Swiss agricultural policy

SALCA life-cycle assessment
Agri-environmental indicators

Peter Weisskopf and Thomas Nemecek
with Gérard Gaillard, Ruth Freiermuth Knuchel, Martina Alig, Daniel Baumgartner, Philippe Jeanneret, Hans-Rudolf Oberholzer

Mendel University, Brno
May 9, 2013
Outline

Swiss agricultural policy
• Swiss agriculture: facts and figures
• Swiss agricultural policy today
• Agriculture policy 2014-2017

SALCA life cycle assessment (Swiss Agricultural Life-Cycle Assessment)
• The concept of life cycle analysis with SALCA
• SALCA emission models and impact assessment methods
• Examples of applications

Agri-Environmental Indicators (Agri-Environmental Monitoring)
• Basic concepts
• SALCA tools
• Examples of results
Outline

Swiss agricultural policy
- Swiss agriculture: facts and figures
- Swiss agricultural policy today
- Agriculture policy 2014-2017

SALCA life cycle assessment \textbf{(Swiss Agricultural Life-Cycle Assessment)}
- The concept of life cycle analysis with SALCA
- SALCA emission models and impact assessment methods
- Examples of applications

Agri-Environmental Indicators \textbf{(Agri-Environmental Monitoring)}
- Basic concepts
- SALCA tools
- Examples of results
Coordination of agricultural and environmental policies: soil

- **biodiversity**
  - landscape
- **soils**
  - Law on environmental protection
  - Ordinance on impacts on soils
  - Ordinance on sustainability
  - agri-environmental indicators
  - life cycle analysis SALCA
- **water**
  - air, climate
  - Law on land use planning
  - Ordinance on direct payments
- **energy**
  - Law on water protection
  - Ordinance on the reduction of risks relating to the use of dangerous substances

Swiss agricultural policy - Facts and figures - Agricultural policy today - Agricultural policy 2014-17
SALCA: An integrated concept for agricultural life cycle assessment

SALCA = Swiss Agricultural Life Cycle Assessment

SALCA consists of the following elements:

• Database for life cycle inventories for agriculture (in collaboration with ecoinvent)

• Models for the calculation of direct emissions from field and farm

• A selection of impact assessment methods (midpoints)

• Methods for the assessment of impacts on biodiversity and soil quality

• Calculation tools for agricultural systems (farm, crop)

• Interpretation scheme for agricultural LCA
Defining system boundaries: crop production analysis

**Infrastructure:**
- Buildings
- Machinery

**Field production**
- Soil cultivation
- Fertilisation
- Sowing
- Chemical plant protection
- Mechanical treatment
- Harvest
- Transport

**Field operations:**
- Catch crops

**System boundary**
- Animal excrements
- Manure storage

**Purchased inputs:**
- Seed
- Fertilisers (min. & org.)
- Pesticides
- Energy carriers
- Irrigation water

**Resources**
- Direct and indirect emissions

**Product treatment:**
- Grain drying
- Potato grading

**Products:**
- Silage maize
- Sugar beets
- Fodder beets
- Beetroot
- Carrots
- Cabbage
- Wheat
- Barley
- Rye
- Oats
- Grain maize
- CCM
- Faba beans
- Soya beans
- Protein peas
- Sunflowers
- Rape seed
- Potatoes

**Co-Product:**
- Straw

---

**SALCA – LCA concept**
- models & methods – examples

**AUM – basics**
- SALCA tools – examples
Defining system boundaries: whole farm analysis

System boundary = farm gate

Resources

Infrastructure
- Buildings
- Equipment
- Machines

Purchased inputs
- Energy carriers
- Fertilisers
- Seed
- Pesticides
- Feedstuffs, straw
- Animal
- Water

Indirect emissions

Field operations
- Tillage
- Sowing
- Fertilisation
- Maintenance
- Irrigation
- Harvest
- Transport to farm

Fodder conservation

Direct emissions

Manure storage

Animal production
- Feeding
- Milking
- Manure management
- Grazing

Vegetal products, e.g.
- Wheat
- Maize
- Potatoes
- Vegetables

Animal products
- Milk
- Meat
- Eggs
- Wool
Defining system boundaries: where to draw the line between animal and plant production?

- Animal production (incl. feedstuffs, buildings, emissions, etc.)
  - Manure storage and treatment
  - Manure application (incl. machinery use and emissions)
  - Nutrient use in plant production

?
Defining system boundaries: single crop or cropping system?
Defining system boundaries: temporal system boundaries

Annual crops:
• Starting after harvest of previous crop (including fallow period or catch crop, if no product)
• Ending with harvest of the considered crop

Permanent crops:
• Annual basis (1st January to 31st December) or
• Multiannual cropping cycle (distinguishing different phases: planting, young plantation, main yielding phase, eradication)
Outline

Swiss agricultural policy
• Swiss agriculture: facts and figures
• Swiss agricultural policy today
• Agriculture policy 2014-2017

SALCA life cycle assessment (Swiss Agricultural Life-Cycle Assessment)
• The concept of life cycle analysis with SALCA
• SALCA emission models and impact assessment methods
• Examples of applications

Agri-Environmental Indicators (Agri-Environmental Monitoring)
• Basic concepts
• SALCA tools
• Examples of results
Estimating direct field and farm emissions

Ideal emission models should

- ... reflect the underlying environmental mechanisms
- ... be site and time dependent
- ... consider the effect of soil and climate
- ... consider the effect of management
- ... be applicable under a wide range of different situations
- ... should have a similar level of detail for the different models

... and: should easily be usable:
- Parameters are measurable
- Data can be collected in a reasonable time
- Calculation is feasible

A compromise is needed!
## SALCA emission models

<table>
<thead>
<tr>
<th>Emission</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia (NH₃)</td>
<td>Considers type of fertiliser, climate, time and technique of application</td>
<td>Menzi et al. (1997)</td>
</tr>
<tr>
<td>Nitrous oxide (N₂O)</td>
<td>Direct and indirect emissions</td>
<td>IPCC (2006)</td>
</tr>
<tr>
<td>Nitrate (NO₃⁻)</td>
<td>Monthly balance, considering crop, sowing and harvest dates, soil tillage,</td>
<td>Richner et al.</td>
</tr>
<tr>
<td></td>
<td>timing and quantity of N fertilisation</td>
<td>(2006)</td>
</tr>
<tr>
<td>Phosphorus (P, PO₄³⁻)</td>
<td>Includes erosion, run-off and leaching, considers P fertilisation, soil</td>
<td>Prasuhn (2006)</td>
</tr>
<tr>
<td></td>
<td>characteristics, topography</td>
<td></td>
</tr>
<tr>
<td>Heavy metals (Cd, Cr, Cu, Hg, Ni, Pb, Zn)</td>
<td>Field or farm level balance, considers inputs, harvest, leaching, erosion and change in soil concentration</td>
<td>Freiermuth (2006)</td>
</tr>
<tr>
<td>Methane (CH₄)</td>
<td>Enteric fermentation and manure management</td>
<td>IPCC (2006)</td>
</tr>
</tbody>
</table>
SALCA emission models: ammonia (NH$_3$)

Four emissions paths are modelled:

1. **Application of farm manure** = $f$(fertiliser amount, NH$_3$ and NH$_4^-$ concentration, covered area, saturation deficit in the air in function of average monthly temperature)

2. **Application of mineral fertiliser** = emission factors according to fertiliser type (2-15%, Asman 1992)

3. **Emission from pasture** = 5% of total N in excrements emitted as NH$_3$

4. **Emission from stable** = emission factors dependent on animal category, housing system, farm manure type (liquid or solid)

Source: Menzi *et al.* (1997)
SALCA emission models
nitrous oxide (N$_2$O)

N$_2$O in air:
adapted method according to IPCC 2006, under consideration of induced N$_2$O-Emissions:

- **Fertilisers**: Direct emissions: 1% of available N
- **Symbiotic N-fixation in legumes**: no emissions
- **Crop residues**: emission factor 1%
- **Storage of farmyard manure**: emission factors 0.1% for liquid manure and 2% for dung
- **Pasture**: emission factor 2%
- **Induced Emissions**: 1% of NH$_3$-N and 0.75% of NO$_3$-N
SALCA emission models: SALCA-nitrate

N mineralisation of soil organic matter

Leaching

N uptake plants

Non leached N

Leaching

Input of mineral N through fertilisers (NH₄, NO₃, Amid-N)

Temperature dependent N-Uptake functions (STICS)

GRUDAF:
60 dt yield
158 kg N uptake

Example:
80 dt yield
211 kg N uptake

Monthly N-uptake

Source: Richner et al. (2006)
Four kinds of P-emissions in water:

- **Surface run-off** in rivers (solved $\text{PO}_4^{3-}$)
- **Drainage losses** in rivers (solved $\text{PO}_4^{3-}$)
- **Erosion** in rivers (P bound to soil particles)
- **Leaching** in ground water (solved $\text{PO}_4^{3-}$)

Emissions are dependent of:

- Soil characteristics (granulation, bulk density, soil water balance) and drainage
- Quantity of P-fertiliser
- Type of P-fertiliser (manure, compost, mineral)
- Field slope and distance to rivers
- Quantity of eroded soil
- Plant available P in upper soil
SALCA emission models: heavy metals

• Input-Output-Balance per field (caused by farming) for: Cd, Cu, Zn, Pb, Ni, Cr, Hg

• Inputs:
  → Fertilisers (mineral and organic)
  → Seed
  → Pesticides
  → Feedstuff and auxiliary materials for animal breeding

• Outputs:
  → Exported primary products (e.g. grains, meat)
  → Exported co-products (e.g. straw, animal manure)
  → Leaching to groundwater and drainage to surface water
  → Erosion to surface water

• Allocation for inputs caused by the farming
• The final balance can be negative!

Source: Freiermuth (2006)
# SALCA impact assessment methods

<table>
<thead>
<tr>
<th>Impact category</th>
<th>Reference</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-renewable energy demand</td>
<td>Ecoinvent (2007)</td>
<td>Fossil und nuclear energy resources</td>
</tr>
<tr>
<td>Global warming potential</td>
<td>IPCC (2007)</td>
<td></td>
</tr>
<tr>
<td>Ozone formation potential</td>
<td>EDIP (2003)</td>
<td>With regionalisation</td>
</tr>
<tr>
<td>Eutrophication potential</td>
<td>EDIP (2003)</td>
<td>With regionalisation</td>
</tr>
<tr>
<td>Acidification potential</td>
<td>EDIP (2003)</td>
<td>With regionalisation</td>
</tr>
<tr>
<td>Aquatic and terrestrial ecotoxicity</td>
<td>CML (2001)</td>
<td>Complemented with characterisation factor for ca. 400 pesticide active ingredients</td>
</tr>
<tr>
<td>Human toxicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Jeanneret et al. (2006)</td>
<td>11 indicator organism groups 2 characteristics</td>
</tr>
<tr>
<td>Soil quality</td>
<td>Oberholzer et al. (2006)</td>
<td>9 indicators for physical, chemical and biological soil properties</td>
</tr>
</tbody>
</table>
SALCA methodology: method for biodiversity - framework

- 11 Indicator species groups
  - ecological and LCA criteria: flora, birds, mammals, amphibians, molluscs, spiders, carabids, butterflies, wild bees, and grasshoppers

- Two characteristics
  - overall species diversity of the indicator species groups
  - diversity of ecologically demanding species

- Extensive inventory data about agricultural practices
  - occupation, emissions, farming intensity indicators (e.g. number of cuts) and process figures (e.g. herbicide type)
  - typical cultivated fields and semi-natural habitats

- Characterisation based on scoring system
  1) estimate every indicator species group’s reaction to farming
  2) aggregation step resulting in scores

- Aggregation and normalisation of scores
  - biodiversity value and biodiversity potential
SALCA methodology: method for biodiversity - principle

Agricultural Activity

AA1
AA2
AA3
AA4
AA5

Impact

Biodiversity

Ind1
Ind2
Ind3
Ind4
Ind5

Scoring

1 1 3 5 2
3 2 3 2 1
1 2 1 4 3
2 1 3 2 1


SALCA life-cycle assessment | Mendel University 13-5-09
Peter Weisskopf | © Agroscope Research Station
Results of SALCA-biodiversity.

Biodiversity scores are given per ha cultivated crop. A, B, C, D are management systems with main characteristics:

**Grassland systems** (hay production):
- (A) 5 cuts/year, fertilised with slurry; 11t DM/ha
- (B) 4 cuts/year, fertilised with slurry; 9t DM/ha
- (C) 3 cuts/year, fertilised with solid manure; 5.6t DM/ha
- (D) 1 cut/year, no fertilisation; 2.7t DM/ha

**Winter wheat systems:**
- (A) Conventional production; 5.8t DM/ha
- (B) Integrated production – intensive; 5.5t DM/ha
- (C) Integrated production – extensive; 4.5t DM/ha
- (D) Organic production; 3.5t DM/ha

Scores of grassland (A) and winter wheat (B) systems are set as *reference scores*. Color codes are given for rough comparison:

- **Blue** (similar to the reference, 95%<score<104%)
- **Green** (better than the reference, 105%<score<114%)
- **Dark green** (much better than the reference, score >115%)
- **White** (no relevance for the considered system)

**Overall species diversity**

<table>
<thead>
<tr>
<th>Production system</th>
<th>Grassland</th>
<th>Winter Wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall species diversity</td>
<td>6.2</td>
<td>7.7</td>
</tr>
<tr>
<td>Grassland flora</td>
<td>3.7</td>
<td>15.2</td>
</tr>
<tr>
<td>Crop flora</td>
<td>6.4</td>
<td>4.6</td>
</tr>
<tr>
<td>Birds</td>
<td>7.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Mammals</td>
<td>2.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Molluscs</td>
<td>5.4</td>
<td>8.2</td>
</tr>
<tr>
<td>Spiders</td>
<td>9.1</td>
<td>10.9</td>
</tr>
<tr>
<td>Carabid Beetles</td>
<td>7.0</td>
<td>10.9</td>
</tr>
<tr>
<td>Butterflies</td>
<td>6.8</td>
<td>10.6</td>
</tr>
<tr>
<td>Wild Bees</td>
<td>7.4</td>
<td>8.0</td>
</tr>
<tr>
<td>Grasshoppers</td>
<td>6.9</td>
<td>8.2</td>
</tr>
</tbody>
</table>

**Species with high ecological requirements**

- **Amphibians**
  - 0.8
  - 8.9
- **Spiders**
  - 9.0
  - 6.8
- **Carabid Beetles**
  - 7.0
  - 6.7
- **Butterflies**
  - 7.3
  - 6.8
- **Grasshoppers**
  - 8.0
  - 6.8

Source: Jeanneret et al. 2006
SALCA methodology: method for soil quality - framework

- Spatial system boundary = farm
- Temporal system boundary = crop rotation period (6-8 years)
- Management data of all plots of a farm in a single year are considered as representative for a whole crop rotation
- Only influences of agricultural management practices are included, no immissions
- The development trend of soil properties is assessed, not absolute values

<table>
<thead>
<tr>
<th>Soil properties</th>
<th>Physical</th>
<th>Chemical</th>
<th>Biological</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>According to ISO 14040 and ISO 14042</td>
<td>Depending on the needs of Life Cycle Assessment</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>9 Direct Indicators</th>
<th>physical</th>
<th>chemical</th>
<th>biological</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rooting depth of soil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macropore volume</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aggregate stability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil organic matter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inorganic pollutants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic pollutants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earthworm biomass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microbial biomass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microbial activity</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Oberholzer et al. (2006)
SALCA methodology: method for soil quality – impact assessment

Example: slurry application

- Risk of soil compaction by wheeling
- Humus balance
- Number of applications per year with possibly toxic effects
- Amount of organic substances

Soil moisture
Soil structure
Soil texture

Management data

Impact classes

Macropore volume
Aggregate stability
Soil organic matter
Microbial biomass
Earthworm biomass
Microbial activity

Direct indicators

Source: Oberholzer et al. (2006)
SALCA methodology: example for soil quality – results DOK

Results of SALCA-Soil Quality for the five DOC treatments

<table>
<thead>
<tr>
<th>Direct Indicators for soil quality</th>
<th>D0</th>
<th>D2</th>
<th>O2</th>
<th>K2</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rooting depth of soil</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Macropore volume</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Aggregate stability</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Corg content</td>
<td>--</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>--</td>
</tr>
<tr>
<td>Heavy metal content</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Organic pollutants</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Eathworm biomass</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>Microbial biomass</td>
<td>-</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Microbial activity</td>
<td>-</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

- **Minor differences between the three farming systems**
  - most management practices are similar or equal regarding soil quality
  - some indicators do not show a positive effect in D2 because of slightly less organic input compared to O2 and K2.

- **D0 and M: impacts on soil quality by insufficient carbon supply**
  - no organic fertilizers, removal of crop residues

- **O2 and K2: positive effect of crop rotation on macropore volume**
  - not negated by a high compaction risk
Outline

Swiss agricultural policy
- Swiss agriculture: facts and figures
- Swiss agricultural policy today
- Agriculture policy 2014-2017

SALCA life cycle assessment (Swiss Agricultural Life-Cycle Assessment)
- The concept of life cycle analysis with SALCA
- SALCA emission models and impact assessment methods
- Examples of applications

Agri-Environmental Indicators (Agri-Environmental Monitoring)
- Basic concepts
- SALCA tools
- Examples of results
Cropping systems research

Example organic vs. integrated farming: energy demand in the DOC trial

Communication of results to farmers: overview of environmental impacts

- Environmental impacts per ha UAA
- Environmental impacts per Swiss-Fr. return
- Environmental impact per MJ digestible energy

<table>
<thead>
<tr>
<th>Impact Type</th>
<th>Units (Toxp./ha)</th>
<th>Units (Toxp./Fr.)</th>
<th>Units (MJ-eq./ha)</th>
<th>Units (CO2-eq./Fr.)</th>
<th>Units (N-eq./Fr.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrestrial ecotoxicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aquatic ecotoxicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy demand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global warming potential</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eutrophication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Own farm
- Model farm
Outline

Swiss agricultural policy
• Swiss agriculture: facts and figures
• Swiss agricultural policy today
• Agriculture policy 2014-2017

SALCA life cycle assessment (Swiss Agricultural Life-Cycle Assessment)
• The concept of life cycle analysis with SALCA
• SALCA emission models and impact assessment methods
• Examples of applications

Agri-Environmental Indicators (Agri-Environmental Monitoring)
• Basic concepts
• SALCA tools
• Examples of results
Agri-environmental indicators: aims

- Based on Ordinance on sustainability in agriculture

- **Aim**: assessment of the effects of agricultural policy and agricultural practices on environmental quality

  → information on **national, regional and sectorial level**

  → information **for decision makers, for the general public, for comparisons** (with other countries)
## Agri-environmental indicator set

<table>
<thead>
<tr>
<th>scope</th>
<th>driving forces: agricultural practices</th>
<th>environmental effects: agricultural processes</th>
<th>environmental state</th>
</tr>
</thead>
<tbody>
<tr>
<td>nitrogen</td>
<td>• N-balance of agriculture</td>
<td>• potential N emissions (NO₃, NH₃, N₂O)</td>
<td>• nitrate pollution of groundwater</td>
</tr>
<tr>
<td>phosphorous</td>
<td>• P-balance of agriculture</td>
<td>• P content of soils</td>
<td>• P pollution of lakes</td>
</tr>
<tr>
<td>energy / climate</td>
<td>• energy consumption in agriculture</td>
<td>• energy efficiency</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• emission of greenhouse gases</td>
<td></td>
</tr>
<tr>
<td>water</td>
<td>• use of pesticides</td>
<td>• risk of aquatic ecotoxicity</td>
<td>• pesticide pollution of groundwater</td>
</tr>
<tr>
<td></td>
<td>• use of veterinary medicinal products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>soil</td>
<td>• soil cover</td>
<td>• erosion risk</td>
<td>• heavy metal content of soils</td>
</tr>
<tr>
<td>biodiversity / landscape</td>
<td>• ecological compensation areas</td>
<td>• potential effects of agriculture on biodiversity</td>
<td>• diversity of wild species</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• habitat diversity</td>
</tr>
</tbody>
</table>
Agri-environmental indicators: organisation

• **Start in 2009**; currently in implementation
  
  → **ART** responsible for driving forces and environmental effects  
  → **Federal Office for the Environment** responsible for state indicators

• Organisation as *"Central assessment of environmental indicators (ZA-AUI)"*, analogous to *"central assessment of farm accounting data (ZA-BH)"*

• Data acquisition in the same network (currently env. 450 farms) and with the same partners as for accounting data:
  
  → **data collection**: reference data for proof of ecological performance, PEP by farmers, state indicators by FOE  
  → **data retrieval** by agricultural trustees  
  → **data storage and management** by advisory service (AgroTech system)  
  → **indicator calculation and interpretation** by ART
Agri-environmental indicators: production chain

farmers → data collection

agricultural trustees → data acquisition, plausibility check, data storage

agricultural research station ART → data analysis and interpretation

Federal Office for Agriculture FOA → publication, conclusions, political measures
Workflow in the project LCA-FADN
(Farm Accountancy Data Network)

- Farm
  - Accountancy-Software
  - Accountancy data
  - Accountancy Software (AGRO-TWIN)
  - Accountancy Data

- Trust and accounting office
  - Plausibility tests
  - FADN database

- LCA centre
  - SALCAprep data extraction
  - SALCAdatabase
  - LCA data
  - Feedback to farmers
  - SALCAcheck LCA validation and benchmarking
  - Farm management software (AGRO-TECH)
  - Technical data

- Existing FADN accountancy data
- Synergies FADN ↔ LCA-FADN
- New FADN Life Cycle Assessment

Outline

Swiss agricultural policy
- Swiss agriculture: facts and figures
- Swiss agricultural policy today
- Agriculture policy 2014-2017

**SALCA life cycle assessment** (Swiss Agricultural Life-Cycle Assessment)
- The concept of life cycle analysis with SALCA
- SALCA emission models and impact assessment methods
- Examples of applications

**Agri-Environmental Indicators** (Agri-Environmental Monitoring)
- Basic concepts
- SALCA tools
- Examples of results
Examples for AEIs: nitrogen

Evolution of N input, N output and N efficiency
Examples for AEIs: nitrogen

Nitrate concentration in groundwater, 2009

- ≤ 10 mg/l
- 10-25 mg/l
- 25-40 mg/l
- > 40 mg/l
- nicht beprobt

Maximalwert
Mittelwert

Ackeranteil
- 0 %
- 0-5 %
- 5-20 %
- 20-40 %
- > 40 %
Examples for AEIs: phosphorous

Evolution of phosphorous surplus and phosphorous efficiency

Quelle: Agroscope Reckenholz Tänikon
Examples for AEIs: phosphorous

Evolution of phosphorous concentration in four Lakes (mean values for years)
Examples for AEIs: nitrogen / phosphorous

Evolution of mineral fertilizer use

- nitrogen
- phosphorous

Quelle: SBV/Agricura
Examples for AEIs: nitrogen / phosphorous

Evolution of concentrated feed

- **imported feed**
- **CH Futtergetreide**
- **Veredelung von Importen 1**
- **Kuchen CH Ölsaaten**
- **CH andere**

1 Abfälle aus in der Schweiz verarbeiteten Agrarrohstoffen (z.B. Ölsaaten, Braugerste)
Examples for AEIs: energy / climate

Evolution of NH$_3$ emissions from animal husbandry (according to emission steps)

$NH_3$-$N = NH_3 \times 0.8224$

- Pasture
- Storage of l.m.
- Spreading of l.m.
- Housing, yard
- Storage of manure
- Spreading of manure

Quelle: SHL 2011
Examples for AEIs: energy / climate

Evolution of $\text{NH}_3$ emissions from animal husbandry (according to animal species)

NH$_3$-N = NH$_3$ x 0.8224

- Cattle
- Pigs
- Poultry
- Urease

Quelle: SHL 2011
Examples for AEIs: energy / climate

Contribution of the single greenhouse gases to total emissions in 2009
Share of agriculture

- CO2
- CH4
- N2O
- Synth. Gase

Share of agriculture

Quelle: BAFU
Examples for AEIs: water

Evolution of pesticide sales

Pesticides sold by companies

Quelle: Schweizerische Gesellschaft für Chemische Industrie

Examples for AEIs: water

Pesticide concentration in groundwater, 2009
Examples for AEIs: soil

Total C storage in soils and C content of soils

Quelle: Agroscope Reckenholz-Tänikon ART
**Examples for AEIs: soil**

<table>
<thead>
<tr>
<th>Category</th>
<th>1979/85</th>
<th>2004/09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building area</td>
<td>-21,265</td>
<td></td>
</tr>
<tr>
<td>Industry area</td>
<td></td>
<td>-3,806</td>
</tr>
<tr>
<td>Specific settlement area</td>
<td></td>
<td>-2,522</td>
</tr>
<tr>
<td>Recreational area, parks</td>
<td></td>
<td>-3,241</td>
</tr>
<tr>
<td>Traffic area</td>
<td></td>
<td>-5,467</td>
</tr>
<tr>
<td>Alp grazing area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Groves</td>
<td>-940</td>
<td></td>
</tr>
<tr>
<td>Forest</td>
<td>-890</td>
<td></td>
</tr>
<tr>
<td>Unproductive area</td>
<td>+247</td>
<td>+759</td>
</tr>
</tbody>
</table>

*Changes in agricultural area 1979/85 – 2004/09*

Quelle: Arealstatistik
Examples for AEIs: soil

Available area of arable soil per inhabitant of Switzerland

1979/85: 7.5 Mio. Einw. x 10 a
1992/97: 6.5 Mio. Einw. x 10 a
2005: 6.5 Mio. Einw. x 10 a

Quelle: BFS
Examples for AEIs: biodiversity / landscape

Evolution of area with environmental-friendly management

- Environmental friendly management
- Organic farming


Quelle: BLW
Examples for AEIs: biodiversity / landscape

Evolution of ecological compensation areas ("biodiversity areas")

1 ohne Hochstamm-Feldobstbäume; vor 1999 nur zu Beiträgen berechtigte ökologische Ausgleichsflächen

Quelle: BLW
Thank you for your attention!

ART – research for agriculture and nature

peter.weisskopf@agroscope.admin.ch