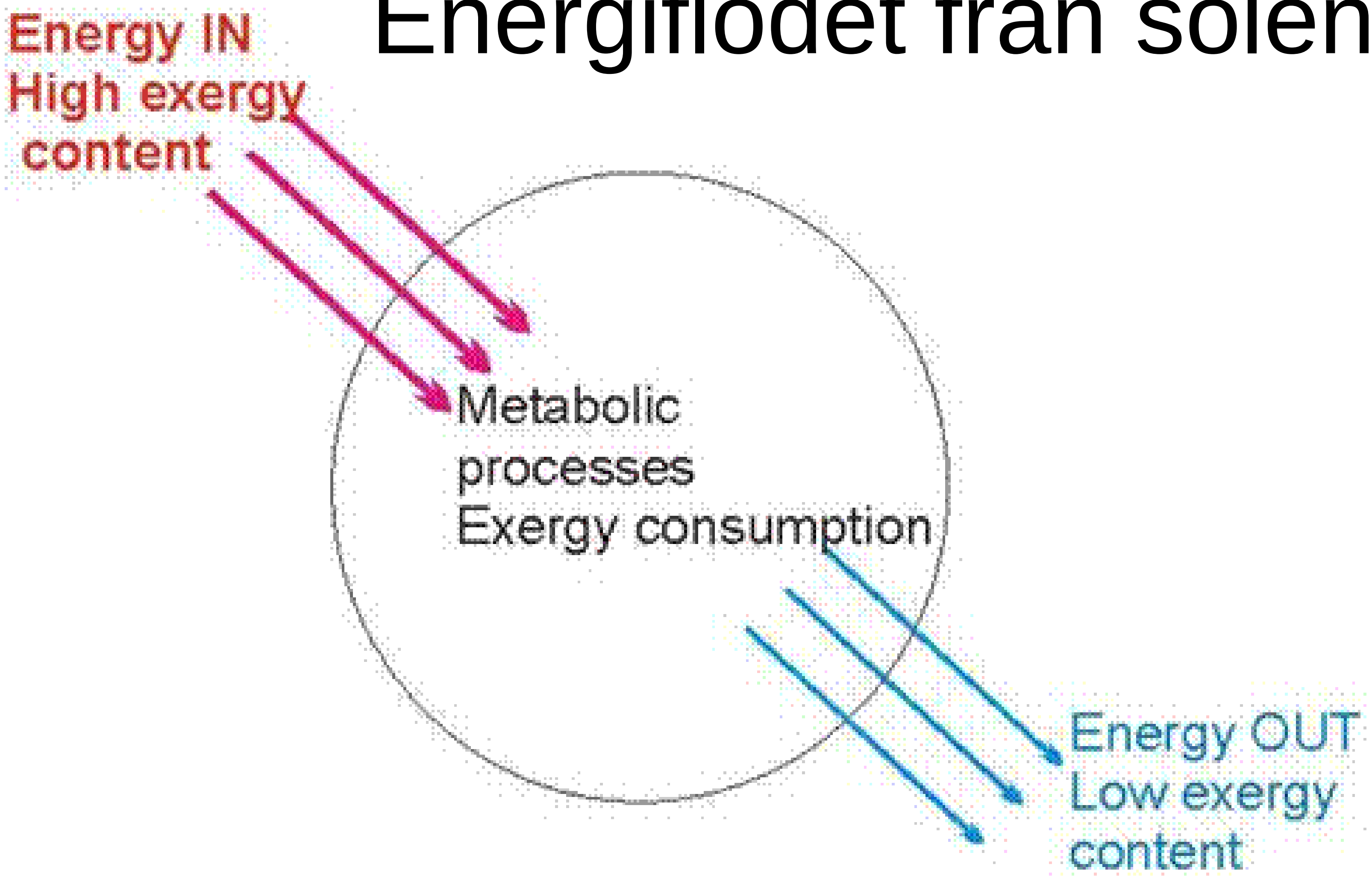
- Kol 45 % Från atmosfären
- Syre 45 % Från atmosfären
- Väte 7 % Från hydrosfären

- N 0,5-3 % Från atmosfären

- P 0,05 – 0,35 Från Litosfären
- K 0,2 -1,7
- Ca 0,06-1,4
- Mg 0,06-0,35
- S 0,03-0,6

- Fe < 0,01 %
- Mn
- Cu
- Zn
- B
- Mo
- Co
- Si

Energiflödet från solen



Ley with Leguminosis

was the sunlight driven nature resource used to create a multiple doubled food production during 150 years before the introduction of artificial fertilizers and chemicals

- Energy from the sunlight
- Nitrogen and carbon from the atmosphere
- Minerals and water from the ground

AG