# Perspectives of organic agriculture and sustainability in 2050

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# Outline

1. Most burning environmental/health issues

2. 2050:  forecasts, projections and urgent changes

3. Models on how to feed the world in 2050

4. FAO's SOL-m

# Burning issues

# In 2050...

- another 2 billion people will live on the planet, 70% of them in cities

- India and China will represent 50% of world population

- further reduction of land productivity due to increasing water scarcity; erratic weather; changes in pest and disease patterns; land degradation

- GHG emissions will reach 685 ppm CO2e, leading to an increase in global mean temperature of 2-2.8 ºC (OECD Environmental Outlook to 2050. 2011).

- 70% increase in food production will be needed compared to 2005-2007 levels to meet the increased demand. Global meat consumption will rise with a further 65% (Steinfeld *et al.*, 2006: Livestock's long shadow)

# Urgent changes in farming systems

**Agro-ecological systems has to play a fundamental role in becoming a solution these burning problems. We need food systems that are healthy, resilient and delicious**

– Support agro-ecological smallholder agriculture and provide economic opportunities for these farmers

– Upscale urban agriculture projects - improve food security, raise incomes, empower women, improve health and urban environments

– Empower local food communities to be co-designers of local solutions and transmit their solutions to other communities

# Urgent changes in farming systems

– Diversify on both genetic and species level: polycultures, food forests, perennials, agroforestry, mixed cropping/rice-fish

– Use locally adapted varieties, save seeds, promote rare and traditional breeds

– Adopt all possible water and soil conservation techniques (earthen dams, swales, rainwater harvesting);

– Rely on renewable energies mostly from on-farm sources;

– Introduce/increase wildlife habitat (edges, ponds, wildflowers strips, etc);

– Establish as many connections within systems to create stability;

– Pay living wages; offer fair contracts; enhance local economies and foster health and safety for workers, farmers and local communities.

# Other urgent changes

Changing our farming systems is not enough if we want our agriculture to be sustainable...

– eliminate food loss and waste

– eat differently

– feed our livestock differently (grass-fed)

– restore degraded ecosystems by initiating large scale restoration projects (e.g. Loess Plateau)

**Large-scale restoration project in China:**

In 10 yrs

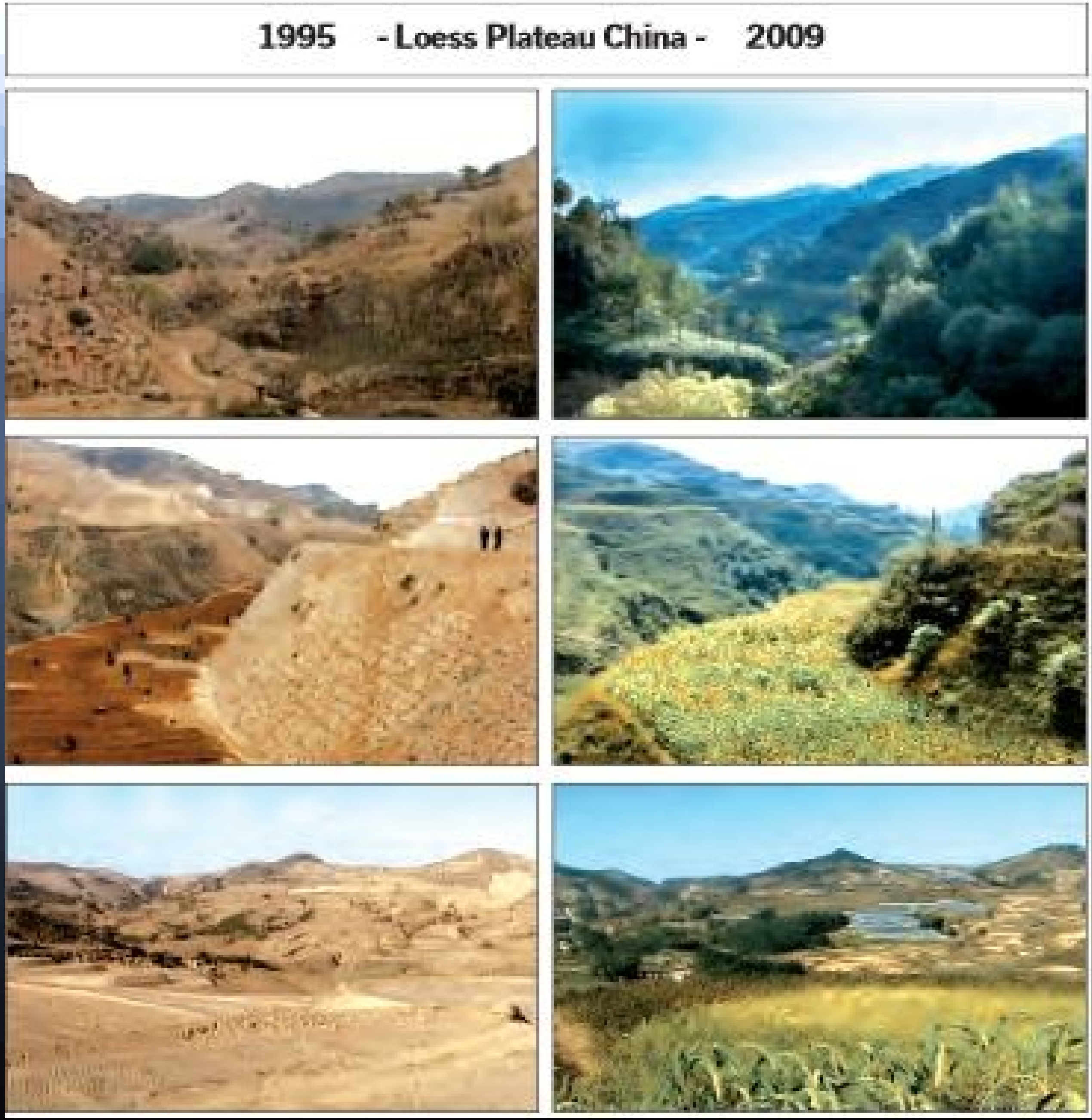
on 35.000 km2

with 500 million $US

complete restoration

agri land was reduced to 40%, yet income raised by 300%.

(video: *“Hope in a changing climate”*)



# Models on how to feed the world in 2050

– **Agrimonde, 2010.**

→ 30% decline in demand in food calories compared to business as usual scenario

– **Erb *et al.*, 2009.**

→ OA can probably feed the world population of 9.2 billion in 2050 if relatively modest diets are adopted, with a low level of inequality in food distribution required to avoid malnutrition

– **Jones and Crane, 2009. (Univ. of Reading)**

→ A wholly OA would supply more grass-fed beef and sheep, far less grain-fed dairy, pigs and poultry and vegetable and fruit production would increase. Same amount of grains would be produced for human consumption than currently.

# SOL-m: rationale

**1. Model needed to address both food availability and environmental impacts of food production**

"the livestock sector emerges as **one of the top two or three most significant contributors to the most serious environmental problems**" (Steinfeld *et al.* 2006) -- deforestation, desertification, excretion of polluting nutrients, overuse of freshwater, inefficient use of energy, diverting food for use as feed and emission of GHGs.

- projected increase of world population
- swelling demand for livestock products
- rapidly diminishing natural resource base

} 2. CALL FOR urgent reduction of the ecological footprint of livestock production.

→ Sustainability and Organic Livestock Model (SOL-model)

computes and analyzes the potential impacts of a global conversion of livestock systems to low-input and organic systems.

# SOL-m: objectives

- To model the potential **impact of up-scaling organic livestock production globally** on food availability, GHG emissions, biodiversity loss, resource use (i.e. land, water, non-renewable energy) and socio-economic well-being

- To study the **macro-environmental and economic trade-offs and synergies** resulting from global conversion

- To clarify the potential **role of organic livestock systems within global food production in addressing global sustainability challenges**.

# SOL-m: modelling approach (1)

– **Linear programming model** (allows for optimization of production with respect to different policy goals)

– **General Algebraic Modeling System** (GAMS)

– Base year: average of 2005-2009

– **Target year: 2050**, based on projections of global population increase and eating patterns

– **Challenge:** compile and harmonize the large set of different data sources to a common database

# SOL-m: modelling approach (2)

– ***Ceteris paribus**:* biofuels, GMOs, aquaculture, fisheries and everything else that does not directly interfere with the research questions are **fixed in the model**

– **Country classifications**: based on FAOSTAT, and United Nations Statistical Division; aggregation on regional/global level

– **Data primarily from FAOSTAT**. Complimentary data (grassland, organic farming, livestock systems, environmental indicators) from other data sources, mainly from peer-reviewed scientific publications. Remaining data gaps filled by expert consultations.

– **Model is structured into a food supply, food demand and food balance module** – food waste in entered as variable

| Environmental impact | Indicator |
| --- | --- |
| **Land occupation** | Land occupation in terms of arable, permanent crops and grassland |
| **Land degradation** | Crop-specific factor covering the erosion- susceptibility of crops (length of period when soil is bare) |
| **Use of fossil energy resources** | Cumulative energy use (based on LCA) |
| **Global warming potential** | GWP (Tier 1 and 2 approaches) |
| **Nitrogen eutrophication** | Nitrogen surplus and losses (per land use activity and country) |
| **Phosphorus eutrophication** | $P_2O_5$ surplus (per crop and country) |
| **Toxicity** | Average amount of and danger of pesticides used per ha |
| **Deforestation pressure** | Additionally required crop land |
| **Grassland exploitation** | Cattle stocking density on grasslands |
| **Biodiversity** | 4 out of 5 main drivers of biodiversity loss (MEA, 2005) |

# SOL-m: scenarios (1)

**Scenario 1:** **baseline FAO scenario for 2050** with the corresponding trends for population growth, yield increases, meat consumption, etc. (Alexandratos and Bruinsma, 2012 ). Livestock type specific feeding ratios (e.g. grassland/ concentrate shares) remained unchanged.

**Scenario 2:** **50% reduction in livestock concentrate feeding.** Feeding ratios were adapted according to feed availability and this determined the livestock numbers.

**Scenario 3:** **complete ban of concentrates** (while non-food by-products from food production are still included in feed).

# SOL-m: scenarios (2)

Scenario 4: **complete conversion to organic livestock husbandry, including feed production.** Organically produced concentrates at potentially high shares are allowed. Animal numbers are determined by feed and food availability when the whole livestock husbandry is organic.

Scenario 5: **combines Scenario 3 and 4, by assuming both a conversion to organic livestock production and a complete ban of concentrate feeding.**

General condition for all scenarios: to provide at least as much calories for human nutrition as the FAO baseline Scenario 1.

# SOL-m: preliminary results (1)

- **In Scenario 2 and even more so in Scenario 3, food availability increases while pressure on forest areas decreases and many positive environmental impacts could be achieved.**

- **Scenario 4** (with organically produced concentrate feed) promises to yield many environmental benefits, however

  **334 million additional ha would be needed for an organically-produced supply, even if demand for animal products would halve** (base year: 70 million ha)

# SOL-m: preliminary results (2)

- **Sufficient calories and protein could be produced in 2050 without compromising environmental impacts through a global conversion** to low-input and organic livestock management.

***IF***

**consumption levels** of livestock products decrease

***AND***

**it refrained from using**

**concentrate feeds** (Scenario 5) !

| Indicator | Base year | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 | Scenario 5 |
|---|---|---|---|---|---|---|
| | 2005-2009; current situation | 2050; baseline according to official FAO forecast | 2050; 50% reduction of concentrate use | 2050; 100% reduction of concentrate use | 2050; full conversion of livestock to organic management | 2050; Scenario 3 and 4 combined |
| Agricultural land | → | ↗ | ↘ | ↘ | ↑ | ↘ |
| Human population | → | ↑ | ↑ | ↑ | ↑ | ↑ |
| Available food energy for human consumption | → | ↑ | ↑ | ↑ | ↑ | ↑ |
| Available food protein for human consumption | → | ↑ | ↑ | ↑ | ↑ | ↑ |
| Share of livestock products | → | ↑ | ↓ | ↓ | ↓ | ↓ |
| Share of plant products | → | ↘ | ↑ | ↑ | ↑ | ↑ |
| Nitrogen surplus | → | ↑ | ↗ | ↓ | ↓ | ↓ |
| Phosphorus surplus | → | ↓ | ↑ | ↗ | ↓ | ↓ |
| Energy use | → | ↑ | ↘ | ↓ | ↗ | ↓ |
| Global Warming Potential (GWP) | → | ↑ | ↑ | ↓ | ↓ | ↓ |
| Land degradation potential | → | ↑ | ↘ | ↘ | ↑ | ↘ |
| Deforestation pressure | → | ↑ | ↓ | ↓ | ↑ | ↓ |
| Toxicity potential | → | ↑ | ↘ | ↘ | ↓ | ↘ |
| Grassland overexploitation | → | ↑ | ↑ | ↗ | ↑ | ↗ |
| Biodiversity | → | ↓ | ↗ | ↑ | ↑ | ↑ |

# SOL-m: preliminary results (3)

**Main conclusions:**

1. **Current livestock systems cannot go on as it is undermining the very base of food production. They have to be grassland-based** by 2050 in order to feed the growing population (land freed from concentrate feed production would be used for plant-based food) and to decrease environmental pressure substantially.

2. **We have to consume much less livestock products.** None of the scenarios, including the base year, could ever be sustainable without a global shift to decreased consumption of livestock products (consumption has to go down to a third or fourth of the base year levels).

# Concluding remarks

**1. WE NEED TO DIVERSIFY OUR FARMING SYSTEMS**

**2. RESTORE OUR GRASSLANDS (and other degraded ecosystems) AND SHIFT OUR LIVESTOCK FEED**

– cover between 3.5 - 5.6 billion ha, accounting for 26-40% of the world's ice-free surface;

– contribute to the livelihoods of 800 million people

– feed source for livestock, a habitat for wildlife, provide *in situ* conservation of plant genetic resources

– betw one-third - one-half of total soil C is stored in grasslands

– 50% of world grasslands are degraded and experiencing desertification.

# Concluding remarks

**3. WE NEED TO ELIMINATE OUR FOOD LOSS AND WASTE**

**4. WE NEED TO CHANGE OUT DIET:**

**– less livestock-based protein, more plant and insect-based** (1900 species used as food: highly nutritious, healthy food source with high fat, protein, vitamin, fibre, mineral content)

**– less processed food**

**– more seasonal vegetables and fruits**

**– more fibres**

**– more diverse and microbiota-friendly diet.**


# Thank you!

www.fao.org/nr/sustainability

www.fao.org/organicag