Climate and agriculture

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Outline

1. CLM in a nutshell
2. Climate and ag
3. Carbon calculators at farm level
   Questions
4. More than carbon: wider scope for farm level tools
   More questions
1. CLM in a nutshell

- Sustainable food & farming, biodiversity, water, rural development
- Research, advice, bridge building
- Started >30 years ago
- Independent, self-owned
- Started out as non-profit, now plc + foundation
- Currently 22 people and network of partner organisations
- One specialty: Measuring, monitoring and benchmarking (standards, systems and tools)
Clients

- Governments: EU, ministries, regional and local authorities
- Retail, food and agri-business (SAI-Platform, Jumbo, Sodexo, Heineken, Cono/Ben&Jerry, Ardo, FrieslandCampina, McCain, Bayer)
- Farmers’ organisations
- Environmental NGOs (FoE, Greenpeace, WWF)
CLM’s scope

• Mainly Netherlands
• Some work at European level (EU research projects)
• Some international activities, e.g. with SAI-Platform, Cool Farm Alliance
• Contact with IATP since early years
2. Agriculture and climate change
GHG emissions per sector, global, 2007

- Energy supply: 26%
- Industry: 19%
- Transport: 13%
- Agriculture: 14%
- Forestry: 17%
- Waste and wastewater: 3%
- Residential & Commercial buildings: 8%

IPCC 2007
CO2 from land

Net emissions/removals by land use  Average 1990 - 2012

- Forest land: 61%
- Cropland: 25.9%
- Burning Biomass: 12.2%
- Grassland: 0.9%
CO2 from land use change

Net emissions/removals by continent (CO2 equivalent) Average 1990 - 2012

- Africa
- Americas
- Asia
- Europe
- Oceania
- World
GHG top-10 emitters (FAOstat)

Top 10 emitters (CO2 equivalent) Average 1990 - 2012

- China, mainland
- India
- Brazil
- United States of America
- Australia
- Indonesia
- Russian Federation
- Argentina
- Pakistan
- Sudan (former)

M = Million, k = Thousand

Emissions (CO2eq)
Today’s focus:
- Farm level only
- Agriculture only (not afforestation or clearing of land)
- Not consumer phase, e.g. reduced meat consumption
- Not about food waste (33% is lost, say FAO)
Delination: farm level

- Raw materials: 30 - 90%
- Manufacturing: 2 - 15% (processing)
- Distribution: 1 - 5%
- Store operations: 10% - 70% (including cooling and preparing dishwashing)
- Consumers: 10% - 70%
Climate change and the farm

- Part of the cause of climate change
- One of the sectors most hit by consequences
- And part of the solution
Climate change and the farm

- **Cause:** emissions of CO2, N2O and CH4
- **Consequences:** droughts, weather extremes, shifting patterns of pests and diseases, longer growing seasons
- **Solution:** fixing carbon in soils (and in landscape elements). Producing biomass.
Climate change and the farm

- **Cause:** emissions of CO2, N2O and CH4.
  - Reduce
- **Consequences:** droughts, weather extremes, shifting patterns of pests and diseases, longer growing seasons
  - Adapt
- **Solution:** fixing carbon in soils (and in landscape elements). Producing biomass.
  - Optimise
Have some more beans, Bessy.

Global Warming Axis of Evil
GHG emissions from farming (FAOstat)

Average 1990 - 2012

- Synthetic Fertilizers: 12%
- Rice Cultivation: 10.1%
- Manure Management: 7.1%
- Manure left on Pasture: 15.2%
- Manure applied to Soils: 3.6%
- Burning - Crop residues: 0.5%
- Burning - Savanna: 5.2%
- Crop Residues: 3.5%
- Cultivation of Organic Soils: 2.8%
- Enteric Fermentation: 40%
GHG emissions from farming (FAOstat)

Average 1990 - 2012

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... and energy embedded in inputs, notably fertilizers
Reduce emissions: increase efficiency

Example efficiency:
- Dairy: reduce number of heifers
- Crops: split application of fertiliser
- Increase production per ha with precision farming

Scope for reduction (order of magnitude):
- Modern dairy farm: 10%
- Extensive arable farm: 25%
Sequestration

A rough though promising estimate

- World agriculture area is about 48 billion square kms, or 4800 billion hectares.
- Assume some 4000 bn hectares can fix CO2
- A farmer can fix $\frac{1}{2}$ tonne CO2 per ha per year
- On all the world´s hectares this equals 2 billion tonnes of CO2
- That is around 5% of global emissions (34.5 billion tonnes in 2012)
Sequestration

Fix carbon in the soil (and landscape elements)
- Leave stubble and crop residue
- Apply manure and compost
- Reduce soil tillage
- Cover crops / green manure
- Maintain grasslands
- Not cut down hedges and trees
- ....
Where it comes together

In a nutshell, advice to the farmer is:
• Produce more efficiently…
• …while caring for the soil

Contradiction?

*Efficiency ↔ Resilience*
Climate smart agriculture (CSA)

Global Alliance on Climate Smart Agriculture
• Launched (by government of the Netherlands) at UN Climate Summit September 2014.
• Backed by 75 countries and organizations, such as the World Bank.
• Sourcebook
Climate smart agriculture

- Often translated to: sustainable intensification
- However, FAO: “Efficiency and resilience should be pursued together”
- Resilience:
  - increasing diversity in the field, e.g. from slash-and-burn to agroforestry
  - More productive livestock more vulnerable to disease and heatwaves
  - Same for plant production: high performance means high maintenance, delicate balance
  - Diversity beyond field level: the farm, the region, the system (ecologic, watershed, economic and social)
So what’s new?

CSA sounds like single issue, though with direct relations to water availability, soil quality, nutrient efficiency, diversity (social and environmental).

*Sustainable farming all over again?*
So what’s new?

However

• CSA is provides a new driver: a “new”, additional direct risk to farming (in addition to soil loss, disease pressure etc).
• Nutrient loss, soil degradation, water shortage can be partly solved (and masked) by technological fixes. Not so with climate.
• CSA is another driver for the `landscape approach`: ecosystems, watersheds, social and economic context (note: easier for govts and local stakeholders than for food companies)
• So: not so much news on the contents, but new driver for change.
Why do food companies worry about sustainability?

- Security of supply
- Company reputation
- Genuine concern
Why do food companies worry about sustainability?
- Security of supply
- Company reputation
- Genuine concern

Why do they publish tools?
- Help farmer understand and improve
- Provide companies insight into (their) actual sustainability impact
- Aggregate results for company reporting…
- …. and eventually benchmarking
Climate smart agriculture: the food chain

• Virtually all food companies and retailers say climate change is priority
• Moving up the chain to farm level (because that is where most of the impact is):
  • asking farmer for his carbon footprint.
  • Farmer: What is it, why should I, and how can I?
  • Food company: here is a calculator – please use it
• Prime focus is efficiency
3. Carbon calculator tools

- CLM’s climate yardstick
- Cool Farm Tool
- Farm smart tool
3. Carbon calculator tools

- Easy to use for farmer solo
- Input basic farm data
- Provide farm level calculations
- Offer relevant measures to farmer
- Provide immediate results, graphs and tables
- Interactive: scenarios and comparison
- Science based
- Focus on emissions, with some attention to soil carbon (emissions or fixing)
CLM climate yardstick

Highlights CLM:
- Very user friendly structure and look-and-feel
- Particularly good animal production data and methodology
- Farm-level focus
- Used in Netherlands and Denmark (background data Dutch and Danish)
CLM Climate Yardstick

Home : Dairy farm : test nieuwe versie : Livestock and stables

Save form

Livestock

• Give the average quantity of animals per category (animal category)

Dairy cows 100 (Number)
Wearers 0-1 years 33 (Number)
Yearlings 1-2 years 30 (Number)
Culled cows (Number)

Purchase/sale

• Indicate number of animals bought or sold

Type of animal
Purchase/sale Number/year
Wearers 0-1 years
Yearlings 1-2 years

Milk production

Fill in the requested values

Per cow 8000 kg/year
Urea number 25 mg/100g
Stable type dairy cattle

- Indicate which stable type is used for your dairy cattle

If your stable type is not listed please choose the one that fits best

Stable type: Free stall cubicle dairy barn with slatted floor

Outdoor grazing

- Indicate the period of outdoor grazing (in months) and the number of hours of outdoor grazing per day

<table>
<thead>
<tr>
<th>Type of animal</th>
<th>Grazing period (months/year)</th>
<th>Time at pasture (hours/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy cows</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Weaners 0-1 years</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Yearlings 1-2 years</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>Culled cows</td>
<td>6</td>
<td>24</td>
</tr>
</tbody>
</table>
Greenhouse gas emission of farm by source

- Feed purchase: 40.3
- Ind. soil emissions: 35.9
- Peat mineralisation: 26.9
- Biological N fixation: 3.3
- Beweeding: 63.0
- Ploughing grassland: 43.4
- Purch. chem. fert.: 77.1
- Fert. application: 15.6
- Manure application: 5.0
- Barn and manure stor.: 4.1
- Rumen fermentation: 387.9
- Transport, contract: 55.2
- Energy use: 0.0

© www.clm.nl
CLM Climate Yardstick

Greenhouse gas emission per kg milk

- **Total**: 1.0 CO2-eq ton/kg milk
- **CO2**: 0.2
- **CH4**: 0.5
- **N2O**: 0.3
Climate Yardstick - workshops

broeikasgasvergelijk bron per liter melk

energielokale
transport, arbeid, dieren
penfermentatie
gel en mengboringen
beweiding
bemesting celstof
sloop
graanland
biologisch N-binding
voer, mineralen
indirecte bodemvloeistoffen
vooraanzicht
FarmSmart

- Online tool, GHG emissions and energy
- Specifically for dairy farmers
- USA based (US Geo data)
Cool Farm Tool

- Worldwide coverage: all crops and regions
- Product-based
- Very broad support base from industry
- Scope for more themes to be covered
Cool Farm Alliance

www.coolfarmtool.org
Cool Farm Tool

- Overseen by University of Aberdeen
- Tool draws on established research, e.g.:
  - Livestock: IPCC Tier 1 and 2 calculations
  - Field N$_2$O: Bouwman model (used in IPCC)
  - Soil: Ogle model
  - Fertilizer emissions: Fertilizer’s Europe
  - Energy: GHG Protocol, IEA and EPA
  - SAI Platform compliant
Welcome to the Cool Farm Tool Online

You have four main options. You can create a new crop or livestock product footprint, view a previously entered product footprint or change your farm settings. Note that after they are first entered, farm settings are unlikely to change.

- add crop product
- add livestock product
- farm settings
- view products
General information

Enter basic crop properties to get started.

Crop type: Dry Bean
Year: 2014
Name: dry_bean_2014
Fresh product weight: 1 tonnes
Finished product weight: 1 tonnes

Co-products

Are there any marketable by-products of this crop that you use or sell?

Other comments

Add comments about this section

Back  Save & continue
Field treatment

This page allows you to specify your farming methodology. In the following sections, provide as much information as possible on fertiliser and pesticide applications and crop residue management.

Fertiliser applications

- **Type:** Monoammonium phosphate - 11% N / 52% P2O5
- **Production:** Estimate production impact from region of origin
- **Source region:** World (2007)
- **Rate:** 65.38 lbs / acre
- **Rate measure:** product
- **Method:** Incorporate
- **Emissions inhibitors:** None
**Product result**

**dry_bean_2014**

- **Crop type**: Dry Bean
- **Reporting year**: 2014
- **Fresh product**: 1.00 tonne
- **Finished product**: 1.00 tonne
- **Product yield**: 2,479.00 kg/ha
- **Growing area**: 1.00 acres, medium, moist

**Summary**

- **Total emissions**: 262.87 kg CO2e
- **Emissions per hectare**: 649.28 kg CO2e
- **Emissions per product**: 262.87 kg CO2e

**Total emissions**

<table>
<thead>
<tr>
<th>Category</th>
<th>CO2</th>
<th>N2O</th>
<th>CH4</th>
<th>Total CO2eq</th>
<th>Per hectare</th>
<th>Per tonne</th>
<th>Per tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy use (processing)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Energy use (field)</td>
<td>40.20</td>
<td>-</td>
<td>-</td>
<td>40.20</td>
<td>99.29</td>
<td>40.20</td>
<td>-</td>
</tr>
<tr>
<td>Fertiliser production</td>
<td>64.92</td>
<td>-</td>
<td>-</td>
<td>64.92</td>
<td>160.34</td>
<td>64.92</td>
<td>-</td>
</tr>
<tr>
<td>Soil / fertiliser</td>
<td>25.96</td>
<td>0.27</td>
<td>-</td>
<td>105.66</td>
<td>260.97</td>
<td>105.66</td>
<td>-</td>
</tr>
<tr>
<td>Carbon stock changes</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Paddy methane</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Post-ripening</td>
<td>41.50</td>
<td>-</td>
<td>-</td>
<td>41.50</td>
<td>102.50</td>
<td>41.50</td>
<td>-</td>
</tr>
<tr>
<td>Crop residue mgmt</td>
<td>0.04</td>
<td>-</td>
<td>-</td>
<td>10.50</td>
<td>23.16</td>
<td>10.50</td>
<td>-</td>
</tr>
<tr>
<td>Off-farm transport</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Waste water</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>172.57</td>
<td>0.30</td>
<td>-</td>
<td>262.87</td>
<td>649.28</td>
<td>262.87</td>
<td>-</td>
</tr>
</tbody>
</table>

**Co-products emissions**

**Field management emissions**

**Machinery operations**

**Transport**
Questions?
4. More than carbon
4. More than carbon

Farmer’s concern is primarily with yield, margin, soil, inputs like N, P and pesticides.

In addition, food companies and retail interested in climate change, water and biodiversity

Include all into the tool: much more interesting
Cool Farm Tool now adding
- Water footprint
- Biodiversity score
- Farm economy

Other tools like FarmSmart, Field to Market and Stewardship Index for Specialty Crops also aim to cover most essential issues.
Biodiversity in the Cool Farm Tool
Measuring biodiversity on the farm

Pressure factors
Land use, GHG, toxic-, eutrophic-, acidic emissions, use of water etc.

Natural conditions and management effort
Conditions: surface of natural area, landscape elements etc.
Management: e.g. delayed mowing, field-margins

Number of species / abundance
Counting species
Measuring biodiversity on the farm

Pressure factors
Basic conditions for biodiversity; indirect / abstract

Natural conditions and management effort
Habitats and their condition; visible on farm / concrete

Number of species / abundance
Actual measurement of biodiversity

From abstract \(\rightarrow\) concrete
Measuring biodiversity on the farm

Pressure factors
Not accurate enough

Natural conditions and management effort
Workable proxy

Number of species / abundance
Too complex, not feasible
# Biodiversity in the Cool Farm Tool

## Input

- **Productive Area**
  - 
  - Management
  - 1. Livestock, crop and variety
  - 2. Cultivation measures: functional
  - 3. Cultivation measures: nature oriented
  - 4. Small natural habitats
  - 5. Larger natural areas
  - 6. Nature on farm yard

- **Non-Productive Area**
  - Management and design

## Questionnaire

- Multiple choice and areas of natural elements
Biodiversity in the Cool Farm Tool

General biodiversity results

Land area

- production
- small non-productive areas
- natural reserves

Start
Livestock & crops
Field (functional)
Field (agrarian)
Small natural areas
Large natural areas
Farm-yard
Results

Biodiversity assessment (ALPHA)

Cultivation measures: functional

10 / 30
3.3 Which measure do you take in favour of the field fauna or flora?

For a part of the plot (at least 0.5 ha), or margins at least 3 m wide

You can select multiple answers.

- Artificial fertiliser not used when grain grown
- No mechanical and chemical weed control during the cropping period
- Grain (other than maize) grown for at least 3 of the 6 years on a plot
- The grain stubble is left standing until the next spring
- A (small) part of the field is not harvested (feed for fauna)
- None of the above
### 3.3 Which measure do you take in favour of the field fauna or flora?

*For a part of the plot (at least 0.5 ha), or margins at least 3 m wide*

*You can select multiple answers.*

- [ ] Artificial fertiliser not used when grain grown
- [x] No mechanical and chemical weed control during the cropping period
- [ ] Grain (other than maize) grown for at least 3 of the 6 years on a plot
- [ ] The grain stubble is left standing until the next spring
- [ ] A (small) part of the field is not harvested (feed for fauna)
- [ ] None of the above

*EASY, BUT UNSURE OF OUTCOMES*
Biodiversity in the Cool Farm Tool

EASY, WITH EVIDENCE OF OUTCOMES
# Biodiversity in the Cool Farm Tool

<table>
<thead>
<tr>
<th>Measure</th>
<th>Median effectiveness score</th>
<th>Median certainty score</th>
<th>Category</th>
<th>Category value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant nectar flower mix</td>
<td>&gt;60</td>
<td>&gt;60</td>
<td>Beneficial</td>
<td>2</td>
</tr>
<tr>
<td>Raise water levels in grassland</td>
<td>&gt;60</td>
<td>40-60</td>
<td>Likely to be beneficial</td>
<td>1</td>
</tr>
<tr>
<td>Take field corners out of management</td>
<td>40-60</td>
<td>40+</td>
<td>Unknown effectiveness</td>
<td>0</td>
</tr>
<tr>
<td>Create beetle banks</td>
<td>&lt;40</td>
<td>40-60</td>
<td>Unlikely to be beneficial</td>
<td></td>
</tr>
<tr>
<td>Reduce grazing intensity</td>
<td>&lt;40</td>
<td>&gt;60</td>
<td>Likely to be ineffective or harmful</td>
<td>Excluded</td>
</tr>
</tbody>
</table>

www.conservationevidence.com
Ideal tool includes (in this order)

- Farm economy
- Nutrient balances
- Pesticide scores
- Soil quality
- Water use score
- Biodiversity
- GHG emissions
Thank you for your attention

www.clm.nl