28 - 30 Novembre 2006 - Cégep de Victoriaville, Victoriaville, Quebec, Canada
SÉMINAIRE: Les sols et la nutrition végétale adaptée à l'agriculture biologique
Développements européen et américain

Soil and plant nutrition adapted to organic agriculture: European developments

Guido Haas

Content (3rd session)

Organic profile - **Ecobalance (LCA)**

- ...
- LCA of agriculture in Hamburg
- LCA dairy grassland farming in southern Germany

Organic AgroExpertise Consultancy
www.agroexpertise.de

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www.iol.uni-bonn.de

Environmental impact of modern agriculture

1. Impact on **biotopes** and **species**
2. Impact on **soil**
3. Contamination of **ground water**
4. Impact on **surface water**
5. Impact on **food quality**
6. Contamination of **air**

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Future Common Agriculture Policy of the European Union: "Cross Compliance"

- Agri-environment measures (payments to farmers) since 1992

- By 1 January 2007 a farm advisory system will start:
  All farmers receiving direct payments have to fulfil standards:
  - environment (e.g., soil erosion, soil organic matter, maintenance of habitats)
  - food safety
  - animal health and welfare

- Farmers will be sanctioned for non-respect of standards.

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Environmental impact of agriculture in Germany

Impact category	Agriculture ...
Landscape image & soil functions	- farms 55% of the land area - often causes to much **soil erosion** in hilly areas
Biodiversity of habitats and species	- creates the **main habitat** for the potentially rich diversity of species in the open land but - has been the main cause for the **extinction of species**. is solely responsible for the **diversity of crop & lifestock species**
Quality of (drinking) **water**	- has predominantly caused the pollution of many upper ground water aquifers with **nitrate**. - pollutes ground water with **pesticides** (responsible for 19% and 10% of all resources below and above the drinking water regulation limit, resp.
Eutrophication	causes - 40% of the N-emission to air - 51% of the N-input to water - 43% of the P-input to water
Acidification	causes 20% of the emissions
Global warming	emits 8.5 % of climate relevant trace gases
Resource	uses 3% of the primary energy

Environmental assessment has to cover central impacts (ranking).

Geier 2000, Haas et al. 1995, Haas 1997

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Environmental Impact Categories

Suitable for	Impact category
All LCAs	Resource consumption
	Global warming, ozone depletion
	Acidification
	Eutrophication
	Water quality impact (ground & surface water)
	Water use / consumption
	Human- and ecotoxicity
	(Bad) smell and noise
Agriculture in particular	Landscape image (aesthetics)
	Biodiversity (species, habitats)
	Soil function / strain
	Animal husbandry (appropriate animal welfare)
	Use of genetical manipulated organism
Industry (not suitable / important in agricultural LCAs)	Consumption of land and natural resources
	Waste - sewage
	Photo-oxidants - ozone smog

Haas et al. 2000, Geier 2000

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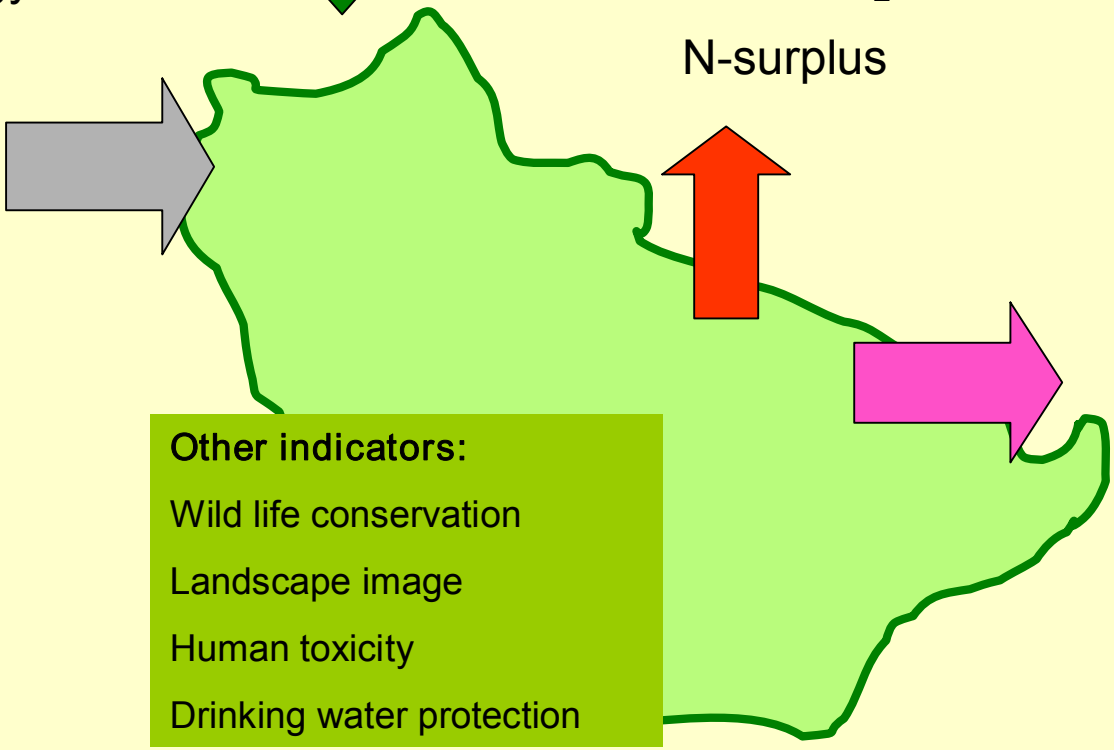
Material and Energy Flows



Deposition

N-deposition

Releases

NH_3,

N_2O, CH_4, CO_2

NOx, SO_2

N-surplus

Input

Primary energy

Fertilizer

Concentrates

Pesticides

Machinery (?)

Output

Animal products

Plant products

Other indicators:

Wild life conservation

Landscape image

Human toxicity

Drinking water protection

Geier et al. 1998

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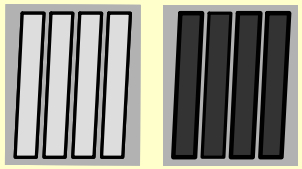
Data collection and projection to the area of investigation

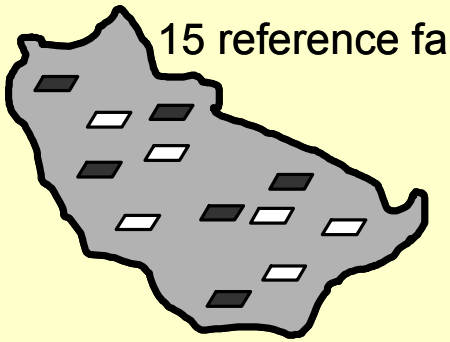
Main livestock and crop procedure models



Interviews and field investigations

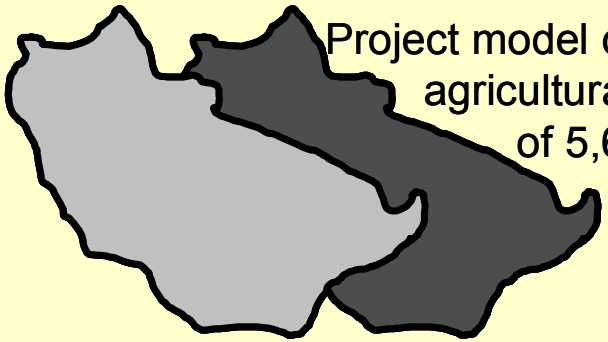
Verification by experts/advisors; cross checking statistical data

15 reference farms



Area of investigation (total 6,877 ha)

Project model data to agricultural area of 5,674 ha



Scenario of conventional and organic farming

Geier et al. 1998, Haas et al. 2007

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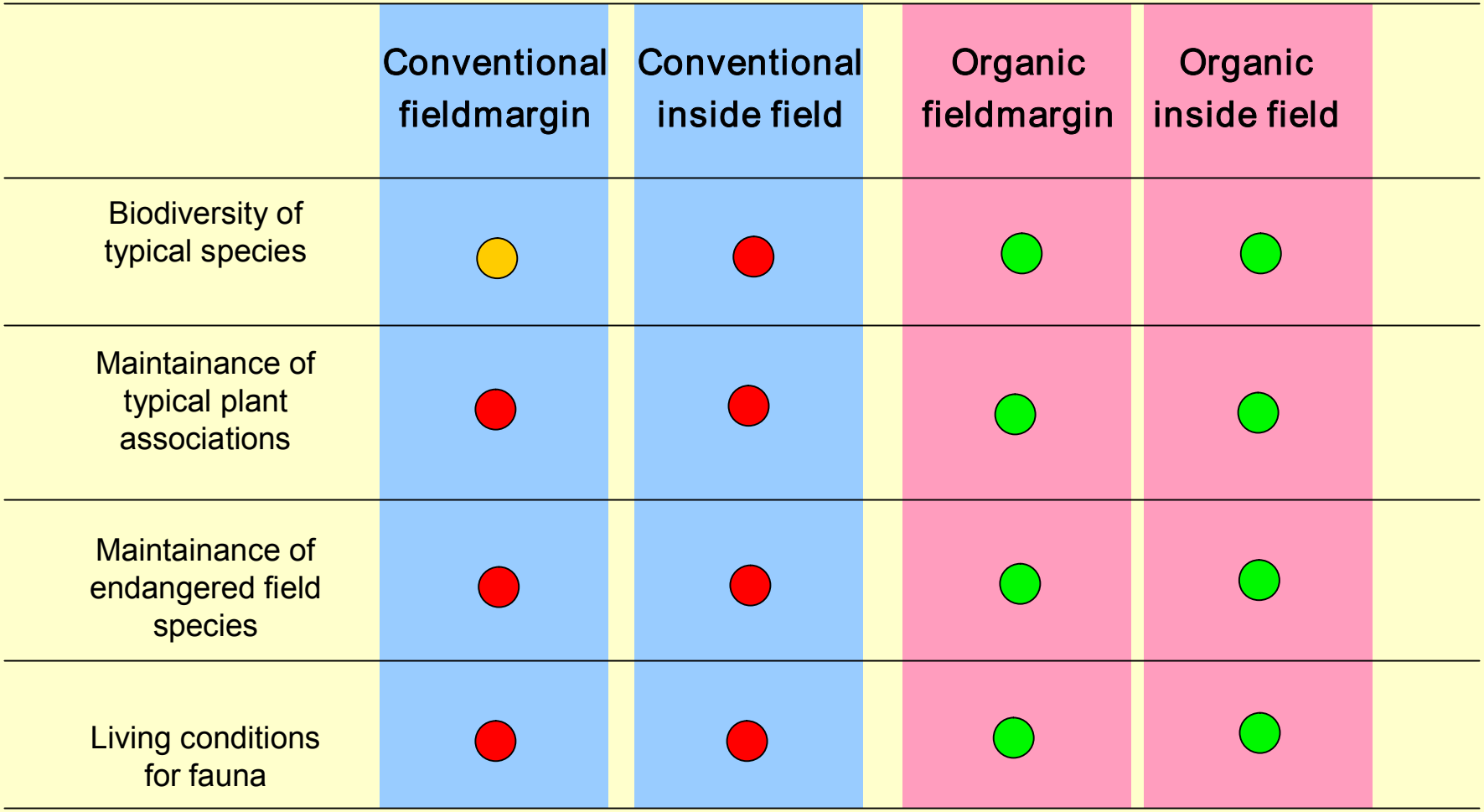
‚Ecobalance of Agriculture in Hamburg'

Floristic assessment of organic and conventional fields



Frieben 1996

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Nutrient balances of winter wheat in conventional (conv.) and organic farming based on model farm analyses in Hamburg

kg ha^{-1} yr^{-1}	Nitrogen		Phosphorus		Potassium	
	Conv.	Org.	Conv.	Org.	Conv.	Org.
Manure	144.0	90.8	37.5	24.4	19 8.0	113.4
Mineral fertiliser	165.3	0	23.1	0	91.6	0
Input total	*309.3*	*90.8*	*60.6*	*24.4*	*289.6*	*113.4*
Grain	144.6	72.0	26.8	14.0	36.0	19.9
Straw	39.8	20.0	9.5	5.2	105.1	49.8
Output total	*184.4*	*92.0*	*36.3*	*19.2*	*141.1*	*69.7*
Balance remainder	*124.9*	*-1.2*	*24.3*	*5.2*	*148.5*	*43.7*

Haas et al. 2007

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Annual area-related abiotic environmental impact of predominant crops in conventional and organic farming in Hamburg (3,272 ha arable land)

	Fossil energy use [GJ ha^{-1}]	Global warming potential [t CO_2-equiv. ha^{-1}]	Ammonia emission [1)] [kg NH_3 ha^{-1}]	Acidification [kg SO_2-equiv. ha^{-1}]
Conventional mean [2)]	*12.22*	*2.80*	*20.7*	*44.1*
Winter wheat	17.88	3.87	33.6	70.9
Winter barley	16.32	3.62	32.9	68.7
Winter rapeseed	12.68	2.93	17.1	37.2
Organic mean [2)]	*4.95*	*1.20*	*9.8*	*21.3*
Winter wheat	6.18	1.32	17.3	36.0
Spring cereal [3)]	5.05	1.03	12.6	26.6
Grass/clover	6.13	1.47	0	3.5

Haas et al. 2007

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Regional environmental impact scenario comparing conventional and organic farming in Hamburg (5,674 ha, 4,669 LU in the year 1995)

Impact category	Environmental indicator	Reduction of ... if organic
Eutrophication potential	N-surplus without NH_3-emission P-balance NH_3-emission	75%: **from 311 t to 77 t:** from surplus of 47 t to a deficit of 19 t 31%: **from 238 t to 165 t**
Resource depletion	Energy use P-fertiliser	55%: from 84,760 to 38,540 GJ 100%: from 81.1 t
Global warming potential	CO_2-equivalents (CO_2-, CH_4-, N_2O-emission)	31%: **from 26,365 t to 18,271** t
Acidification potential	SO_2-equivalents (SO_2-, NH_3-, NO_x-emission)	31%: **from 474 t to 328 t**
Drinking water protection	N-surplus (to estimate nitrate contamination) Pesticide use	75%: **from 311 t to 77 t** 100%: from 22.7 t, no risk of contaminating any water body
Human toxicity (working environment)	Pesticide use	No risk of contamination for farmers
Biodiversity (incl. ecotoxicity)	Typical species diversity of biotopes, number of endangered species, endangered and typical plant associations, living conditions for fauna, pesticide use	Arable land: clear improvement Grassland: improvement Structures (ditches and boundaries): clear improvement
Landscape image (aesthetics)	Local landscape image description, diversity and visual effect of crops	No difference between organic and conventional
Soil protection	Accumulation of heavy metals, soil compaction, humus balance	No difference between organic and conventional farming

Geier et al. 1998/ Haas et al. 2007

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LCA case study in the Allgäu region
- 18 dairy pure grassland farms

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Comparing intensive, extensified and organic dairy grassland farms (n = 3 x 6) in the Allgaeu Region by process life cycle assessment

	Farming Intensity		
	Intensive	Extensified	Organic
Characteristics			
mineral N-fertilizing	yes	no	no
purchasing fodder	yes	yes	limited
Farmed grassland area [ha]	33 (23 - 46)	35 (17 - 62)	26 (16 - 34)
Grassland yield (gross) [t DM / ha]	11.8 (10.9 - 12.8)	10.5 (9.0 - 12.7)	10.7 (8.8 - 12.1)
Stocking rate [LU / ha]**	2.2 (2.0 - 2.6)	1.9 (1.6 - 2.3)	1.9 (1.6 - 2.1)
Milk performance (annual) [kg / cow]	6,760 a * (5,100 - 8,050)	6,390 ab (5,500 - 7,640)	5,280 b (4,800 - 5,500)

* Letters indicate mean significant difference (Tukey); other parameters are not significant

** LU - livestock-unit (each 500 kg liveweight)

Haas et al. 2001, AEE 83, 43-53.

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Agricultural Life-Cycle Assessment Framework

- Efficient methods to comprehend and **assess** agricultural **impacts on the environment**
- by **combining suitable indicators**.

- **Nucleus** of agriculture is the **farm**.
- **Farmer** is the **decision maker** and manager of the production process.
- Farmers need environmental **advice**, **proof/check** (cross-compliance payments) and **weak-point-analyzes.**

= > Analyzing farming system / production process by Process-LCA at the farm level.

Haas et al. 2000

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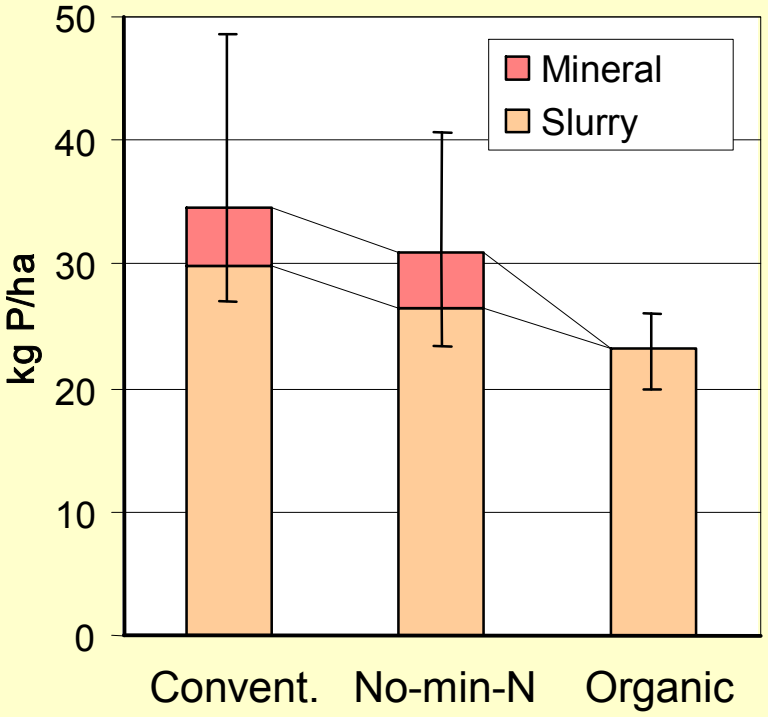
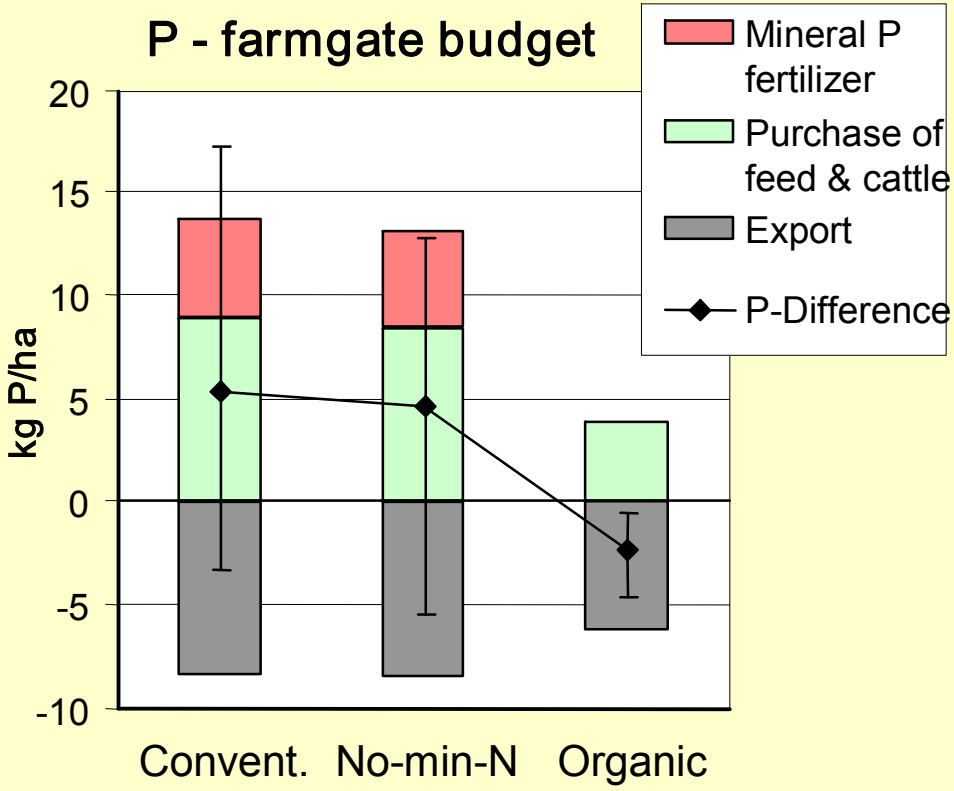
P fertilization - P farmgate budget

of grassland dairy farms in the Allgae region





Haas et al. 2001, AEE 83, 43-53.

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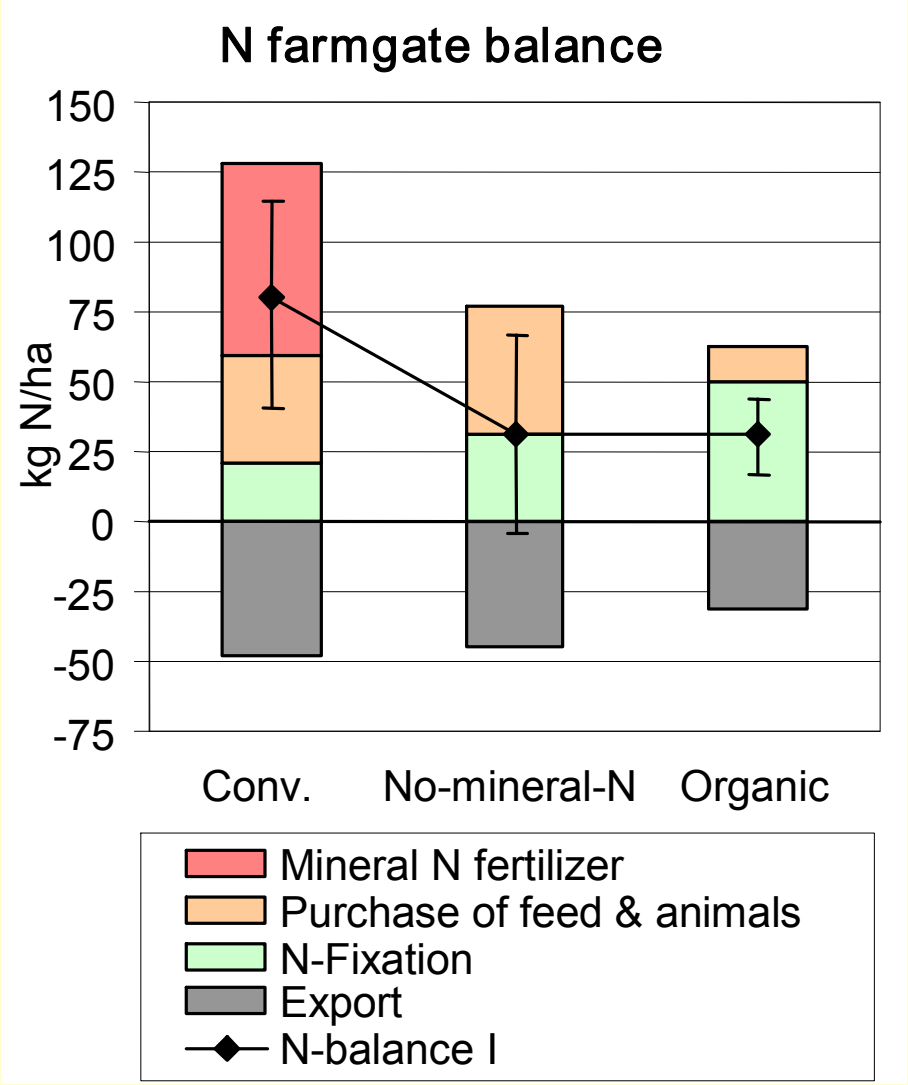
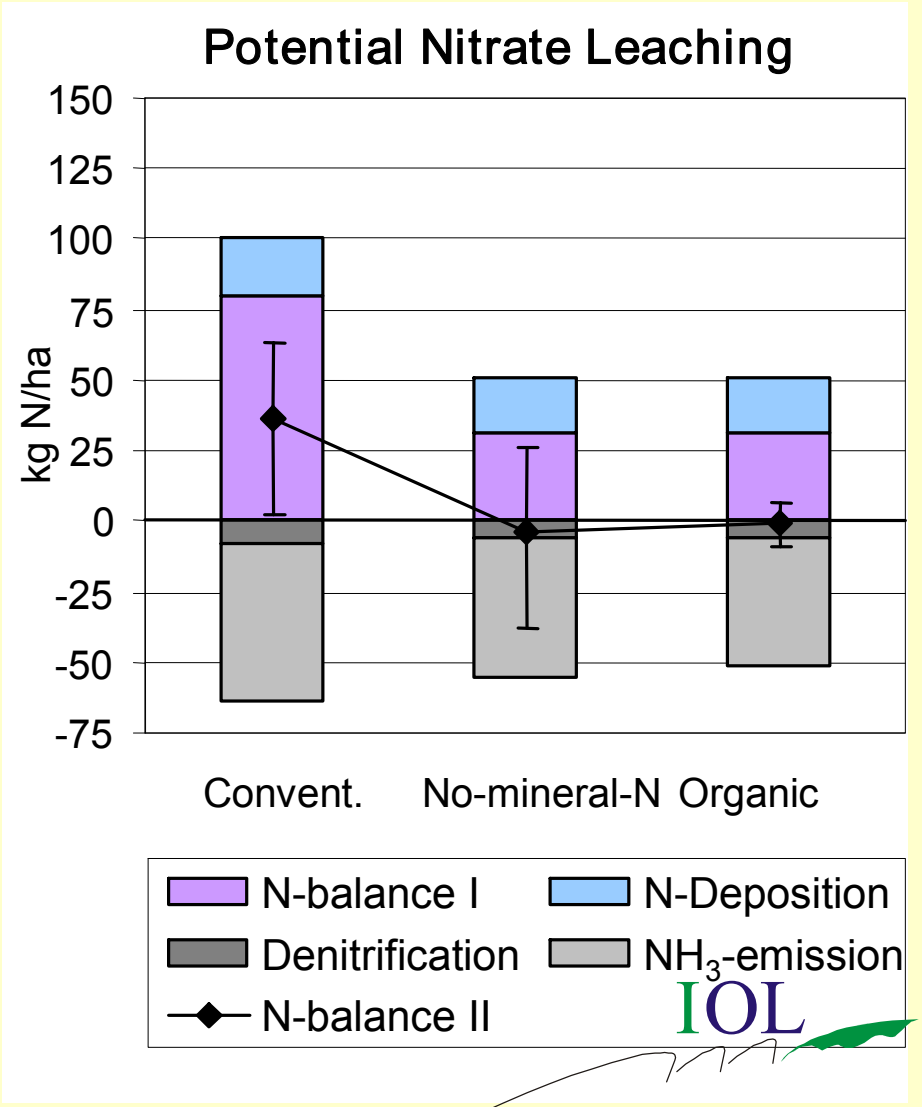
N farmgate budget - Leaching potential

of grassland dairy farms in the Allgae region





Haas et al. 2001, AEE 83, 43-53.

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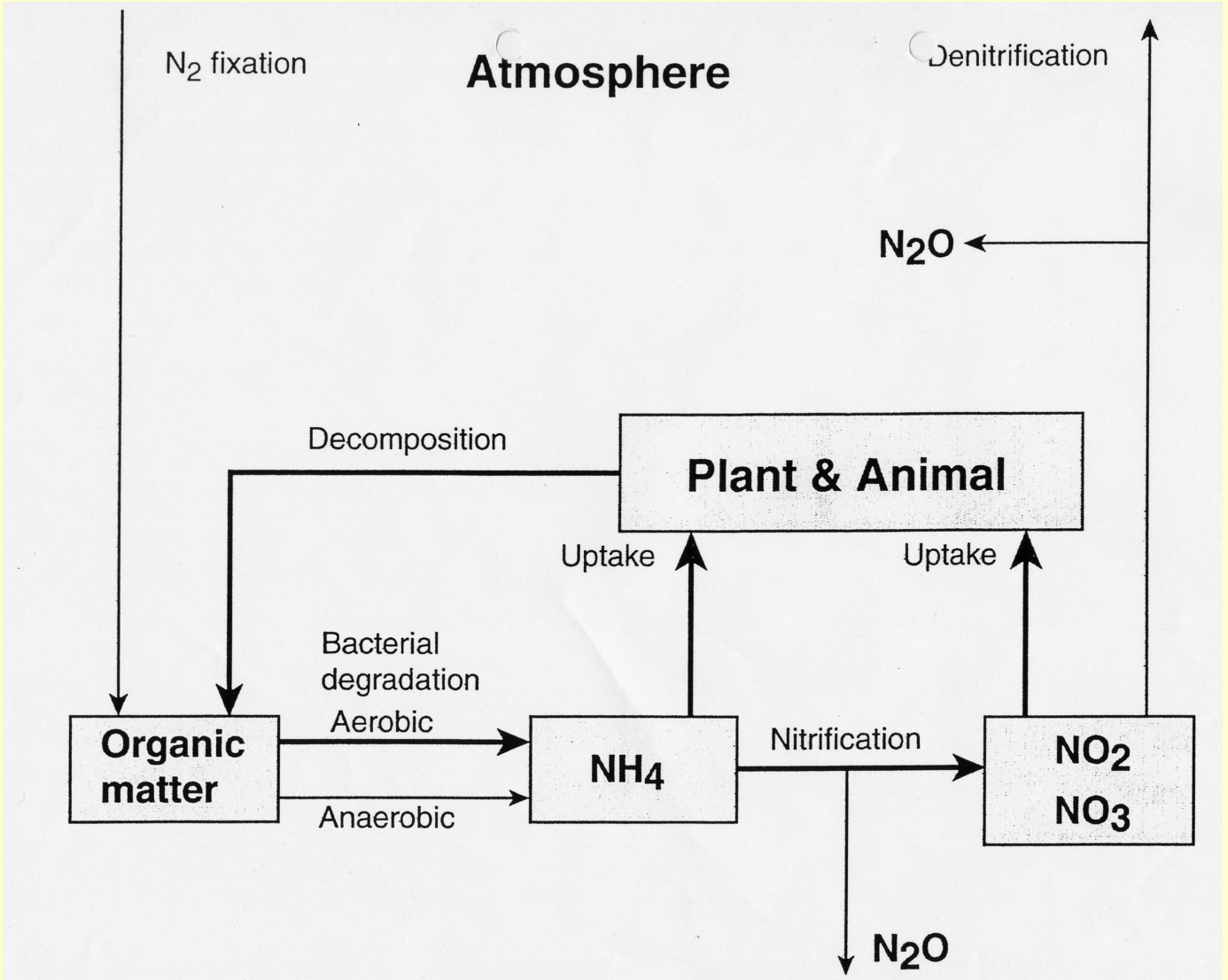
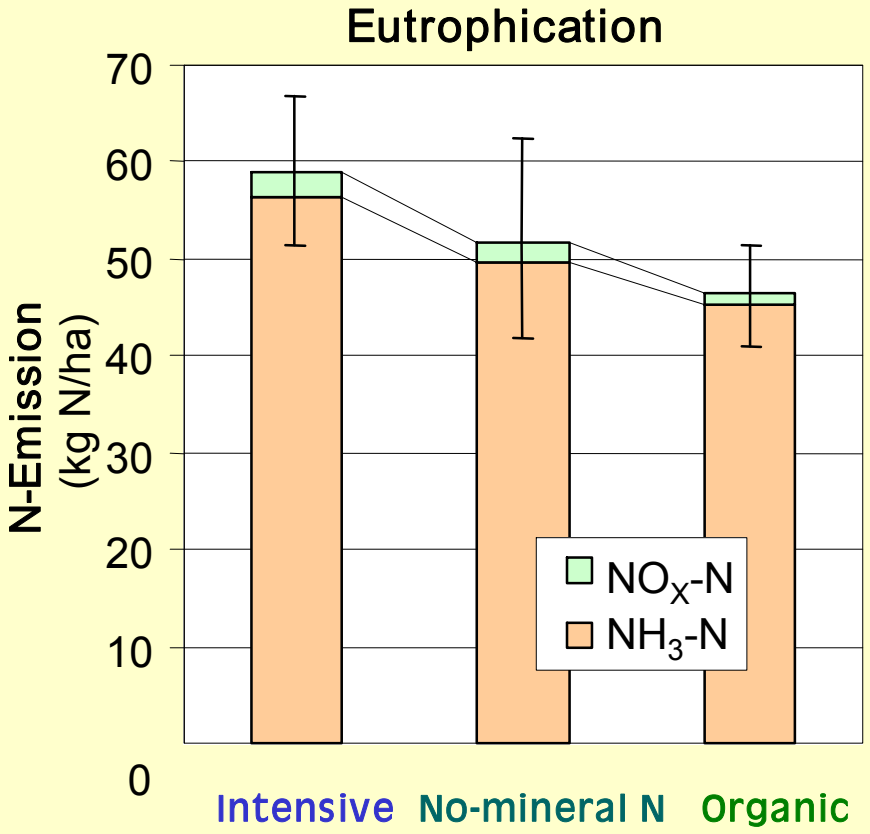
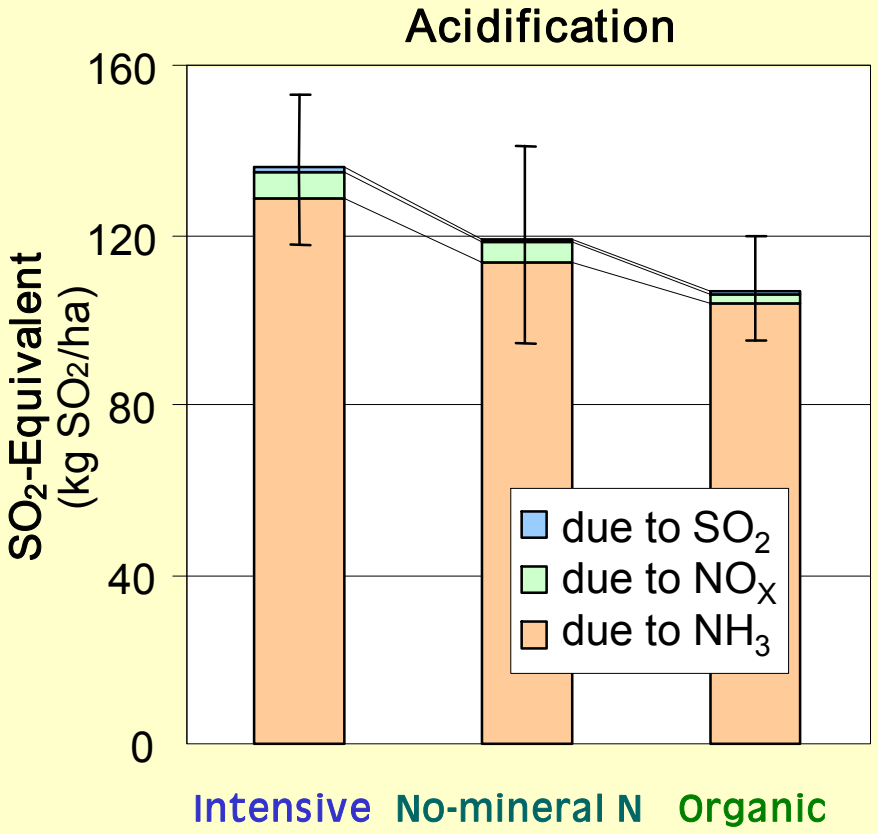


Figure 17.1 Biological transformation in the nitrogen cycle.

Comparing intensive, no-mineral-N and organic farms





Haas, Wetterich, Köpke 2001, AEE 83, 43-53.

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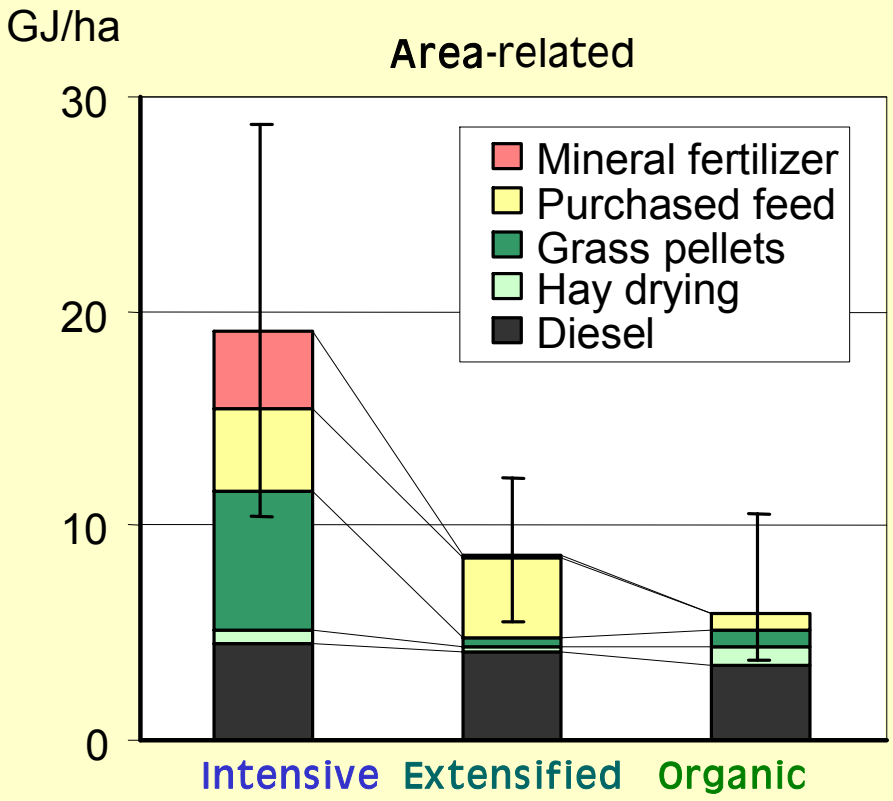
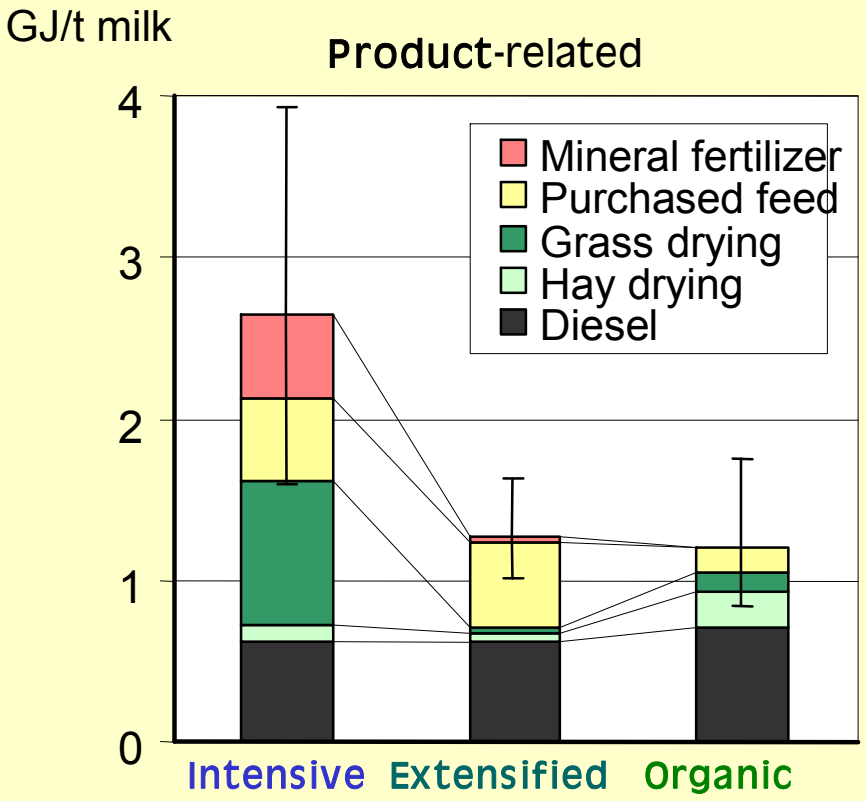
Comparing intensive, no-mineral-N and organic farms

Impact category: Fossil energy use





Haas, Wetterich, Köpke 2001, AEE 83, 43-53.

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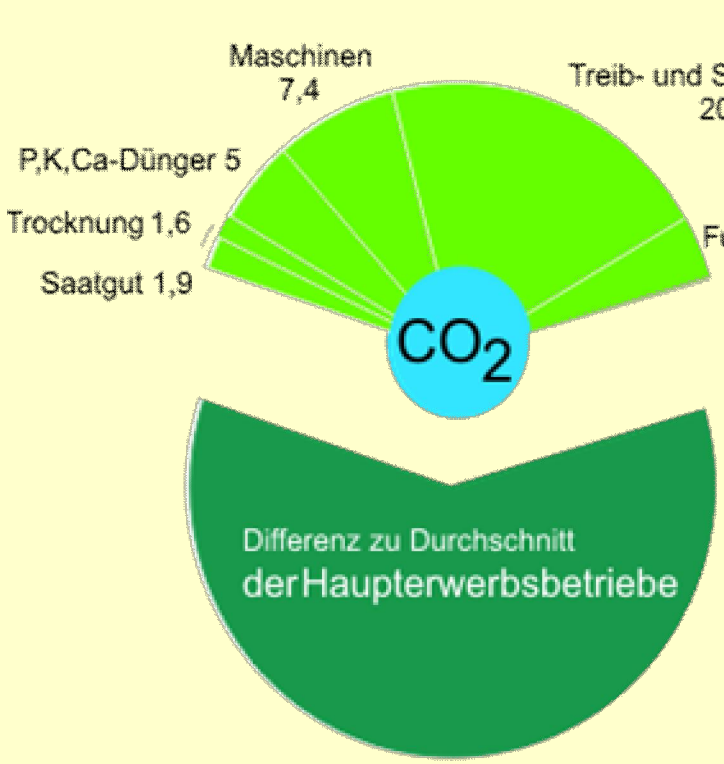
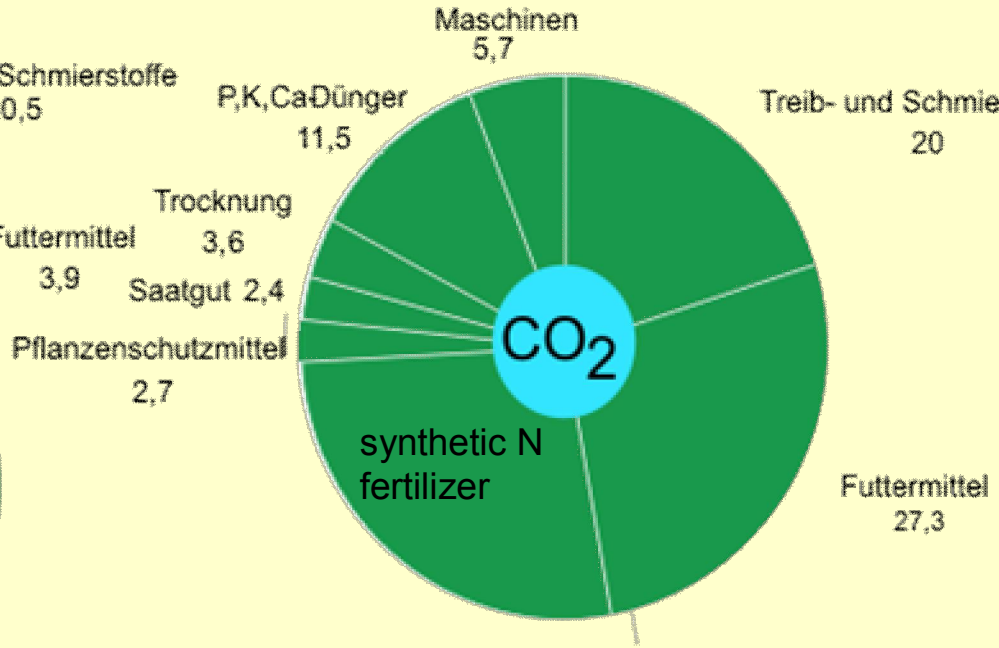
Comparing CO_2-emission due to fossil energy use





S= 0,503t CO_2/ ha
Durchschnitt
Ökologischer Landbau

S= 1,253t CO_2/ ha
Durchschnitt
Haupterwerbsbetriebe

Haas et al. 1995, study for the German National Parliament

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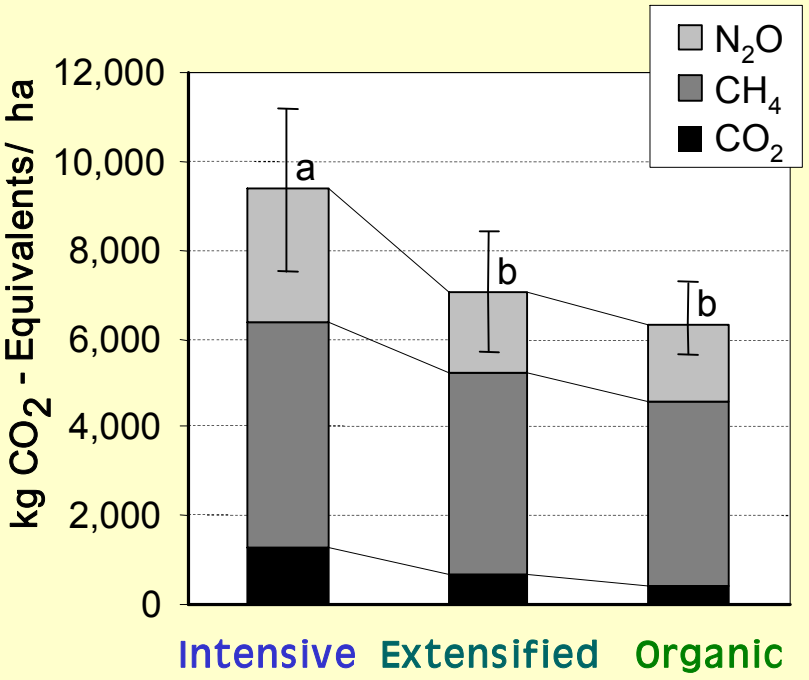
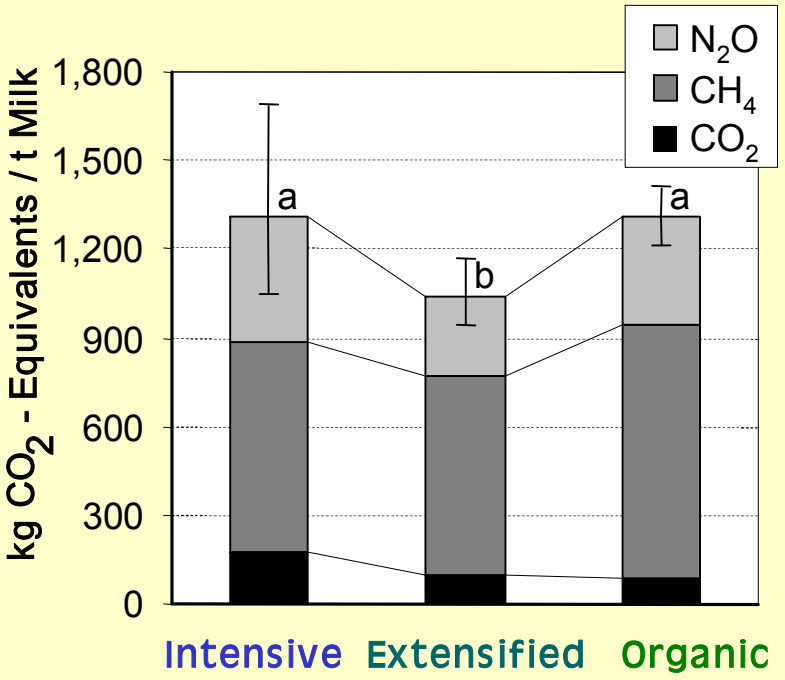
Comparing intensive, no-mineral-N and organic farms
- choose adequat Functional Unit (reference unit)
Impact category: Global warming

Area-related: kg CO_2/ha



Product-related: kg CO_2/t milk



Haas et al. 2000, LCA

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Modeling landscape image

Pasture land and fruit trees in Arboldswil/Switzerland 14. June 1996

Modeling chopping down fruit trees in 3 steps

What is the landscape definition of the people who live in the region?

LCA Allgäu: Landscape Image

	Scoring / Estimation Index				
	5	4	3	2	1
	unsatisfactorily		average of region		very good
Grazing cattle					
- breed [share of brown swiss]	≤ 20 %	> 20 %	> 70 %	> 90 %	100 %
- grazing period of dairy cows [in month]	< 1	< 3	< 5	< 6	≥ 6
- grazing / alpine young cattle keeping	permanent housing		grazing in summer		alpine grazing in summer
- horns, bells	hornless, no bells		horned or bells		horned and bells
Grassland & hedges and field margins (derived from biodiversity estimation)					
Farmstead (each feature single scored) farmhouse, farm buildings, garden, surrounding	untypical for the region				typical for the region

Wetterich & Haas 1999, report

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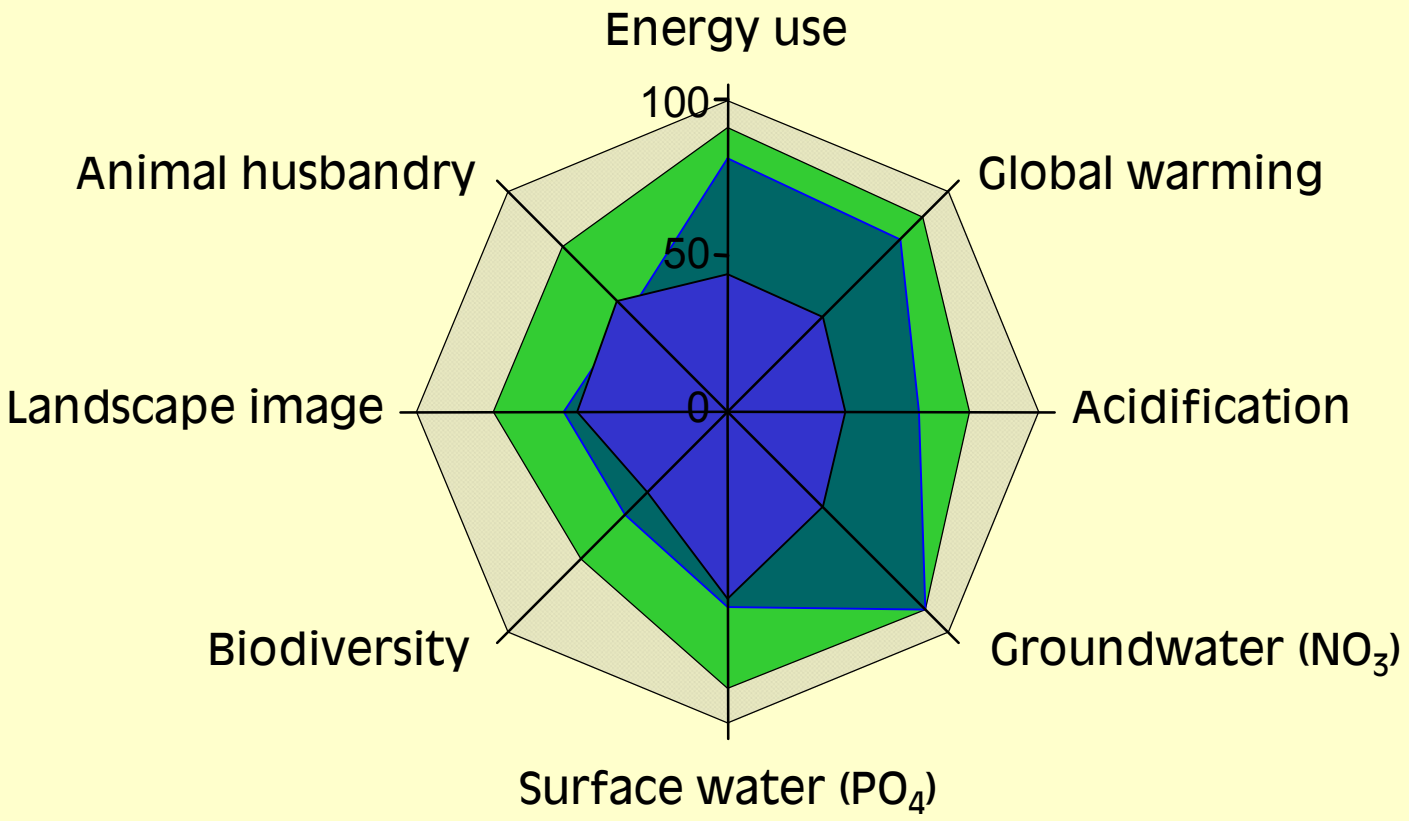
Comparing Environmental Impact of Farming System

by Process Life Cycle Assessment



Intensive, De-Intensified and Organic

Dairy-Grassland-Farms in the Allgäu Region (mean of 6 each)

Haas et al. 2001, AEE 83, 43-53.

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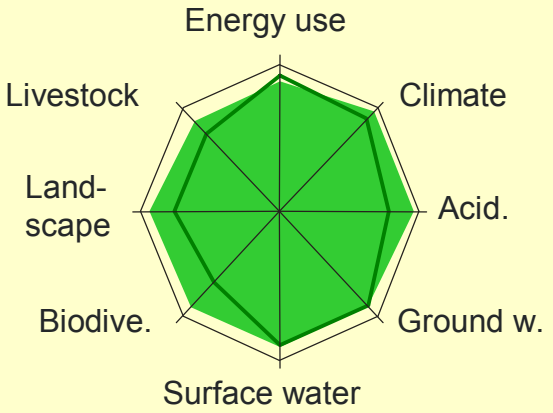
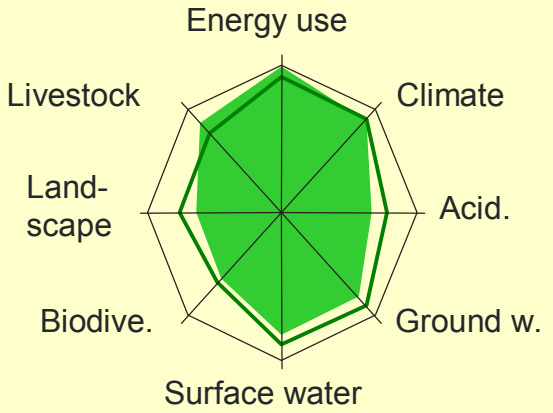
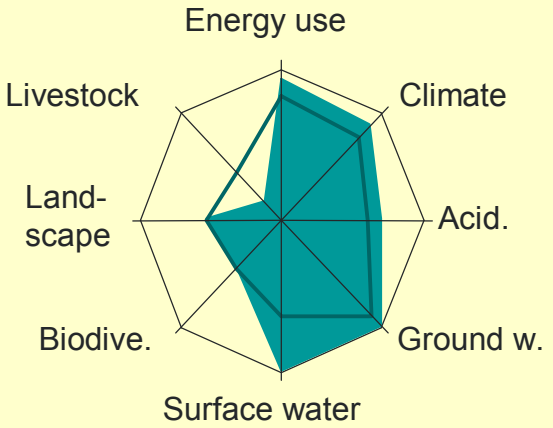
LCA used as an advisory tool for farm weak point analyses



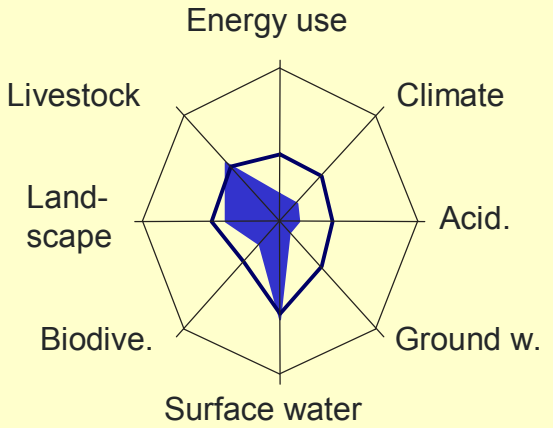
■ Farm O1 □ Mean Organic



■ Farm O6 □ Mean Organic



■ Farm E3 □ Mean Extensified



■ Farm I5 □ Mean Intensive

Haas & Wetterich 2000, ZAU 12/3, 368-377.

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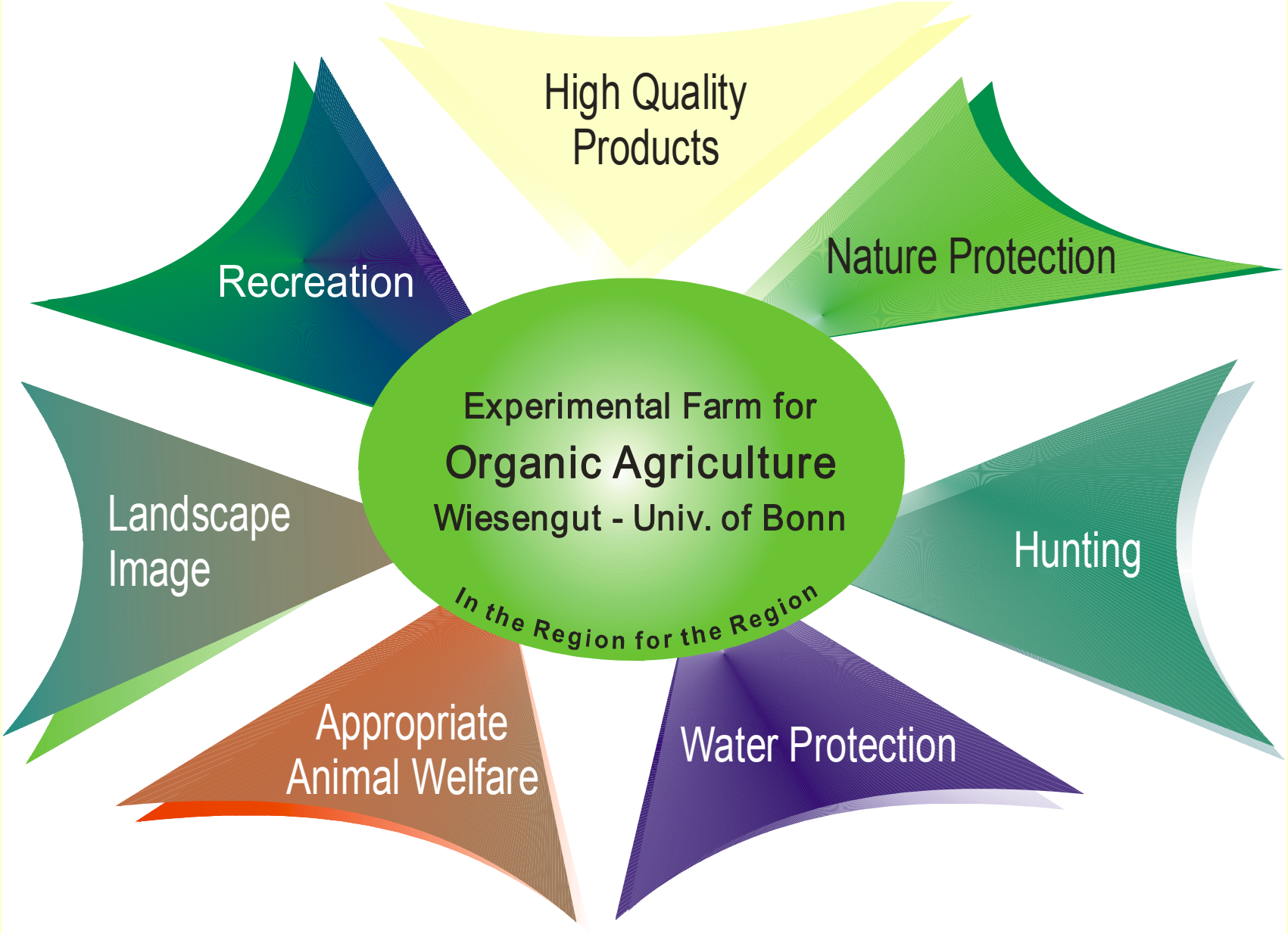
Agriculture is more than producing food



References

Dairy

Haas, G., C. Deittert 2005: Stoffflußanalyse und Produktionseffizienz der Milchviehhaltung unterschiedlich intensiv oekologisch wirtschaftender Betriebe (Nutrient matter flow analyses and productivity of organic dairy farms at different intensity levels, research report). Projektbericht Bundesprogramms Oekologischer Landbau, 73 p.

Haas, G., C. Deittert, U. Koepke 2006/2007: Impact of feeding pattern and feed purchase on area- and cow-related dairy performance of organic farms. Livestock Science, online available, paper version in press.

Haas, G., C. Deittert, U. Koepke 2007: Farm gate nutrient balances of organic dairy farms at different intensity levels in Germany. Renewable Agriculture and Food Systems, in press.

Haas, G., U. Geier, B. Frieben, U. Koepke: Improving environmental impact by converting to organic farming in a rural area of the city of Hamburg: a scenario using the Life-Cycle-Assessment method. submitted.

LCA

Haas, G., U. Koepke 1994: Vergleich der Klimarelevanz oekologischer und konventioneller Landbewirtschaftung (Comparing the impact of conventional and organic agriculture on climate change). In: Enquete-Kommission "Schutz der Erdatmosphaere" des Dt. Bundestages (Study for the Federal German Parliament) (Hrsg.), Bd. 1 Studienprogramm, Studie H, 98 S. mit 33 S. Anhang. Economica-Verlag Bonn.

Haas, G., U. Geier, D. G. Schulz, U. Koepke 1995: Comparing conventional and organic agriculture - part I: climate relevant carbon dioxide emission from the use of fossil energy use (only abstract in English). Berichte ueber Landwirtschaft 73, 401 - 415.

Haas, G., F. Wetterich, U. Geier 2000: Life cycle assessment framework in agriculture on the farm level. J. of Life Cycle Assessment 5 (6), 345-348.

Haas, G., F. Wetterich, U. Koepke 2001: Comparing intensive, extensified and organic grassland farming in southern Germany by process life cycle assessment. Agriculture, Ecosystems & Environment 83, 43-53.

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