PROCEEDINGS
OF THE INTERNATIONAL CONFERENCE
ON ORGANIC AGRICULTURE AND CLIMATE CHANGE

September 28 - 29, 2009
Sofia, Bulgaria

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Editor: Darko Znaor

Avalon

P.O.Box 14, 8730 AA
't Bosk 71, 8731 BK
Wommels
The Netherlands
Tel (+31) (0)515 331955
Fax (+31) (0)515 331980
E-mail: office@avalon.nl
http://www.avalon.nl


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INTRODUCTION

The problem

Climate change is one of the most challenging issues the mankind faces today. The Earth is warming up! The burning of fossil fuels, the cutting of forests and environmentally-unfriendly farming practices are the key reasons why the average temperature of the Earth's surface has risen by 0.74 °C since the end of the 19th century. The temperature rise causes glaciers, permafrost and sea ice melting. It disturbs and destroys ecosystems and species, causes sea levels rising, seasons changing and more extreme weather, resulting in more frequent flooding and drought, more disease, more famine and hundreds of millions of environmental refugees.

The role of agriculture

Contrary to most other sectors, agriculture is both the source of greenhouse emissions (GHG) and a likely victim of climate change. Agriculture is a significant source of two greenhouse gases: nitrous oxide and methane. Agricultural soils and livestock directly emit GHG, while agriculture's indirect emissions include fossil fuel use in farm operations, the production of agrochemicals and the conversion of land to agricultural use from forests. Agricultural direct emissions globally make up 14% of all anthropogenic GHG emissions. However, the total global contribution of the agricultural sector, including all direct and indirect emissions, is in the range of 17-32% of all global human-caused GHG emissions. Livestock farming and fertiliser use are by far the two most significant sources of GHG deriving from agriculture. Through enteric fermentation in the rumen, ruminant livestock (cattle, sheep and goats) produce methane, contributes to about 60% of all global methane emissions. Additionally, both methane and nitrous oxide are emitted from the storage, application and decomposition of manure in the soil. Nitrogen fertilisers applied on agricultural land emit nitrous oxide, a gas whose global warming potential is nearly 300 times greater than of CO2. Besides livestock farming and fertilisers, agriculture emits GHG through the production of legume crops, residue burning and land use change (e.g. conversion of carbon-rich grassland soils or forests into arable land).

Organic farming and GHG emissions

Organic farming contributes to the reduction GHG emissions because it reduces the consumption of fossil fuels (notably those used in fertiliser manufacturing), reduces emissions of CO_2, methane and nitrous oxide. It also reduces vulnerability of soils to erosion, while at the same time increasing carbon stocks in the soil. Consequently, conversion to organic farming is believed to be a viable way of reducing GHG emissions. Depending on the commodity produced, organic farming emits 6-60% less GHGs than non-organic farming. However, when calculated per kg of product, in the case of substantially lower yields, organic farming can result in a higher global warming potential.
Objectives

The conference objectives were to:

1. Inform about potentials and challenges of organic farming in regard to climate protection.
2. Provide opportunity to exchange ideas about research, education and demonstration projects and opportunities on organic farming and climate change.
3. Inspire to adopt policies fostering development of organic farming and promoting the spread of its practices.

Target group:

The conference will bring together a range of organic farming stakeholders, mainly from Central and East European countries, the Balkans, the Caucasus and Central Asia. The participants are expected to come from the ministries, universities, research institutes, extension service, organic NGOs and the business sector.

The programme

Sunday, September 27, 2009.

Arrival and registration of participants

19.00 – 21.30 Welcome dinner (organic)

Monday, September 28, 2009.

Theme: Organic Farming and International Policies on Climate Change

Chairman:	Prof Branko Bošnjaković, Supervisory Board Member, Avalon, the Netherlands
08.45 – 09.00	Musical opening
09.00 – 09.10	Greetings and Introduction Mr Martien Lankester, MD. Executive Director, Avalon, the Netherlands
09.10 – 09.20	Word of Welcome Ms Nona Karadjova, Minister, Ministry of Environment and Water, Bulgaria
09.20 – 09.30	Word of Welcome Dr Viara Stefanova, Head of Department of Agroecology, Ministry of Agriculture and Food, Bulgaria
09.30 – 09.35	Word of Welcome Mr Martijn Elgersma, Deputy Head of Mission, Royal Netherlands Embassy Sofia
09.35 – 09.50	The role of Organic Farming in Environmental Protection and the FAO's Policies Dr Rainer Krell, Environment Officer Bioenergy and Climate Change, Food and Agriculture Organisation of the United Nations, Italy
09.50 – 10.10	International Organic Farming Movement and Climate Change Policies Mr Markus Arbenz, MSc., Executive Director, IFOAM (International Organisation of Organic Agriculture Movements), Germany
10.10 – 10.30	The role of ecosystem restoration in preventing climate change Mr John Liu, MSc., Director, Earth's Hope, the USA (video presentation)
10.30 – 11.00	Coffee break

Theme: Green Farming vs. Black Carbon

Chairman:	Mr Martien Lankester, MD. Executive Director, Avalon, the Netherlands
11.00 – 11.40	The Role and Potential of Soil Carbon Sequestration in Protecting Climate Prof Rattan Lal, Director of the Carbon Management and Sequestration Center, School of Environment and Natural Resources, the Ohio State University, the USA
11.40 – 12.20	Organic Farming and Climate Change Dr Claude Aubert, Organic Agriculture Pioneer, Association of the French Members of IFOAM, France
12.20 – 12.45	Impact of Large-Scale Conversion to Organic Farming on Greenhouse Gas Emissions Dr Darko Znaor, Associated Expert, Avalon, the Netherlands/Croatia
12.45 – 13.00	Discussion
13.00 – 14.30	Lunch

Theme: Organic Food and Farming and Climate Change in EU Member States

Chairman:	Prof Rattan Lal, Director of the Carbon Management and Sequestration Center, School of Environment and Natural Resources, the Ohio State University, the USA
14.30 – 15.10	Relevance of Organic Farming for Climate Change in Germany? Dr Guido Haas, Organic AgroExpertise Consultancy, Germany
15.10 – 15.50	Lower Your Carbon Foot Print and Eat Organic: the Case of Poland Mr Tokya E. Dammond, MSc., Chairman and Founder of Symbio Polska S. A., Poland
15.50 – 16.05	Discussion
16.05 – 16.45	Coffee break

Theme: Painting a Wider Picture

Chairman:	Dr Rainer Krell, Environment Officer Bioenergy and Climate Change, Food and Agriculture Organisation of the United Nations, Italy
16.45 – 17.15	Carbon Mining: the Story of Carbon Disappeared from the Agricultural Soils of Central and Eastern Europe Prof Tamas Nemeth, Head of Research Institute for Soil Science and Agricultural Chemistry of the Hungarian Academy of Sciences, Hungary

17.15 – 17.45	Organic Livestock: Good or Bad for Climate Protection? Ms Kathleen Hewlett, Policy Researcher, the Soil Association, UK
17.45 – 18.00	Discussion
19.00 – 21.30	Dinner (with as much as possible organic ingredients from Bulgaria)

Tuesday, September 29, 2009.

Theme: Organic Farming Soil Carbon: a Tradable Commodity?

Chairman:	Dr Nune Darbinyan, President of Eco-Globe, Armenia
09.00 – 09.30	Carbon Neutral Organic Food and Farming Business Drs Volkert Engelsman, Managing Director of EOSTA, the Netherlands
09.30 – 10.00	International Carbon Market Mechanisms: is there Any Role for (Organic) Farming? Mr Matt McCandless, M.N.R.M., P.Eng., Project Manager, International Institute for Sustainable Development, Canada
10.00 – 10.30	Discussion
10.30 – 11.00	Coffee break

Theme:	**Successful Project Examples**
Chairman:	Drs Volkert Engelsman, Managing Director of EOSTA, the Netherlands
11.00 – 11.35	SEKEM Initiative: Farming the Desert Organically (Bio-dynamically) Mr Tobias Bandel, Project manager, SEKEM, Egypt
11.35 – 12.05	The Lessons of the Loess Plateau: Fighting Climate Change in China Mr John Liu, MSc., Director Earth's Hope, the USA (video presentation)
12.05 – 12.30	Discussion
12.30 – 13.00	Presentation, Discussion and Adoption of the King's Village Declaration on Climate Change and Organic Farming Mr Martien Lankester, MD. Executive Director, Avalon, the Netherlands
13.00 – 14.30	Lunch
14.30 – 19.30	**Organic Food Excursion**
19.30 – 21.30	Dinner (with as much as possible organic ingredients from Bulgaria)

The King’s Village Declaration
on Organic Agriculture and Climate Change

The Netherlands - November 2009

By endorsing the King’s Village declaration, 98 participants, representing 28 nationalities, of the Avalon International Conference on Organic Agriculture and Climate Change, held on September 28 and 29, 2009 at King’s Village, Sophia, Bulgaria, would like to urge farmers, the business community, consumers and policy makers to act responsibly and to support the further adoption of organic farming.

Organic Farming & Protecting Our Climate

Organic farming can make a contribution towards solving numerous social, environmental, economic and agronomic problems. In particular, organic farming can contribute to protecting our climate from further degradation and undesirable changes. The existing scientific evidence suggests that organic farming mitigates climate change on two levels. It reduces the consumption of fossil fuels (notably those used in fertiliser manufacturing) and thus cuts emissions of greenhouse gasses. At the same time it increases the long-lasting carbon stock in the soil, decreasing its concentration in the atmosphere. Soil carbon plays a key role in maintaining long-term soil fertility. It provides plant nutrients, enhances the soil’s microbiological activity, structure and water holding capacity. The latter is particularly important in our time, when extreme weather conditions such as excessive rainfalls and droughts tend to occur more frequently.

Organic Farming, Climate & Food Productivity

Organic farming is a multi-objective concept and its environmental and socio-economic benefits go far beyond mere climate protection. The impact of potential large-scale conversion to organic farming on climate change is not yet fully explored and known. The few pioneering studies suggest that a wide-spread conversion to organic farming can contribute to reaching the greenhouse emission reduction targets. However, the role of organic farming in halting climate change should also be further explored in the context of its impact on regional and global food productivity. Organic farming’s “climate performance” should be assessed not only against the farmed area, but also against the quantity of food and fibre it produces. By adopting organic farming practices, farmers can help in mitigation and adaptation to climate change.

Changing our habits

By buying organic food and by changing dietary habits, notably by eating fewer animal products, consumers can also help in reducing greenhouse emissions. Using environmentally-friendly means of transport for food shopping is another way for consumers to behave responsibly. The price we pay for food, in general, does not reflect the environmental and social costs associated with its production, transport, processing, storage and trade. These negative externalities are not internalised in the food price. When buying organic food, consumers do not buy only a climate-friendly product, but also a product that provides many other environmental benefits, scores high on animal welfare and tends to have a higher nutritional value per weight unit.

What can policy makers add?

A great deal of responsibility for climate protection rests on policy makers. The current international carbon trading schemes do not credit carbon-friendly farming methods. Paying farmers for avoiding greenhouse gas emissions and/or for sequestering soil carbon would be a good way of rewarding responsible farmers for the positive environmental externalities they create. In order to catalyse the further development of the organic food and farming sector, policy makers could put in place a set of regulatory, economic and informative policy instruments favouring the development of organic farming and discouraging climate-damaging farming methods.

Creating a dialogue

Avalon and its network partners will actively lobby for the recognition of the role of organic farming in halting climate change, and invite responsible farmers, consumers and policy makers to support and enable the further adoption and development of organic farming to help in solving one of the most challenging problems of humankind: climate change.

Interested in follow up?

We invite your reactions and welcome discussion in an open dialogue. Please direct your opinions on this subject to office@avalon.nl. For further information and news on this topic, please visit our websites at www.avalon.nl and www.avalon-conference.org.


OF. BRANKO
A VASILEVA


KTBG
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The Role of Organic Agriculture in Environmental Protection and FAO

Rainer Krell[1]

Food and Agriculture Organization of the United Nations
Environment, Climate Change and Bioenergy Division, Italy
Email: rainer.krell@fao.org

ABSTRACT

Agro-environmental discussions are changing focus from individual disciplines (biodiversity, soil, water, air) towards adaptation to climate variability under the urgency of food security, reduced and degraded natural resources and increased economic polarization (poverty).

Organic agriculture, as an advanced but still evolving system, principally addresses the various arising environmental concerns (biodiversity, soil, water, gaseous emissions, energy balances, climate change adaptation) and has some integrated practical solutions which only require different degrees of local adaptation, many of which have been developed over the last decades. Thus it is probably the best available package for integrated environment-friendly approaches in agriculture.

Considering the immense diversity of environmental conditions and food and medicinal species on a global scale it is obvious that many production aspects can benefit from more knowledge on local adaptive practices. The immensity of the overall challenge necessitates effective collaboration. This is one of the reasons for FAO's support to ORCA, the global Organic Research Centres Alliance, and its close association with existing conventional agricultural research centres.

Effective practical action under very complex conditions (like multi-disciplinary integration) also requires good communication, clear processes, transparency and considerable goodwill. Thus in addition to the above mentioned activities, FAO is also contributing through support and in partnership with other UN and non-UN organisations. It works on standard harmonization and labelling, a multi-lingual glossary, information access; it initiates and supports discussions on organic agriculture research and trade, especially outside of the temperate areas.

1. Connection of Organic Agriculture to the Environment

Agriculture is about as inseparable from the environment as weather is from climate.

Our capacities to directly influence local weather have only rarely exceeded temporary influences (traditional and industrial rain making and rain stopping as compared to the impact of deforestation and desertification on more permanent local weather changes (micro-climates)). In comparison, our agricultural activities have permanently affected environmental conditions, and continue to do so, on almost one third of the earth's land surface (almost 4 billion hectares): from causing local weather changes (micro-climates) resulting from deforestation and desertification to species extinction, soil losses, and lower or polluted water tables. The more local we look, the more drastic is some of that impact. Compared to extinction potentially resulting from global climate change, these seem minimal, but they are already reality and added together are of significant impact. Such losses may worsen the impact from the global climate effect since impoverished natural and agricultural systems are less resilient and less flexible to adapt.

Agriculture has a very strong direct effect on the local field and surrounding environment. The degree of disturbance and its geographical extent determine how permanent and how destructive that impact will be. It may range from a slight shift in species abundance in some agro-forestry or grazing systems (we know very little about the changes in the soil fauna and flora or the insect diversity as a result of

1 The opinions expressed in this article as well as any conclusions are those of the author. They do not necessarily represent the opinions of FAO.

such changes) to irreversible changes such as complete extinction of species and land degradation to the point of total desertification. The choice is ours! The trend of impacts shows that we are (and not so slowly) cutting off the branch of the planetary environment that agriculture is sitting on.

Beyond the purely physical/biological environment, there is also a psychological (mental and emotional) and social environment that is very important for our (human) well-being and consequently for the rest of the world (i.e. we behave generally more destructive when we do not feel well). Organic agriculture (OA), by providing healthier and also less intoxicating food, has a tremendous potential to enhance our well-being, i.e. our physical and psychological environment, and thus enables us to evolve and strengthen our innate capacities for higher awareness and for responsible care of ourselves and the entire environment. In this paper, discussions will relate predominantly to the physical/biological environment.

Certain agricultural practices like organic agriculture, while still impacting the environment, have an undoubtedly less negative impact than, let's say, industrial agriculture, even when compared to the latter's best practices. These best practices are promoted almost everywhere and are also used by the agricultural industry to green its image. They however, all too frequently fall short of proper implementation or of even appropriate concepts for helping the conservation of our environment's life sustaining qualities. This is where OA makes the biggest difference and has well established methods for verification.

Part of OA's intrinsic values and approaches are based on working within environmental constraints and at least striving to work in collaboration and harmony with natural forces and resources and thus OA is one of the few agricultural practices that is least invasive to natural environments or to biodiversity. It explicitly requires that no natural habitats are converted for the expansion of its growing areas.

Organic farming practices have been shown to consistently conserve higher numbers of plant and animal species in and near fields. Soil qualities are generally maintained better or even improved as compared to most conventional practices and even after long-term use (>20 years) overall soil quality had actually been improved. The improvement of soil structure and organic matter content, especially if combined with reduced or no-till practices and higher crop diversity, has provided farmers with better results during periods of water stress (droughts).

Agriculture as a whole contributes about 10-20 % of all global anthropogenic greenhouse gas (GHG) emissions. By far the greatest contribution comes from fertilizer use (38%), enteric fermentation (32%), biomass burning (12%), rice pady (11%) and manure handling (7%) (Smith et al. 2007). Thus by eliminating most fertilizer contributions and getting cattle back to pasture, OA can reduce a significant percentage of all agricultural GHG emissions.

Organic agriculture also provides management practices that can help farmers adapt to climate change through strengthening agro-ecosystems, diversifying crop and livestock production, improving soil fertility, pest control and water retention to best prevent and confront high weather and climate variability and actual changes in climate. It also, generally, has a lower Green House Gas footprint than comparable conventional or industrial agriculture practices (FAO, 2008; Niggli et al. 2009).

One could interpret the official recognition of OA's contribution to environmental conservation and improvement in the way OA has been supported under the EU's agro-environmental schemes rather than the commodity based programmes, although such interpretation may not correspond to original motivations or intentions. Organic agriculture is also recommended and specially supported in watersheds important for drinking water collection or around protected natural areas (FAO 2004).

The old paradigm "environment is bad for business" is slowly transforming and OA may have had a part in this, since it is good (or at least better) for the environment and is good business. Because of these double benefits it also has found more financial backing and investment over the last decades and some additional political attention. The recent climate change concerns and the new Carbon commodity hopefully benefit also investment in OA (FAO 2009c).

OA is a different approach and means change, because it is based on collaboration and harmony with natural processes and with the values of human well being without ignoring ancient and modern knowledge and the basic and current social and economic needs of people. Since not all of these are part of certification criteria and since new organic farmers not always share these values, there is a trend to combine fair-trade certification with organic production certification. The connection to the environment is that poverty leads to environmental destruction and higher awareness brings more responsible behaviour also toward our environment. The mentioned values, however, need to be guarded savagely and continuously while engaging in active and open dialogue if organic agriculture wants to remain part of the solution and not loose political and economic ground to pressures from other interests!

To be able to collaborate with the many necessary partners in agriculture and environmental conservation extremely good communication is needed on all levels, as well as clear goals and procedures and a lot of goodwill. To create harmony in all this, OA needs to be able to continuously evaluate itself and correct itself, which requires the proper mechanisms, data sharing, transparency, fairness, dynamic actors and continuous and effective conflict resolution. It also needs to cultivate emotional, mental and spiritual maturity, i.e. wisdom, on a large scale. This is no small task and none that can be accomplished only with organic agriculture or with organic and environmental conservation. However, the good news is that the awareness of such needs is part of the organic movement, is reflected in the IFOAM initiatives and also in the global research action supported by FAO and many partners (see ORCA in FAO 2009b).

2. FAO emphasis on environment and its protection

As mentioned at the beginning, agriculture cannot be separated from the environment at all and to protect agricultural production, which is part of our food security, it is necessary to protect the services and resources provided by the environment to agricultural production. Thus the environment features important in all facets of FAO's work and for the same reason (and more) does not find a special focus in the organization. Yet different sectors of agriculture prioritize differently their responsibility vis-à-vis the environment versus their responsibility towards government or industry needs and farmer needs. And thus under the (consecutive) umbrellas of sustainability, livelihoods, food security and now climate change, the environment has been given different levels of attention.

One can say for sure though that today most environmental discussions center around the need to create best resilience and adaptability for the expected climatic variability and to some extent around a new trade commodity: Carbon. Thus much discussion about agricultural measures for crops, income generation, biodiversity, water, soil and air conservation focus on creating highest adaptability and resilience to climatic variability. Within each technical sector there may however be different ideas about what degree and kind of environmental conservation or agriculture practice is necessary, since each comes to their own views based on their own specific ways of perceiving the function of the environment (e.g. the economist for its contribution to income, the agronomist for its contribution to production and the conservationist for its contribution to preserving the earth's natural heritage, and so on).

Thus, since governments, research and also FAO still predominantly function and think in the old subject area silos, despite growing attempts to break down these well established patterns, the results are often all but encouraging from the holistic, organic, agro-eco-system perspective.

3. Integration

Approaches like organic, vedic or biodynamic agriculture with an inherently more complete, though not yet all holistic approach fare, in general, a little better in integrating different disciplines and at the same time experience more difficulties in large scale implementation . But we are living in a time of learning to deal with increasingly complex interactions and systems, one of the positive and most challenging side effects of globalization and better communication technologies.

We seem to be still in the early stages of relearning our ways and means of collaboration for a higher good at a time of unsurpassed individualism, even egoism, facilitated by almost equally unsurpassed and widely available economic and technical capacities through which it is easy to forget our own nature, i.e. that of biological creatures intimately connected to nature, its cycles, resources and laws, no matter what our minds or media or industry lead us to believe.

From that awareness OA offers much better alternatives to maintain ourselves within nature's (environmental) capacities. We are also at a threshold of a much deeper understanding of our environment, of nature in general, which is likely leading us to excel far beyond current OA capacities in a safe, friendly, responsible and caretaking fashion. For that, too, OA provides a very good and proven foundation and platform.

Organic agriculture is often still seen more as an economically favourable activity rather than a significant and necessary environment-friendly approach. Successful carbon trading under certain circumstances may favour OA. For Africa and for success in soil reclamation and social and economic impact the Tigray project in Ethiopia is a great example (FAO 2007a). Though not exclusively organic it shows the potentials of organic methods in major project components and should be convincing enough to attract more investment and duplication in other parts?

4. All things connected

Since not only agriculture is connected to the environment, but all other human activities are as well, an integrated approach to protecting the environment would have to include economic measures, and also social and cultural approaches, i.e. a set of rules and values that guides human activities to prevent excesses like those that lead to the financial crises and environmental damages of the last century. We also know that poverty is one of the worst enemies of natural environments, since natural biomass resources are frequently the last resort for basic life support of the poorest, not only in Africa, but also in Europe, like some of the environmental devastation in the Balkan region during and following the most recent conflicts, as well as increasingly less appropriate farming practices in marginal areas often by the poorest farmers or non-farmers in the same and other eastern European countries specially after the changes of the late 80's. Of course, there are also major destructive impacts propagated by the mainstream industrial agriculture with its strong techno-economic focus and as a result of misguided or self-guided fiscal and political measures. An integrated package of concrete measures has been for example suggested in A Green New Deal (NEF, 2008), put together by a group of concerned organizations, economists and others: "The Green New Deal will rekindle a vital sense of purpose, restoring public trust and refocusing the use of capital on public priorities and sustainability".

However, for example, the new "greening of Africa" is largely spearheaded by investments that are embarking to revive the green evolution of the 60's and 70's with newer biotechnologies such as GMO's and more chemical inputs (Agra, 2008 and FAO, 2008a).

Both should be carefully evaluated for their real contribution to rural and poverty development, to increasing the indebtedness of farmers and governments and to our increasing environmental debt. The same obviously holds true for other regions in which investment and policies for agriculture have been promised to solve our food and environmental challenges for the next 20, 30 or 50 years. Where organic agricultural methods are not a major part of sustainability measures, the sustainability of those same measures may need serious questioning and (re-)evaluation.

The four corner stones of a healthy environment – biodiversity, soil, water and air – just as the four basic ingredients of our human well being – markets, health, culture and environment – have to be guarded and integrated well to obtain sustainability and conserve conditions for well-being in the future.

5. Specific FAO activities in organic agriculture

There is no organic agriculture department nor an organic agriculture budget at FAO, as there is also no budget for environmental action. Organic agriculture is at best part of other activities or cross-sectoral actions by individual professionals from different technical sectors of the organization, like trade, statistics, legal, Codex, rural development, natural resources, livestock, plant production, or biodiversity.

As mentioned above access to clear and practical information is an important element for success in the collaborative efforts necessary for successful OA. Therefore, in line with FAO's global function as honest information broker, rather than as a political force, and as part of its mission to reduce hunger and contribute to better food and living conditions for all, as well as contributing to achieving the Millenium Development Goals, FAO supports OA through a number of activities and products (FAO 2008b):

Organic agriculture's contribution to land and biodiversity conservation as part of protected area management, especially for buffer zone management has been discussed in FAO 2004.

There are a number of Climate change related documents, studies and expert consultations dealing with agriculture's contribution to and mitigation of Climate Change as well as papers discussing adaptation considerations (FAO 2009d). Integrated approaches find some attention while the dominant trend supports technological solutions or even GMO style breeding rather than broad system adaptation and integral flexibility. Only few discuss the matter from an organic production process perspective.

Organic agriculture's impact on greenhouse gas emissions (Carbon balancing and sequestration and CDM participation) has been reviewed as well as its energetic efficiencies and potential contributions to Climate change adaptation (FAO 2006, FAO 2007b, FAO 2008 and Niggli et al. 2009, FAO 2009c).

Organic agriculture's and other environmental and social standards and their certification for sustainable agriculture and bioenergy production are under review FAO BEFS, BEFSCI and BIAS. And a study on the contribution of organic agriculture and ecotourism with Italian partners is close to being finalized.

Other major recent results include the multi-lingual Glossary on Organic Agriculture (FAO 2009b) and the conclusion of the International Task force on Harmonization and Equivalence in Organic Agriculture, which presented its suggestions in 2008 (UNCTAD 2008)

The ORCA concept (see Figure 1) has been developed jointly by the Food and Agriculture Organization of the United Nations (Italy), Tufts University (USA) and the Research Institute of Organic Agriculture (Switzerland). It is open to further discussion (see ORCA portal at FAO 2009b).

In the context of the holistic need for agriculture in general and organic agriculture specifically, the proposed Organic Research Centres Alliance (ORCA) intends to internationally network and strengthen existing institutions with scientific credentials and empower them to become centres of excellence in transdisciplinary organic agriculture research. The objective is to ensure that environmental, economic, and social benefits accruing from organic research are shared worldwide. The ORCA concept is designed following a research paradigm that heavily draws on traditional knowledge, improves it with scientific investigation and shares it widely. Research centres may be physical laboratories or "institutions without walls", formed through alliances between producers and scientists, as well as twinning between developing and developed countries' institutions (FAO 2009). A database of institutions of relevance to ORCA can be searched under ORCA Database (FAO 2009b).

Specific FAO organic agriculture projects are linked on the same web page, but often organic agriculture activities are part of larger non-organic projects or small short-term projects supporting local groups, communities or institutional activities.

One such larger project is aimed at the protection of pollinator diversity. As part of the activities to help protect natural pollinators, less agrochemical use and more integrated, divers production systems are favoured, among which organic agriculture features strongly.

Organic agriculture and similar methods are included in bioenergy programmes for reducing environmental impact and to contribute to a transition from a fossil fuel based agriculture to a climate, environment and socially responsive agriculture.

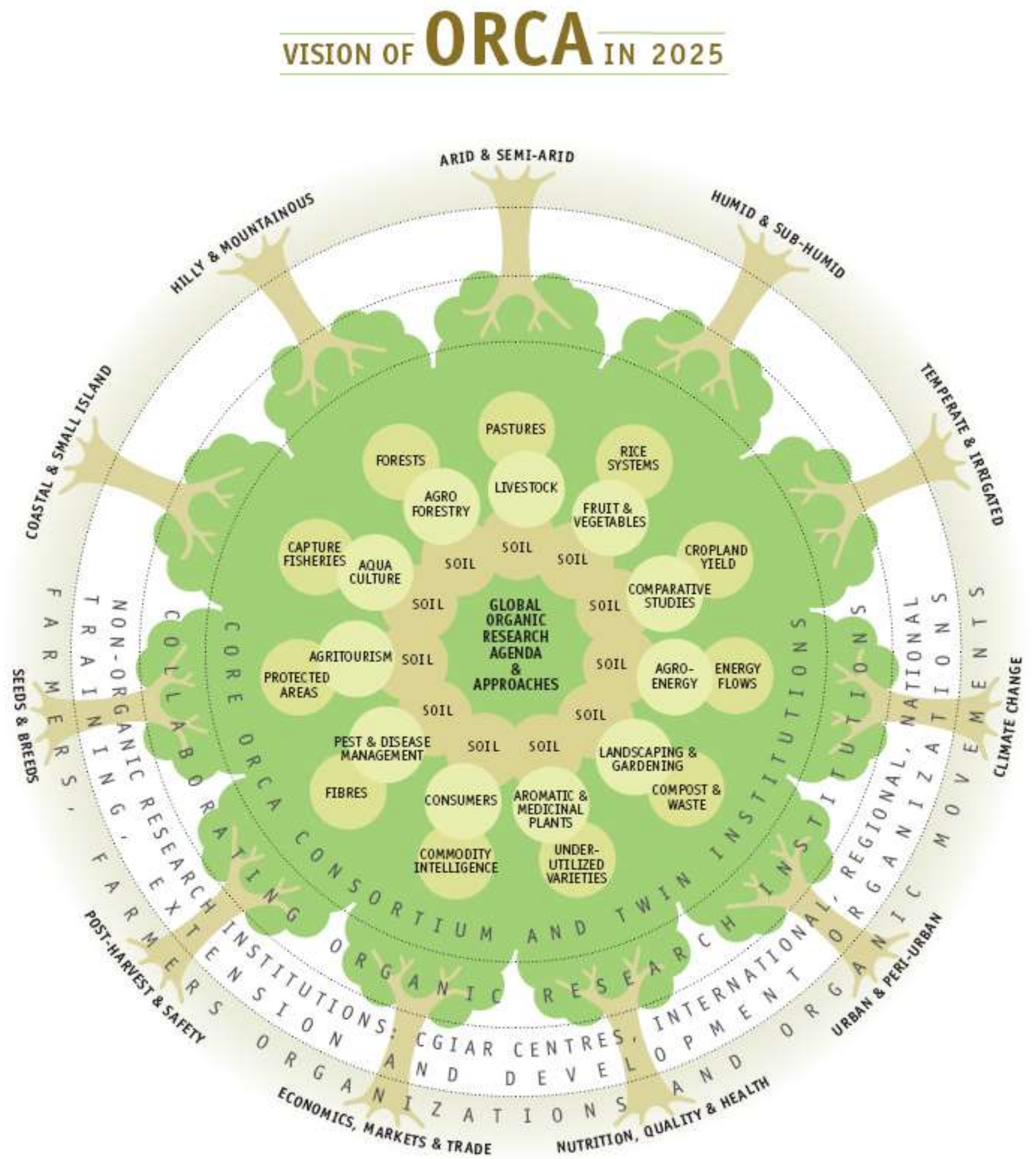

Figure 1: Vision of ORCA in 2025 (FAO 2009b)

In addition, many of the other programme activities related for example to prevention of soil erosion, of water efficiency, of biodiversity and agro-biodiversity conservation and management, of pollinator conservation, of guidelines for sustainability assessment, of climate adaptability, of codex alimentarius standards and more, are directly and indirectly contributing to increased environmental sustainability, i.e. conserving our environment under growing pressures. Many of the principals and methods are equally applicable to organic agriculture. Without continued efforts, however, organic agriculture is not necessarily included or considered in such activities.

FAO’s terrestrial and remote observation and mapping programmes try to inform decision makers on the current states and trends. More precision and resolution and thus utility for national planning is regularly added.

Apart from some of the above mentioned environment related information, the FAO organic agriculture webpage also presents country specific information, national and international meetings, a considerable number of publications related to organic markets, standards, economic comparisons and more.

6. Conclusions and key messages

Poor land use, careless agricultural management and wrong policy incentives damage natural habitats and accelerate the loss of plants, animals and ecological processes that serve as the foundation of agricultural productivity and are our basic life support. The deeper root cause of that is lack of awareness and of cultivating and protecting the best human values.

Our actions affect our environment and our environment affects our state of being (well-being). We create what we firmly believe in. The more we become aware of that, the more we can influence or direct our impacts and our environment to create what is best for all of us. Our knowledge of technologies empowers us – but also makes us responsible for their responsible use.

It is absolutely essential for our survival as a species to protect the very resources we depend on for our biological food and to produce the healthiest food possible for our mental and emotional well-bering and evolution. OA is a proven approach to do just that. Therefore, with an attentive eye on its proper application, OA can provide all necessary services, those to feed a growing population, to protect the vital land-based resources of this planet and to secure the physical foundation for our evolution of consciousness.

The challenge for conservationists and agriculturists is to identify collaborative routes which are economically and socio-politically feasible. The expansion of organic agriculture and its integration into landscape planning represents a cost-efficient policy option for building self-generating food systems and for connecting agro-ecosystems and natural areas.

Choices in agricultural management can enhance or threaten domesticated and wild biodiversity. Encouraging organic agriculture within and around protected areas can reverse the trend of negative threats to biodiversity and invasive use by local residents, while allowing local residents to derive better livelihoods from their lands. It simultaneously delivers ecosystem services and services to the environment like landscape connectivity and environmental health that industrial agriculture cannot provide.

Although there is basically no FAO budget designated specifically to organic agriculture and no staff is directly dedicated to OA, FAO's output and participation in global initiatives like ORCA, many related studies and projects, the harmonization of standards, the glossary, marketing support and more, contribute significantly to organic agriculture becoming a feasible and attractive model for sustainable agriculture worldwide.

FAO promotes organic agriculture as an alternative approach that maximizes the performance of renewable resources and optimizes nutrient and energy flows in agro-ecosystems. Although FAO can provide well researched, reliable information, and facilitates education and awareness raising, it is eventually the users of that information, i.e. you: government, industry, trade organizations, farmer organizations, and consumers, who have to make the necessary decisions to make agriculture more sustainable, more organic and eventually holistic, i.e. make agriculture an integrated beneficial part of our global ecosystems.

Activism, research and political and technical action need to be maintained to keep OA a viable option. FAO can also help with some of the educational processes, building of higher awareness and the ability to act sustainably. Joint efforts are absolutely essential. FAO's involvement with such joint efforts like the harmonization process and ORCA (the global research system) are a good example.

Lets do more of this!!!

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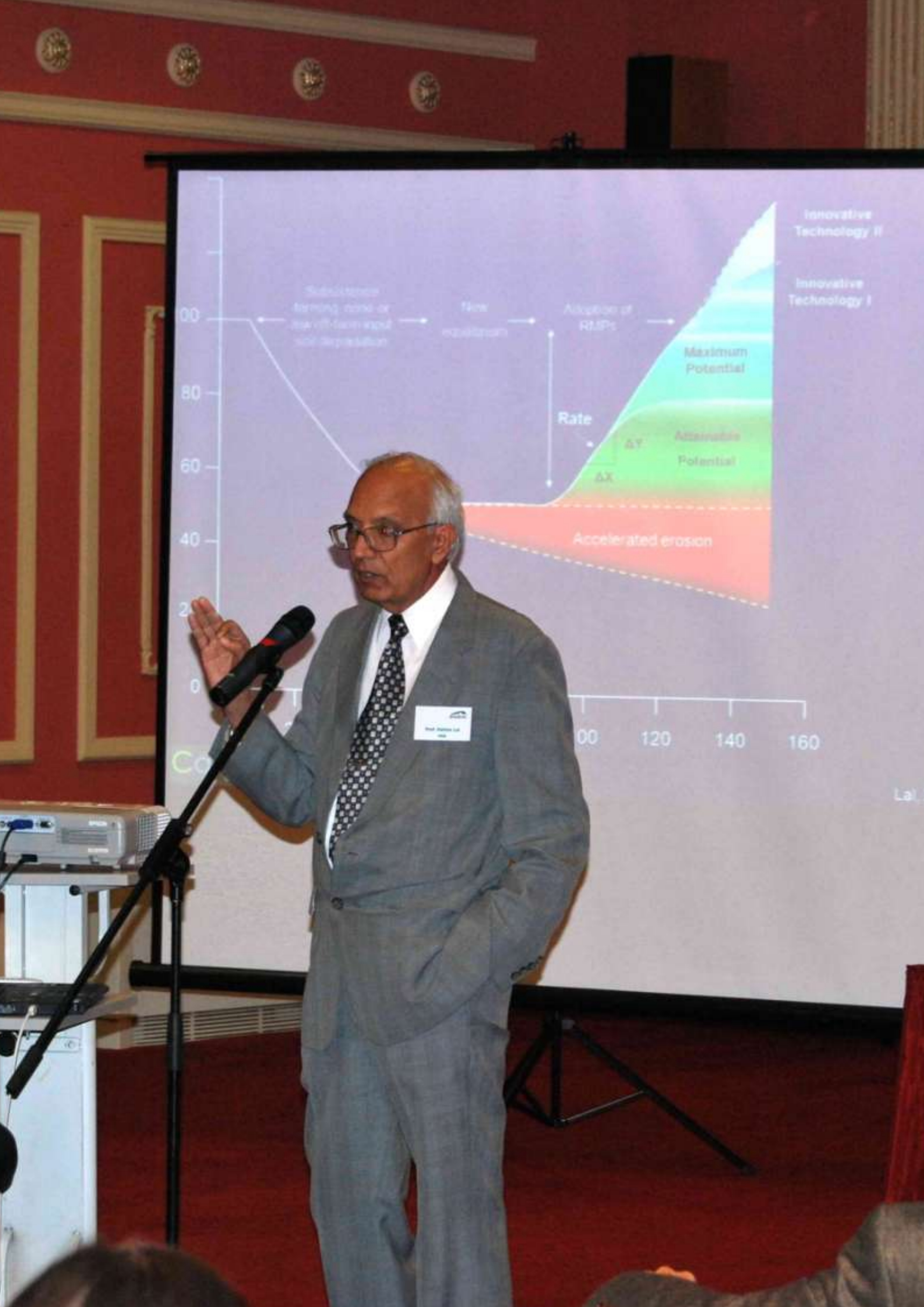
Innovative Technology II
Innovative Technology I
Adoption of RMPs
New equilibrium
Maximum Potential
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Accelerated erosion
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Managing Soil Carbon For Protecting Climate and Advancing Food Security

Rattan Lal

Carbon Management and Sequestration Center,
The Ohio State University College of Environment and Natural Resources, Columbus, the USA
Email: lal.1@osu.edu

ABSTRACT

The world is faced with several inter-related but important issues such as food insecurity affecting more than 1 billion people, atmospheric concentration of CO_2 at 390 ppmv and increasing, and the severe problem of soil and environmental degradation being exacerbated by an excessive human appropriation of natural resources. Adoption of an eco-efficient approach, by enhancing use efficiency of inputs while decreasing losses and improving soil/ecosystem/social resilience, is an important strategy. Recommended management practices include conservation agriculture with complex crop rotations, mulch farming and cover cropping, integrated nutrient management with liberal use of manures and other biomass including biochar, and judiciously integrating livestock and trees with crop production systems. It must be understood, however, that agricultural ecosystems are sustainable in the long term only if all outputs are carefully balanced by appropriate use of inputs to maintain essential ecosystem services, and minimize risks of soil and environmental degradation.

1. Introduction

World soils play an important role in the global carbon (C) cycle, and in the net anthropogenic emissions into the atmosphere because of their large C pool. Total soil C pool, 2500 Pg to 1-m depth, comprises of two distinct but related components: (i) soil organic C (SOC) pool of about 1500 Pg, and (ii) soil inorganic C (SIC) pool of about 950 Pg. The SIC pool is an important component of soils of arid and semi-arid regions (Lal, 2001). The SOC pool comprises of relatively undecomposed biomass (remains of plants and animals) undergoing rapid changes in its composition over time or the labile pool, and highly decomposed/recalcitrant material called humus. Both labile and recalcitrant fractions of the SOC pool are strongly related to soil quality. Soil fertility, especially nutrient recycling and availability, is influenced by the magnitude of the labile fraction. Soil structure, water retention and transmission properties, susceptibility to erosion and crusting/compaction are strongly impacted by the concentration of the humus fraction. Conversion of natural to agricultural ecosystems causes depletion of the SOC pool because of the (i) higher rate of decomposition caused by differences in soil moisture and temperature regimes, (ii) lower amount of biomass C returned to the soil, and (iii) more losses of SOC through accelerated erosion and leaching. Thus, most agricultural soils contain 25% to 75% lower SOC pool than their counter parts in natural ecosystems (Lal, 2004). Further, the magnitude of depletion is more in soils prone to severe degradation by erosion, salinization, nutrient depletion, structural decline etc. The magnitude of the depletion is also indicative of the technical or potential C sink capacity, the amount of atmospheric CO_2-C that can be stored into agricultural soils through conversion to a judicious land use and adoption of recommended management practices (RMPs). Thus, there are several challenges to sustainable development (Jansen, 2003). There has been a strong emphasis on renewable agriculture (Brock and Barham, 2009; Egelyng et al., 2006; Altieri et al., 2005), use of resource conservation in agricultural sustainability (Raerdon, 1995; Pretty, 2008; Pollock et al., 2008; Pretty et al., 2006; 2007; 2008), integration of crops and livestock (Powell et al., 2004), the use of lifecycle analysis (Renouf et al., 2008; Mouron et al., 2006) to optimize the emergy (An et al., 1998) and energy flow (Pimentel and Pimental, 2008; Meul et al., 2007a).

The objective of this manuscript is to discuss strategies of sustainable management of soil and water resources which can create positive C and nutrient budgets, enhance SOC pool, improve soil quality, increase use efficiency of input, and increase agronomic or net primary productivity (NPP). Rather than a comprehensive review, the goal is to discuss some examples of land use and soil management practices which set-in-motion processes which lead to SOC sequestration, and improve ecosystem services.

2. Eco-Efficiency and Sustainability

An important strategy of increasing the SOC pool and NPP is to improve eco-efficiency of agro-ecosystems. The term eco-efficiency was first proposed by the World Business Council for Sustainable Development (WBCSD, 1992), and adopted by 1992 Earth Summit to implement Agenda 21. It implies creating more goods and services while using fewer resources and creating less waste and pollution. Principal criteria of eco-efficiency include the following (Lovins, 2008): (1) a reduction in the material intensity of goods or services, (2) a reduction in energy intensity of goods or services, (3) a decrease in spread of toxic substances, (4) an increase in recyclability, (5) an increase in use of renewable resources, (6) an increase in durability of products, and (7) increase in ecosystem services. Eco-efficiency is related to both "ecology" and "economy" (Atkinson and Wilkins, 2004; BCPC Forum, 2004; Wilkins, 2008), and implies efficient and sustainable use of resources in agronomic production and soil management. Five criteria outlined by BPCP Forum (2004) for an agronomic system to be eco-efficient include the following: (1) high efficiency of resource use, along with the maximum use of renewable inputs, (2) low pollution of the environment at local and regional/global levels, (3) high and predictable agronomic output, (4) high functional biodiversity in relation to strengthening of ecological processes, reducing emission of greenhouse gases (GHGs), and controlling soil erosion, and (5) high adaptability to changes in the social, economic, and physical environments. The eco-efficiency approach has also been proposed for dairy production (Meul et al., 2007a; b)

There is a strong need for adopting the eco-efficiency concept in agronomic production because of: (1) declining yields in the rice-wheat system of Asia and other intensive agronomic systems, (ii) stagnating yields in Sub-Saharan Africa (SSA), and elsewhere in rainfed cropping systems, (iii) increase in severity and extent of soil degradation and desertification, (iv) increase in risks and vulnerability to climate disruption, and (v) increase in global food demand, especially in developing countries where majority of 1.02 billion food-insecure people live.

3. Anthropogenic Climate Change

There are several nations which are highly vulnerable to climate change (Cline, 2007). Vulnerability of agroecosystems, accentuated by projected change in temperature and precipitation, may be more in regions of low than high latitudes. Densely populated regions (China, India, Bangladesh, Ethiopia, Pakistan, Nigeria) are projected to experience increase in temperature (Table 1). Consequently, there may be a decrease in effective precipitation despite an absolute increase in the total annual amount.

The decrease in effective precipitation is caused by increase in losses by runoff and evaporation, and reduction in plant-available water capacity caused by soil degradation. The latter is exacerbated by increase in decomposition of soil organic matter (SOM) because of increase in temperature. The adverse impact of climate change is likely to be more in regions with predominantly resource-poor farmers, degraded/depleted soils, weak institutional support, poor infra-structure, and lack of resources for investment in agriculture. These regions are represented by developing countries of South Asia (SA), SSA, Central America, The Caribbeans, and The Andean regions (Table 1).

4. Processes and Strategies to Enhance Eco-Efficiency

There are two strategies to improve eco-efficiency of agricultural ecosystems: (1) enhancing ecological resilience, and (2) improving productivity (Figure 1). With increasing biotic and abiotic stresses, it is important to enhance the ecological resilience. Holling (1973; 1996), Gunderson and Allen (2010) and Gunderson et al. (2010) described 3 attributes of a resilient ecosystem: (1) persistence of a relationship within a system, and ability of systems to absorb changes of state variables, driving variables and parameter, (2) occurrence of alternative and multiple states in contrast to the assumption of a single equilibrium and global stability, and (3) discontinuous nature of change. Thus, resilience of an ecosystem refers to its ability to restore itself. Soil's susceptibility to degradation processes can be reduced by improving its quality. Overuse of soils and environmental change are responsible for the widespread decline in soil quality and increasing susceptibility to degradation and desertification (Nortcliff, 2009). In this regard, soil quality is an important indicator of sustainable land use and management (Herrick, 2000). Yet, it is not just enough to increase the efficiency. Because of the increase in world hunger (FAO, 2008) and rapid increase in food demand, total agronomic production must also be increased (Fairbank, 2009).

Table 1: Estimated change in climate in some densely populated countries (adapted from Cline, 2007).

Country		Temperature (°C)		Precipitation (mm/day)	
		1961-90	2070-99	1961-90	2070-99
Bangladesh		24.46	28.13	6.40	1.57
Brazil					
	Amazon	26.04	30.08	5.97	5.84
	Northeast	25.58	29.46	3.58	3.52
	South	22.04	25.90	3.95	4.15
China					
	Northeast	2.73	8.89	1.32	1.57
	Central	9.49	14.48	2.03	2.43
	Southeast	18.78	22.67	4.47	4.82
	Northwest	6.06	12.08	0.37	0.44
	South Central	17.50	21.27	3.59	3.95
	Tibetan Plateau	-1.45	4.15	1.13	1.53
Ethiopia		23.08	26.92	2.04	1.97
India					
	Northeast	20.54	24.54	3.51	4.23
	Northwest	23.55	27.52	1.58	1.97
	Southeast	26.76	30.06	3.05	3.42
	Southwest	26.23	29.32	3.04	3.47
Mexico		20.68	24.91	2.09	1.84
Nigeria		26.73	30.46	3.09	3.29
Pakistan		19.91	24.76	0.83	0.96
Russia					
	Black Sea	7.85	16.52	1.34	1.32
	Far Eastern	-10.56	-2.69	1.05	1.52
	North European	2.05	8.60	1.62	2.01
	N. Ural Siberia	-7.02	1.00	1.30	1.70
	Northeast Siberia	-13.97	-5.84	0.79	1.15
	S. Ural Siberia	-0.25	6.79	1.33	1.62
	Southeast Siberia	-5.51	1.48	1.31	1.68
USA					
	Alaska	-5.10	1.12	1.14	1.70
	Lakes, Northeast	8.26	14.17	2.54	2.63
	Pacific Northwest	7.57	12.11	1.98	2.09
	Rockies, Plains	6.68	12.36	1.18	1.24
	Southeast	16.69	21.44	3.52	3.44
	S. Pacific Coast	12.11	16.56	16.56	1.36
	Southwest, Plains	15.05	20.20	20.20	1.20

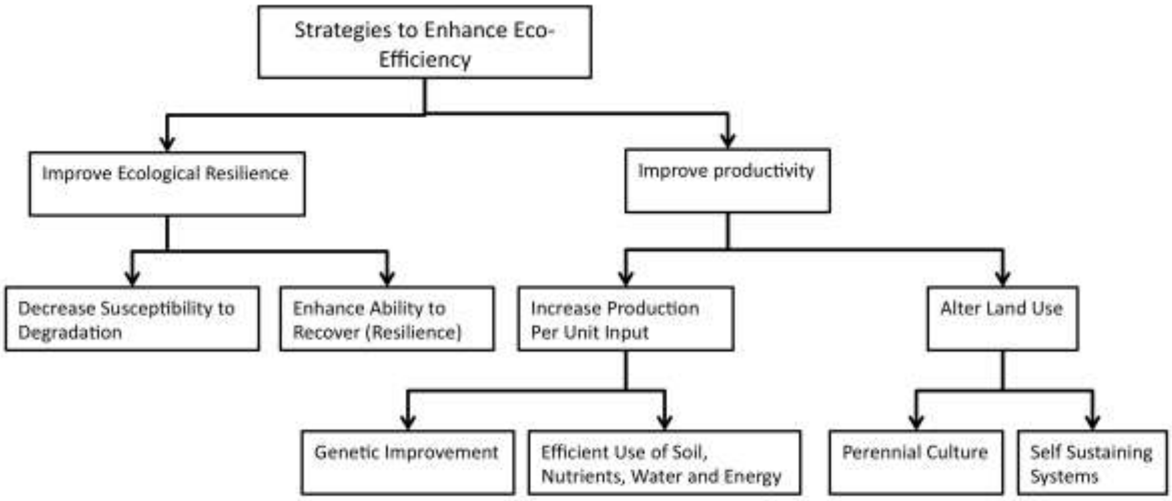

Figure 1: Strategies to enhance eco-efficiency of agro-systems

5. Soil Fertility Management

Agricultural ecosystems are sustainable only if nutrients harvested (and lost by erosion, leaching) are replaced by natural processes (e.g., biological nitrogen fixation or BNF, recycling, deposition) and/or managerial activities. It is indeed difficult to sustain economic development without maintaining the services and quality of soils and other natural resources over time (Van der Berg, 2002). Soil degradation and land tenure arrangements are principal causes of low yields (Saidou et al., 2004). China and other countries in South Asia which have been successful in enhancing agronomic yields and achieving food self sufficiency have done so through realizing the importance of: (1) using organic manures in enhancing soil fertility and agronomic productivity, (2) exploring all possible organic resources for recycling, (3) maximizing resource use efficiency, (4) adopting diverse crop rotations and crop intensification, (5) conserving water in the root zone, and (6) applying chemical fertilizers judiciously (Yang, 2006). In Jaingsu, China, Dong et al. (2006) reported that use of farm yard manure (FYM) on a regular basis is essential to improving/maintaining soil organic matter (SOM) content and crop yield, especially with intensive cropping. In soils with low SOM concentration in the North China Plain, long-term application of FYM (along with chemical fertilizers) is essential to improving soil quality and achieving high yields (Gong et al., 2009). Similar to China, several long-term experiments conducted in South Asia have also indicated the importance of manuring on increasing and sustaining high crop yields (Majumdar et al., 2002). If an adequate amount of manure is not available, however, nutrients harvested must be replaced through judicious application of chemical fertilizers (Mandal and Sinha, 2004; Hocking et al., 1997). In addition to N, applications of P (Aulakh et al., 2003; Ghosh et al., 2003) and micro-nutrients are also essential. Imbalanced use of chemical fertilizers can exacerbate the problem of low fertilizer use efficiency (Pathak et al., 2003). Several studies conducted in SSA have also indicated the importance of creating positive C and nutrient budgets in soil on agronomic production. Soils of SSA have been cropped for generations with extractive farming practices, leading to severe depletion of the inherent fertility and decline in SOM reserves. There exists a negative nutrient budget on continental scale. Thus, a liberal and continuous use of FYM is important to enhancing SOM pool and increasing agronomic yield (Bayu et al., 2004). In addition to supplying macro and micro-nutrients, application of FYM also improves soil structure and aggregation, water holding capacity, water infiltration rate and resistance to soil erosion. Rotation and manuring experiments, conducted in Niger, showed that fertilizers N application increased yield of pearl millet, cowpea, and groundnut, but continuous cropping caused decline in SOM concentration. For coarse-textured soils of the West African Sahel, an integrated use of millet crop residues retained on farm fields after harvest and application of chemical fertilizers sustained high agronomic yields (Yamoah et al., 2002). In Malawi, Snapp et al. (2002) reported that legume-based cropping systems produced residues which contained about 50 kg N/ha/yr, and increased yields of the following maize crop.

6. Soil Organic Matter Management

The SOM concentration and its management are key factors to enhancing eco-efficiency of agronomic systems (Allison, 1973; Keulen, 2001). Consequently, SOM management is deemed crucial to sustainable agriculture (Entry et al., 1996; Lavelle et al., 2001; Lefroy et al., 1995; Martius et al., 2001). Several indicators of agricultural sustainability have been developed on the basis of SOM concentration in the root zone (Doran et al, 2002; Subedi et al., 2009; Van Passel et al., 2007). Usefulness of long-term experiments (Poulton, 1996; Mitchell et al., 1998; Rasmussen et al., 1994) has been assessed on the basis of SOM pool. The SOM management is widely recognized as a tool of bending the curve towards sustainability (Reskin, 2000), and for achieving the future yield growth in field crops (Reilly and Fuglie, 1998). Management of SOM is a handle to assess the serious issue of desertification (Reynolds et al., 2007) and food security (Lal, 2009). Maintaining SOM concentration at above the critical level of ~1.1% in the root zone (Aune and Lal, 1997) is essential to numerous ecosystem services: (1) enhancing nutrient reserves, (2) improving plant-available water capacity, (3) increasing soil structure and tilth, (4) providing food (energy source) and habitat for soil organisms, (5) decreasing risks of soil erosion and sedimentation, (6) reducing non-point source pollution, (7) improving soil biodiversity, (8) increasing use efficiency of inputs and agronomic production, (9) decreasing hypoxia/anoxia of coastal ecosystems, (10) improving soil and ecosystem resilience, (11) mitigating climate change by off-setting anthropogenic emissions, and (12) improving adaptability by enhancing buffering capacity of soils and ecosystems. Thus, soil management is crucial to sustainable use of natural resources, and has been the basis of choosing agricultural practices. For the predominantly extractive farming systems in SSA, depletion of SOM pool is more intense in East Africa, followed by coastal West Africa, and southern Africa (Ayuk, 2001).

There are numerous challenges of managing the SOM pool (Feller et al., 2001; Korschens, 1998; Lal, 2009). Understanding the interaction between social, political and cultural factors on SOM pool (Figure 2), is essential to translating theory into practice (Palm et al., 2001). Yet, adaptation of recommended management practices (RMPs) cannot be promoted without understanding of these complex interactions.

Perpetual removal of crop residues is an important factor responsible for decline in SOM concentration (Powell and Hons, 1991). Consequently, effective recycling of crop residues and other organic amendments/manures are essential to sustainable land use in SSA (Kapkiyoi et al., 1999; Diels et al., 2001; Bationo and Buerkert, 2001). There is an urgent need to improve the management of all types of SOM input in soils of SSA (Ganry et al., 2001), in conjunction with crop rotations and judicious input of nitrogenous fertilizers (Bationo and Ntare 2000).

Similar to the soils of SSA, recycling of crop residues is also essential to restoring the SOM pool in depleted soils of SA (Kanchikarimath and Singh, 2001; Aggarwal et al., 1997; Singh et al., 1998; Tiwari et al., 2008; Singh, 1995; Manna et al., 2003; Rao and Gill, 1995). Integrated use of manure, and complex crop rotations are also critical to creating a positive C budget (Yadav, 1995; Venkateswarlu et al., 2007; Wani et al, 2009). Because storage and release of nutrients is an essential benefit, management of SOM pool is essential to improving productivity of low-input agriculture in Brazil (Tiessen et al., 2001), and elsewhere in highly weathered soils of the tropics. The idea is to apply biosolids from any source, such as urban organic wastes (Brinder and Patzel, 2001), sugarcane biomass without burning prior to harvest (Vallis et al., 1996), crop residue brought in as mulch (Dong et al., 2006), or deposition of aeolian organic matter (Zaady et al., 2001).

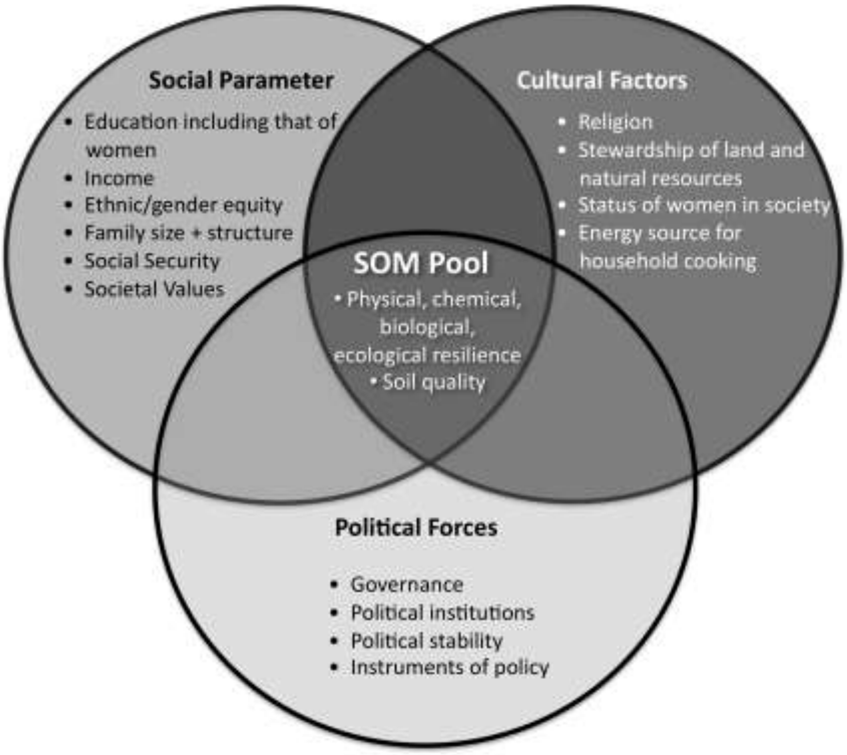

Figure 2: Social, cultural and political parameters affecting management of soil organic matter (SOM)

7. Conservation Agriculture

There has been a gradual evolution in terminology used to denote cropping systems specifically designed to conserve soil and water, and improve use efficiency of the resources. During 1960s and 1970s, a system of seedbed preparation that facilitated retention of crop residues on the soil surface as mulch was termed no-till (NT) or mulch-tillage. The land area under NT farming is estimated between 70 million ha (Mha) (Clarin, 2009) and 100 Mha (Table 2). Hardly 5 to 7% of the cropland area, mostly in North and South America, is sown by no-till farming despite more than 50 years of research (since late 1950s) because of some biophysical and socio economical constraints (Lal, 2007). Principal constraints to adoption of NT farming by resource-poor farmers are multiple and competing uses of crop residues (Larbi et al., 2002), non-availability of NT seeder and herbicides, and land tenure rights. During 1980s and 1990s, a system of seedbed preparation which drastically reduced pre-planting seedbed preparation, facilitated retention of crop residue as mulch, and included winter cover crop in the rotation cycle was termed "conservation tillage". Since the beginning of the 21st century, the widely used term "conservation agriculture" (CA) refers to a cropping system comprising of the following practices: (i) elimination of pre-planting tillage and use of a NT system, (ii) retention of crop residue mulch on the soil surface, (iii) use of complex crop rotations including cover crops and agroforestry, (iv) use of integrated nutrient management (INM) systems based on BNF, manuring, recycling of organic materials, and judicious use of chemical fertilizers.

Table 2: Area under no-till farming in different countries (Adapted from Derpsch, 2007).

Country	Area (10^6 ha)
USA	25.3
Brazil	23.6
Argentina	18.3
Canada	12.5
Australia	9.0
Paraguay	1.7
Indo-Gangetic Plains	1.9
Others	3.6
Total	95.9 (7% of cropland)

The CA has received a considerable attention since 2000 because of its lower C footprint compared with that of the conventional farming. The data in Table 3 compares C output:input ratio for conventional farming vis-à-vis CA. All inputs shown in Table 3 have been converted into the C equivalent, and loss of soil C by erosion is duly considered. The output:input ratio is estimated at 9.1 for CA compared with 7.3 for conventional farming. These calculations are based on the following assumptions, which must be validated for site-specific situations: (i) crop yields in CA may be 3 to 4% more than in conventional farming because of favorable soil-water regime, effective erosion control, and better use-efficiency of nutrients and other inputs, (ii) a soil managed by conventional farming based on plow tillage is prone to accelerated erosion at the rate of about 10 Mg soil/ha/yr and 20% of the C transported by erosional processes is emitted into the atmosphere as CO_2, and (iii) the soil managed by CA sequesters C at the rate of 500 kg/ha/yr compared with the baseline pool in the conventional farming system. These assumptions need to be validated for specific soil, ecoregions and production systems adopted under site-related conditions.

Table 3: Carbon footprint of conservation agriculture vs. conventional till corn in the U.S. (recalculated from Pimentel and Pimentel, 2008).

Parameter	Kg C E/ha	
	Conventional Till	No-Till
1. Input	803	786
2. Output (gram + straw yields)	6431	6686
3. Soil erosion	-60	0
4. C sequestration	-500	500
5. Net C output	5871	7188
6. C output:input	7.3	9.1

There are several examples of the site-specific application of CA production systems. In the Central Mexican highlands, Govaerts et al. (2009) reported that residue mulch is an essential component of the CA system. Residue removal resulted in decline in aggregation, increase in surface crusting, accelerated soil erosion, and decline in water infiltration rate. Consequently, the lowest soil moisture reserve was observed in no-till plots without residue mulch. In the humid and sub-humid regions of Brazil, Machado and Silva (2001) observed that CA (with residue mulch and cover crops) increased SOM content while improving soil fertility. In the sub-humid and semi-arid Pampas of Argentina, Diaz-Zorita et al. (2002) reported that increase in SOM with CA depends both on soil texture and soil management. The SOM concentration decreased when the duration of the row-crop cycle increased. Using no-till system in combination with pastures and longer cycles of maize and wheat increased SOM concentration compared with elimination of pastures and longer cycles of sunflower and soybeans. In semi-arid Kenya, Gicheru et al. (2004) reported that using CA with manure and mulching created a favorable water balance in a crust-prone sandy loam soil. Field experiments on Vertisols in the central Highlands of Queensland indicated that CA improved grain yield in 2 of 4 years. Further, all pasture treatments improved SOM concentration compared with continuous cropping (Armstrong et al., 2004). For some Alfisols in Australia, Willis et al. (1999) reported that double cropping and pasture treatments increased water infiltration rate and SOM concentration. The retention of cereal and pasture stubble increased total water entry by reducing crust formation.

8. Soil Organic Matter and Agronomic Production

The SOM concentration is an important determinant of soil quality. It improves soil edaphic conditions by enhancing: (i) soil aggregation, structure and tilth, (ii) plant available water capacity, (iii) nutrient reserves and cycling, (iv) soil's resistance against erosivity of rain, runoff and wind, (v) activity and species diversity of soil biota, (vi) nutrient cycling processes, (vii) aeration and gaseous exchange, (viii) microbial biomass C, (ix) processes that create favorable soil temperate regime, and (x) crop growth and net primary production. Thus, there are numerous reports indicating positive correlation between agronomic yield and concentration of soil organic carbon (SOC) in the root zone (Ganzhara, 1998; Lal, 2006). The data in Figure 3 shows a positive correlation between SOC concentration in the root zone and grain yield of soybean on 3 farms in Central Ohio. A similar relationship is observed in the data from Thailand showing a positive relationship between grain yield of maize and SOC concentration (Figure 4). It is these and numerous other examples which form the basis of a general recommendation that management of SOM concentration (and pool) in the root zone to above the critical level is essential to enhancing and sustaining agronomic production, and achieving food security.

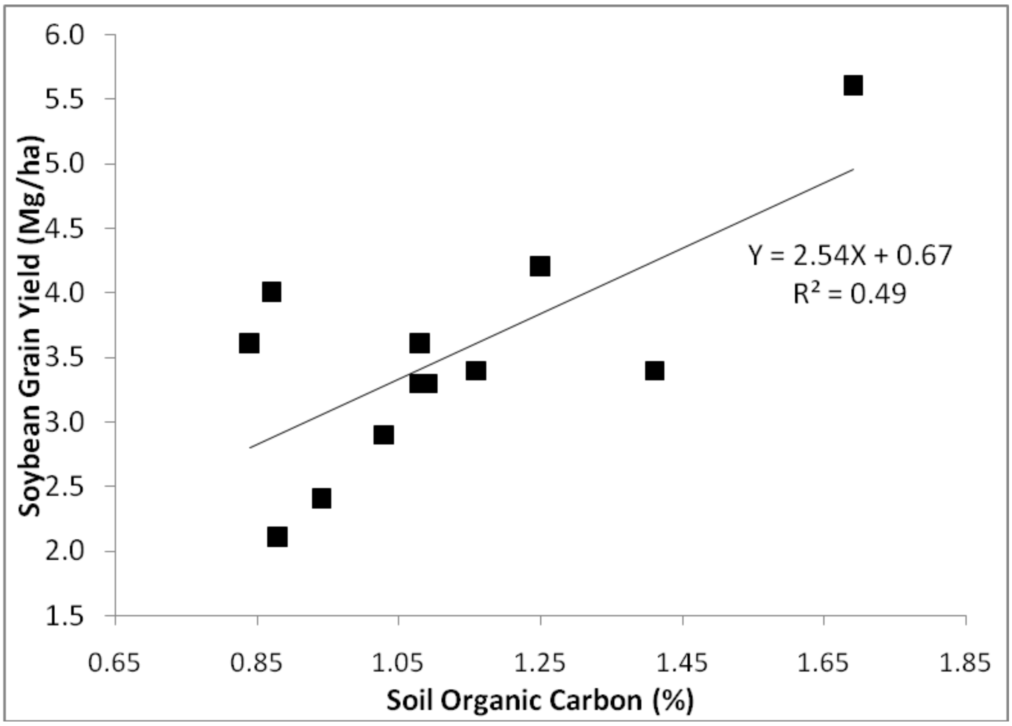

Figure 3: Relation between soybean grain yield and soil organic carbon concentration on 3 farms in central Ohio (Redrawn from Fahnestock et al., 1995).

In addition to enhancing crop yields, soil C sequestration also mitigates climate change by off-setting anthropogenic emissions. The technical potential of C sequestration in cropland soils is 0.6-1.2 Pg C/yr (Lal, 2004). The technical potential of C sequestration in soils of all ecosystems is about 3 Pg C/yr which can create a drawdown of 50 ppm of atmospheric CO_2 by 2100 (Hansen et al., 2007). If farmers/land managers are compensated for providing eco-system services at the rate of $50/Mg of C, it would create another income stream of ~$25/ha/yr (~$10/acre/yr). This is an important incentive and is urgently needed to promote the adoption of RMPs by resource-poor farmers in developing countries, and to facilitate transition to eco-friendly agriculture in industrialized nations.

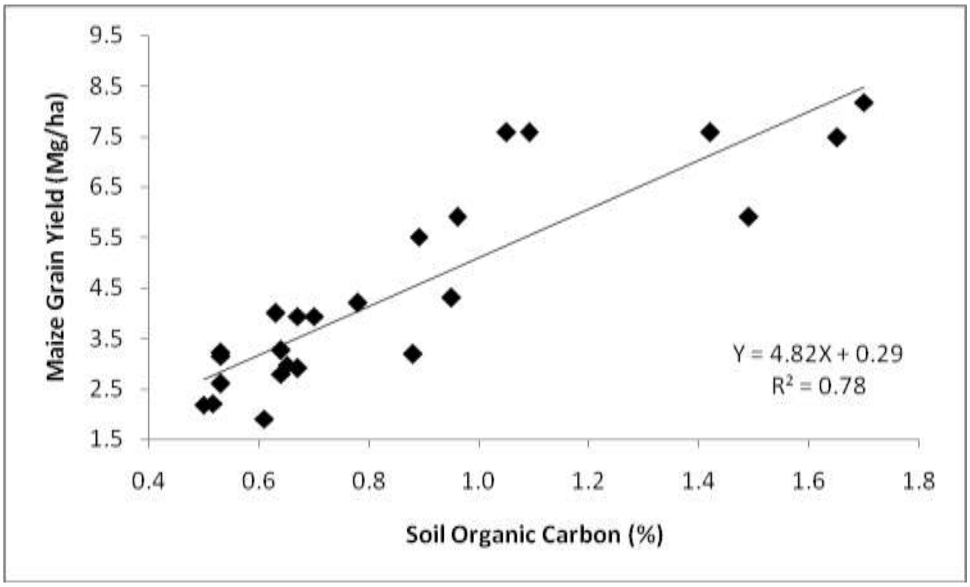

Figure 4: Effect of soil organic carbon concentration on the grain yield of maize in northeastern Thailand (Petchawee and Chaitep, 1995).

9. Conclusion

Sustainable management of soil and water resources is essential to addressing three issues of global significance: achieving food security, adapting to and mitigating climate change, and improving the environment by restoring degraded and desertified soils and ecosystems. Because resource-poor small land holders of the tropics and sub-tropics use extractive farming, the problem of soil degradation is exacerbated by negative C and nutrient budgets. Consequently, arable lands are strongly depleted of their soil organic matter or nutrient reserves, and are characterized by degraded soils of low physical, chemical and biological quality. Further, there exists a positive correlation between the concentration of soil organic matter in the root zone and agronomic yield. Thus, soil restorative practices needed are those which create positive C and nutrient budgets while improving soil structure, controlling soil erosion, and improving activity and species diversity of soil biota. In this regard, the importance of adopting an eco-efficient approach can not be over-emphasized. The strategy is to restore soil quality and enhance ecosystem services. Soil C sequestration in terrestrial ecosystems (e.g., croplands, grazing lands, forest lands, degraded lands, wetlands) has a technical potential of 3 Pg C/yr for 25 to 50 years, with an atmospheric drawdown capacity of 50 ppm of atmospheric CO_2 by 2100. Further, restoring soil quality is essential to achieving global food security. Payments to farmers for ecosystem services equivalent to $50/Mg C can be an important tool to promote adoption of recommended management practices. This is a win-win strategy, and a bridge to the future until low-carbon or no-carbon fuel sources take effect.

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Organic Farming and Climate Change
Can organic farming mitigate the impact of agriculture on global warming?

Claude Aubert

Independent Organic Farming Consultant &
Association of the French Members of IFOAM, France
Email: aubertcl@orange.fr

ABSTRACT

Agriculture is responsible for more than 30% of the total human-induced greenhouse gases (GHG) emissions. Three gases are responsible for those emissions: CO_2, CH_4 (methane) and N_2O (nitrous oxide). Organic farming emits less GHG than conventional farming for several reasons: lesser energy use, lesser nitrogen use, no artificial fertilizers, more grassland, sequestration of carbon in the soil. However, the ability of organic farming to mitigate the GHG emissions is strongly dependant on the way it is practiced. Our food habits, and mainly the part of animal food (specially ruminant meat) have also a strong influence on the GHG emissions of food.

1. Introduction

Global warming represents a major threat for food security, especially in tropical countries. It is expected that global warming will worsen the drought and the irregularity of rainfall in many countries. Mitigating the emissions of greenhouse gases is therefore an important challenge that can significantly contribute to improve food security. This can be achieved by reducing the CO_2 emissions due to combustion of fossil fuels, but also by changing agricultural techniques and food habits.

Agriculture is responsible for at least 30% of the global warming (Table 1). This important contribution is due to three gases: CO_2 (carbon dioxide), CH_4 (methane) and N_2O (nitrous oxide).

- CO_2 emissions come mainly from the fertilizers industry, from the machinery used on the farm and, according to the production system and to the changes in land use, from the release in the air of part of the carbon present in the soil. Deforestation is also an important contributor to the emissions of CO_2 by agriculture.
- CH_4 emissions come mainly from livestock, from enteric fermentation of ruminants and manure fermentation, and also from rice fields.
- N_2O emissions come mainly from the soil (nitrification and denitrification) and to a lesser extent from animal manure.

Table 1: Greenhouse Gas emissions by agriculture (after Scherr, 2008)

Emission sources	Annual emissions (million t CO_2-eq)	Gas emitted
Soil fertilization (organic and mineral)	2,100	Nitrous oxide
Enteric fermentation in rumen	1,880	Methane
Biomass burning	700	Methane, nitrous oxide
Rice production	600	Methane
Livestock manure	400	Methane, nitrous oxide
Other (mechanization, irrigation, greenhouses)	900	Carbon dioxide, nitrous oxide
Deforestation and devegetation	8,500	Carbon dioxide
Total	15,080	
Fossil fuel burning (for comparison)	27,700	Carbon dioxide

The impact of organic agriculture, compared to conventional agriculture, has not been very extensively studied. However, some conclusions can be drawn from research done in this field, in particular on the factors influencing the emissions of greenhouse gases by agriculture.

2. Energy consumption and carbon dioxide (CO_2) emissions

The direct energy consumption (mainly for mechanization) is about the same in organic and conventional agriculture. But if we add the indirect consumption, mainly for the manufacture of nitrogen fertilizers, the total energy consumption becomes much lower in organic agriculture, at least by hectare. Indeed the production of 1 ton of N as chemical fertilizer needs about 1 ton of oil and even more in some factories.

In Great Britain, a research made by the Ministry of agriculture concluded that, for most of the productions, the amount of energy used to produce 1kg of food is lower in organic than in conventional agriculture: for example, it amounts, for vegetables, between 28 and 75% of the energy used in conventional agriculture, for beef 55%, for wheat 84%. On the contrary, the organic production uses 14% more energy per kg than the conventional for potato, 10% more for eggs, 11% more for chicken (Figures 1, 2 and 3).

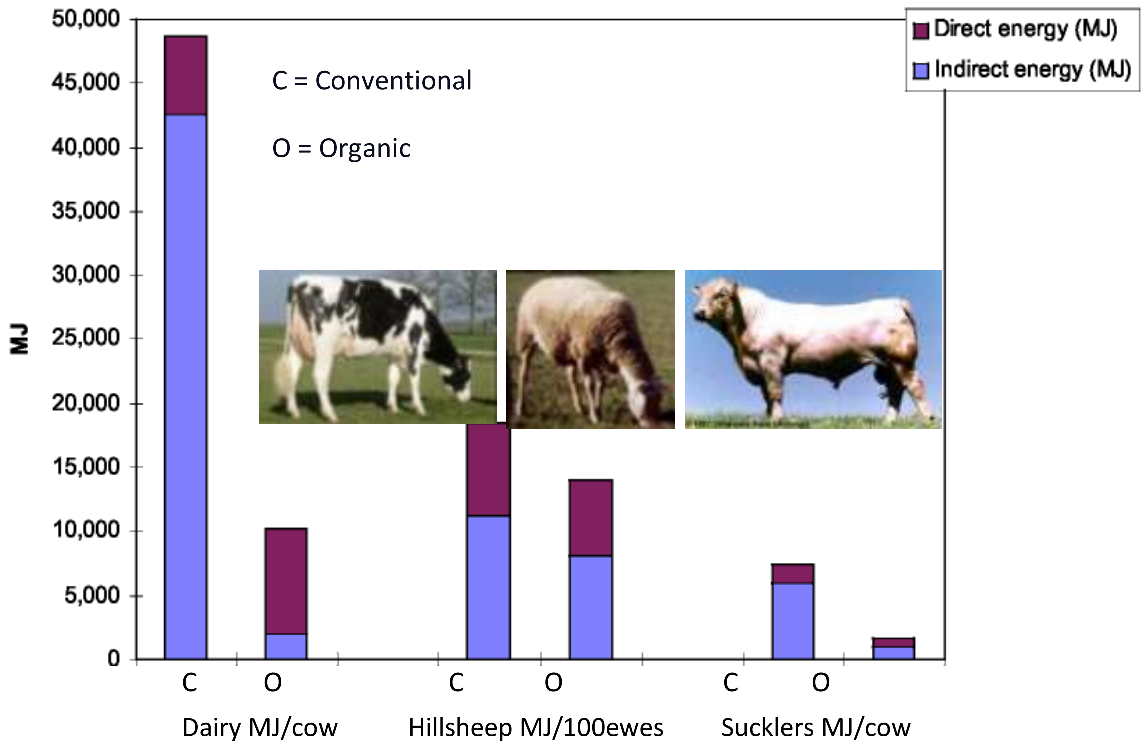

Figure 1 - Direct and indirect energy consumption in different types of stock breeding (after MAFF, 2000)

In France, according to the results of 950 farms, 274 of which being organic, the energy consumption par ha is much lower in organic farms for all types of production, but with a great heterogeneity. For instance in grain production the energy consumption is 66% higher in conventional because the fertilisation represents 46% of this consumption, whereas it is only 6% in organic. By ton of product, the result is better in conventional farms for productions, like grain, where the differences in yield are important. For other productions, for instance milk, the organic remains more efficient by litre of milk produced (Bochu, 2008).

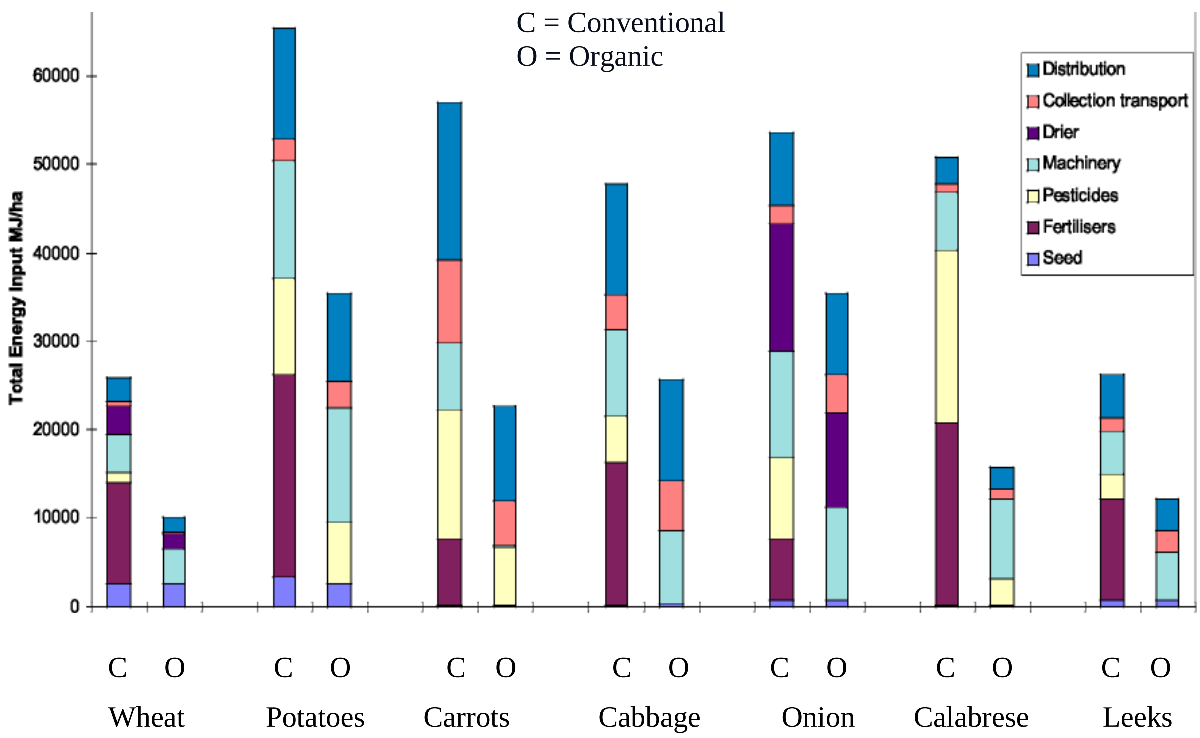

Figure 2: Energy consumption per area unit in organic and conventional agriculture (MJ/ha) (after MAFF, 2000)

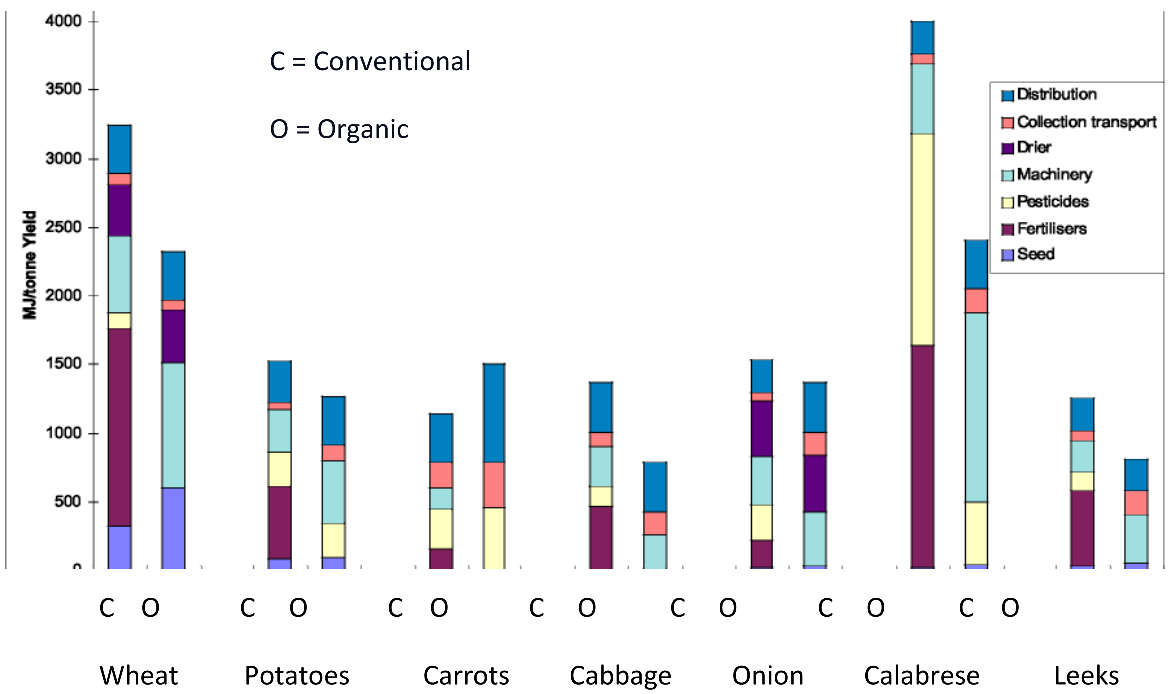

Figure 3: Energy consumption per ton in organic and conventional agriculture (MJ/ton) (after MAFF, 2000)

In Germany, a comparison between 18 organic and 10 conventional farms showed that the energy input per ha is always lower in organic than in conventional farms (Figure 4).

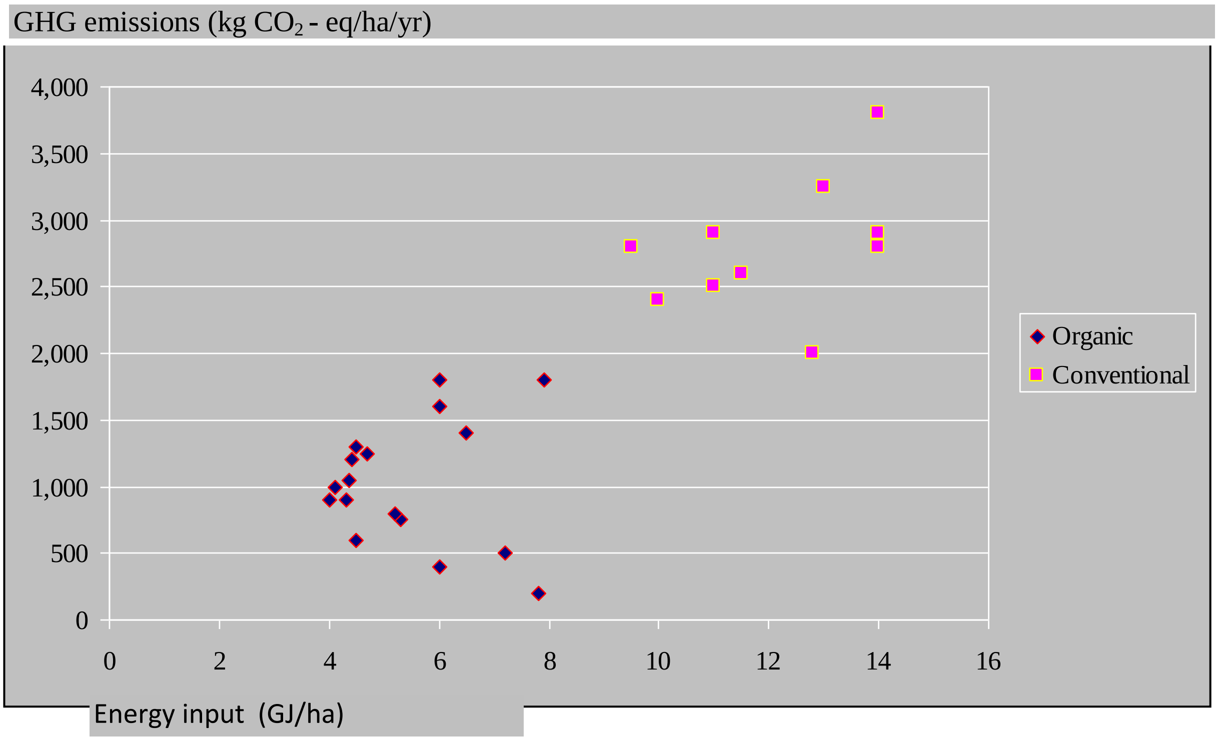

Figure 4 - Greenhouse gases emissions according to energy input (Hülsbergen, 2008)

3. Methane (CH_4) emissions

The methane emissions are not much lower in organic than in conventional agriculture. However, the longevity of milking cows – which is usually longer in organic than in conventional stock breeding - is a way to decrease the amount of methane produced per kg milk (Figure 5).

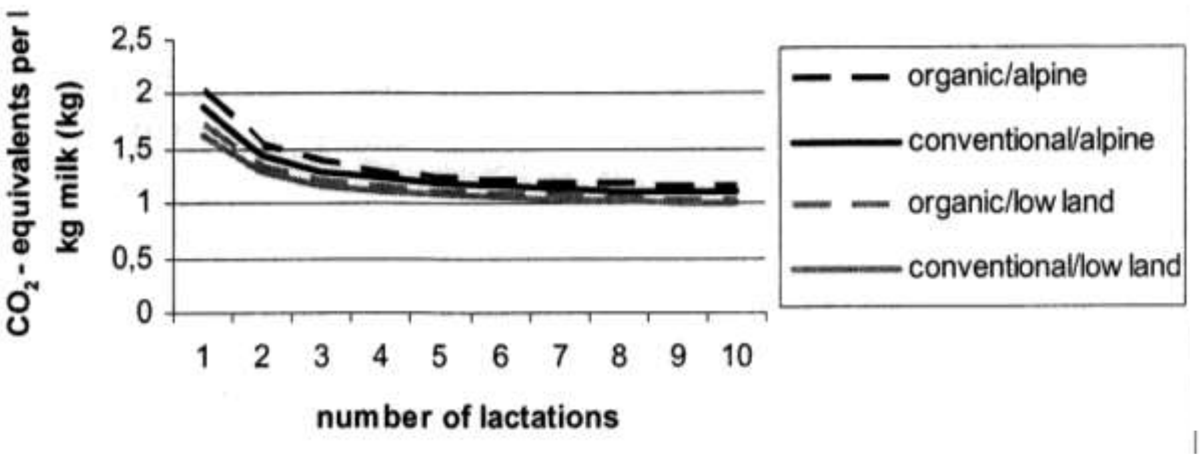

Figure 5: GHG emissions by litre milk according to the production system and the number of lactations (Boincean, 2008).

As far as the fermentation of effluents is concerned, the reduction of GHG emissions by composting has been confirmed by several experiments, the emissions of methane being much lower and not offset by the slight increase in N_2O emissions. For exemple, in an experiment in Canada the GHG emissions have been 487 kg eqCO_2/cow/year by composting, 729 kg with manure heap and 1481 with slurry (Pattey, 2008).

4. Nitrous oxide (N_2O) emissions

N_2O is emitted mainly by the soils. The amount emitted per ha and per year depends on many factors : type of soil, type of crop, rainfall, rotation, compaction of the soil, amount and type of nitrogen fertilization. The main factor related to the farming techniques is the nitrogen fertilization. The N_2O emissions increase rapidly with the amount of nitrogen fertilizers (Figure 6).

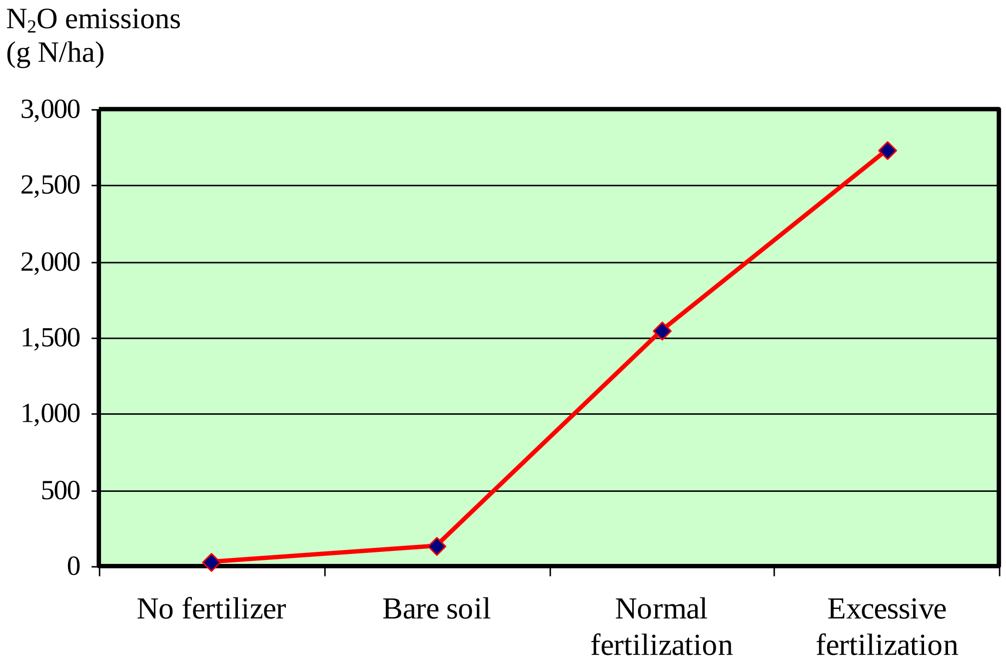

Figure 6: N_2O emissions according to the fertilization (rape production) (Germon, 1999)

Nitrogen fixed by legumes contributes considerably less to N_2O emissions than nitrogen spread as fertilizer. This leads to revise the evaluations based on the default IPCC emission factor (1% of nitrogen applied), which was the same for nitrogen fertilizers and for symbiotic fixation. Consequently, on a farm, the more nitrogen fixed biologically, the less N_2O is emitted.

Table 2: Greenhouse gas emissions per ton chemical nitrogen (kg CO_2- eq/ kg N) (author's estimation)

Energy consumption by manufacture	2.7
N_2O emissions by manufacture	4
Indirect N_2O emissions by application	4.9
Indirect applications by application	4.1
Total	15.7

Table 3: N_2O emissions by nitrogen fertilisation (kg CO_2- eq/ kg N) (author's estimation)

Chemical nitrogen	15.7
Organic nitrogen	9.0
Biologicaly fixed nitrogen	1.0 - 2.0
Total	25.7 - 26.7

In a research made in Denmark (Olesen, 2008), the impact of various factors (rotation, fertilization, green manure) has been studied. The emissions are lower in organic systems and are decreased with green manuring and increased with manure application. In this experiment, the emissions per kg produced are higher in organic systems if the IPCC default emission factor is applied. If the emissions due to the nitrogen biologically fixed are considered as not higher than the background emissions, which is a better estimation, the emissions remain superior in organic in the rotation without annual legumes, but lower in the rotation with legumes.

The N_2O emissions are closely related to the nitrate (NO_3) content in the soil. As shown in Figure 7, the nitrate content in the soil is in most cases much lower in organic than in conventional soils.

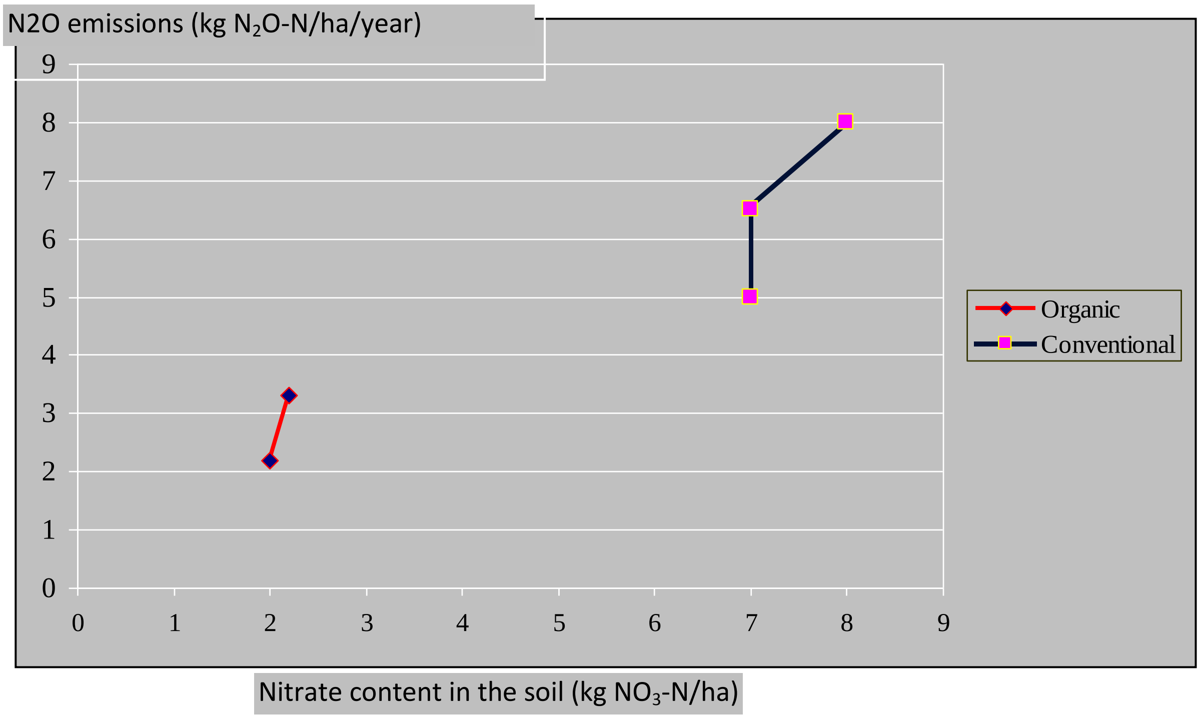

Figure 7: N_2O emissions according to the nitrate content in the soil (Sehy, 2004)

5. Global Warming Potential (GWP): $CO_2 + CH_4 + N_2O$ emissions

The results of two long term comparisons between organic and conventional systems in Switzerland (DOC and Burgrain experiments) show that the emissions per ha and per kg produced are lower in organic systems (Figure 8).

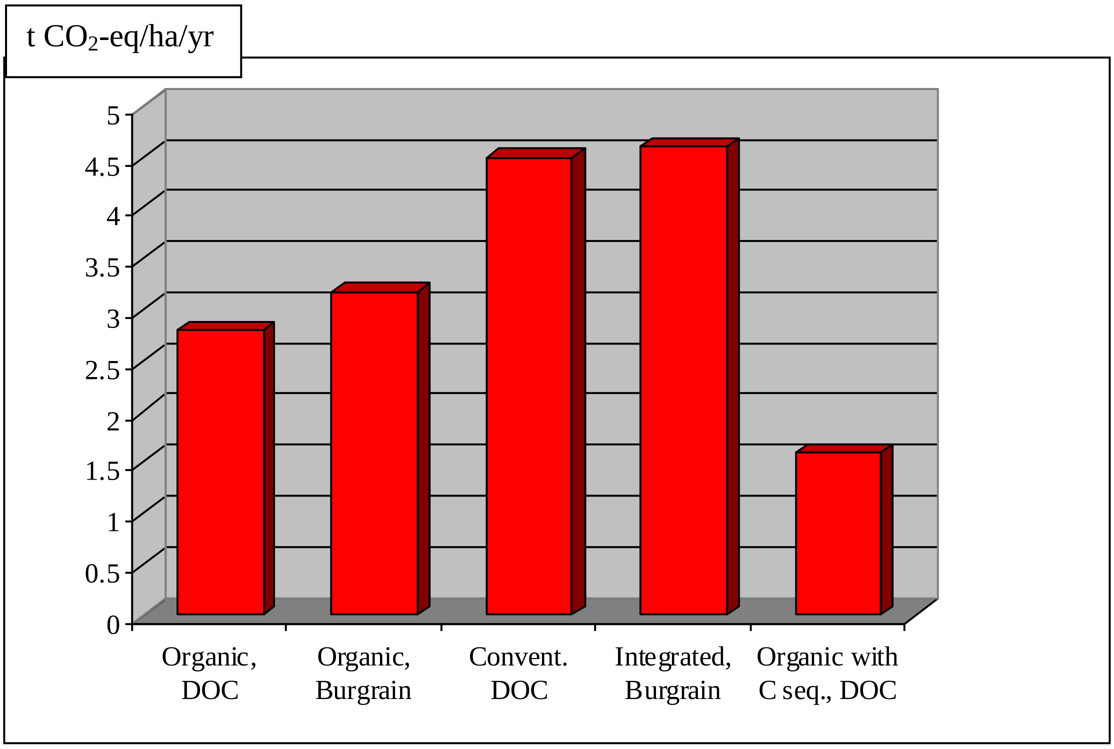

Figure 8 - GHG emissions in organic and conventional agriculture (after Nemececk, 2008)

6. Sequestration of carbon in the soil

The data are variable according to the situation and the production system. The amount sequestered in organic farming varies, in most cases, between about 100 kg C/ha/year and more than 500 kg C/ha/year (Table 4).

In stockless farms, in some cases, organic agriculture can de-sequester carbon (Brock, 2008),

An experiment made in Moldavia has confirmed the importance of having perennial legumes in the rotation: in two rotations with manure supply, the one with legumes increased the organic matter content of the soil, whereas the one without legumes decreased it. On the other hand, the variant with manure + NPK did sequester more carbon than the variant with only manure (Boincean, 2008).

Comparisons between different experiments are sometimes difficult because the depth at which the samples have been taken is not always made clear, and the amount of organic present in the top soil may be only half, or even less in tropical regions, of the total amount.

In comparisons with conventional agriculture, the results are different if one considers the net amount sequestered in the soil or the difference with conventional agriculture (Table 5). For instance, in the DOC experiment (Fibl, Switzerland) the amount sequestered in the biodynamic plot was only + 87kg C/ha/year, but the difference with the conventional plot was + 287 kg C/ha/year.

In order to compare the capacity of organic agriculture to sequester carbon, the comparison should be done at the regional scale taking in account the change in soil utilization (from annual crops to grassland or the contrary), the plantation of hedges, etc. In Great Britain, for instance, 13 millions of carbon from the soil are lost every year, which represents 7.3% of all GHG emissions in this country (Aseez, 2008)

Table 4: Gain in carbon in the soil in organic compared to conventional agriculture

Type of experiment	Country	Gain in carbon in the soil in organic compared to conventional agriculture (kg C/ha/yr)	Author and year of publication
DOC (Fibl, Suisse)	Switzerland	287	Fliessbach, 2008
Long term trial Rodale Institute	USA	688	Heperly, 20008
Comparative study of 18 organic and 10 conventional farms	Germany	170	Hulsbergen, 2008

The average gain is 380kg C/ha/year, in accordance with estimations made by other authors.

Table 5: Impact of various agricultural practices on carbon content of the soil (t C/ha/year) (Source : Hülsenbergen, 2008)

Change of land use from pasture to cropland	> -1
Maize for silage	- 0.4 to - 0.8
No till	0 to + 0,25
Fertilization with manure or compost	> + 0,5
Organic agriculture	0 to + 0,5
Perennial legumes	+ 0,6 to > 1
Change of land use from cropland to pasture	> 1

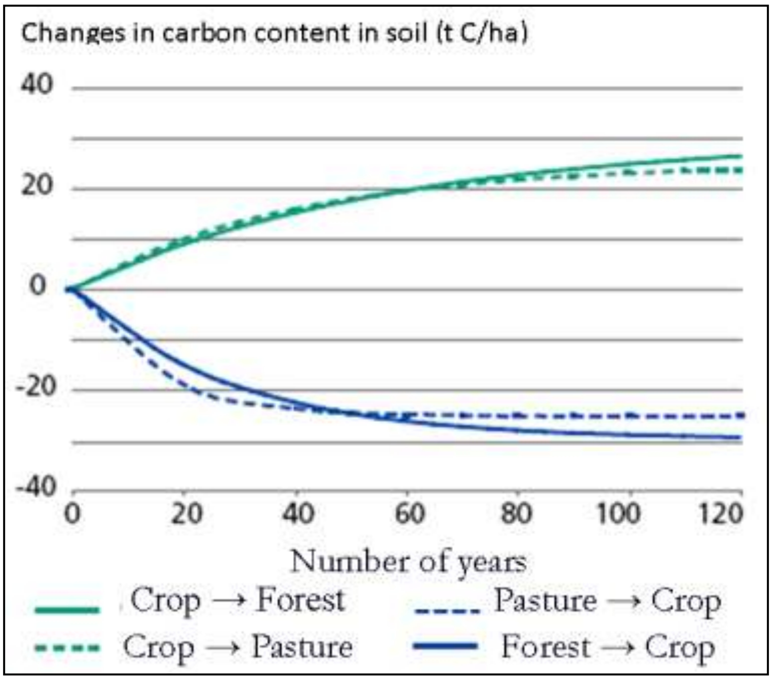

Figure 9: Changes in carbon content in the soil according to land use change (author)

Farmers' aiming at the mitigation of the GHG emissions by organic (and conventional) agriculture should include following practices:

- Replace, as far as possible, nitrogen fertilizers (organic and mineral) by more legumes
- Feed the ruminants more grass and less maize grain, grain and soya cake
- Improve the rotations (more legumes, especially perennial, more green manure)
- Compost animal dejection
- Produce biogas.

7. Impact of food habits

The food habits have an enormous impact on the GHG emissions by the production of food.
The part of animal products and particularly of meat but also of milk, in the diet has a very high impact on the contribution of our diet on the GHG emissions. For example, the production of 1 ton milk emits about 1 ton CO_2- eq, whereas 1 ton of soymilk emits 10 times less (Riedecker, 2008). But the highest impact is the consumption of the meat of ruminants: the production of 1 ton protein as ruminant meat emits about 30 times more GHG than as legumes.

The food industry emits also a lot of GHG: the production of 1kg deep frozen French fries emit 5.7 kg CO2eq (Redlingsdhofer, 2008).

Decrease the meat consumption would strongly contribute to mitigate the GHG emissions from food (Figures 10 and 11).

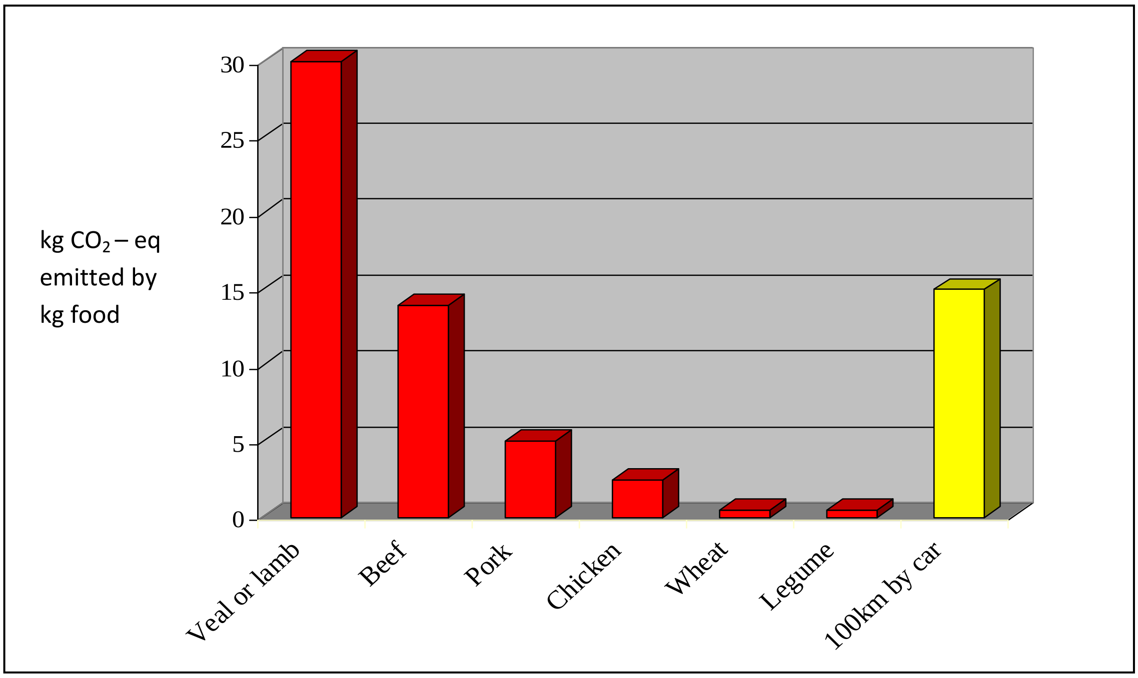

Figure 10: GHG content of vegetable and animal food (Aubert C, 2007)

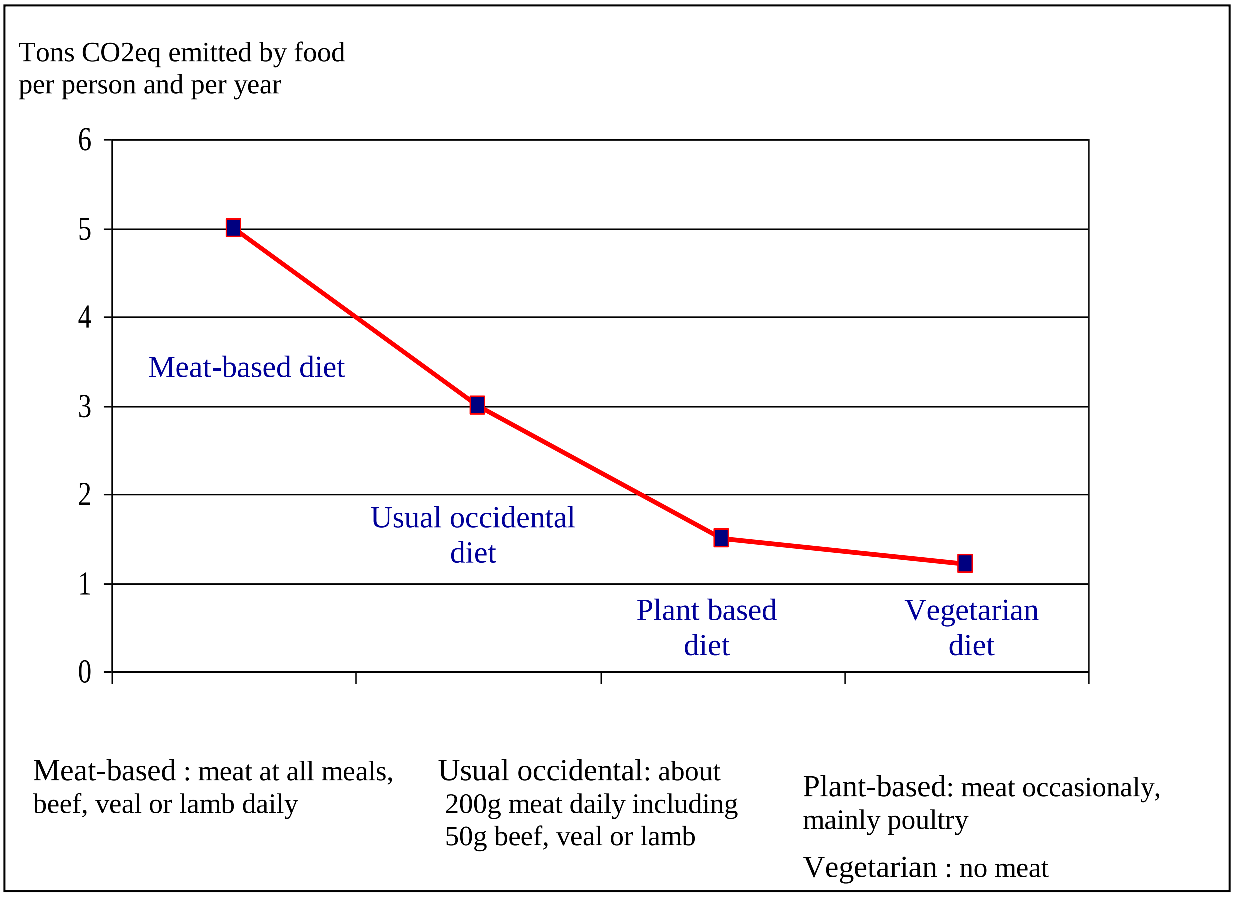

Figure 11: Amount of CO_2-eq in our plate according to our food habits (Aubert, 2008)

8. Conclusion

Based on the on the above presented evidences the following conclusions can be made in regard to organic farming and GHG emissions:

1. Organic agriculture emits less GHG than conventional agriculture.
2. Organic agriculture can still improve its mitigation potential (with better rotations, more legumes, energy savings, renewable energies).
3. Changing our food habits (eating organic, less animal food, eat local, etc.) can strongly reduce the GHG emissions of our food.
4. Divide by two, or more, the GHG emissions of agriculture and food is possible but it needs political and individual will to change agriculture techniques and food habits.

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Impact of Large-Scale Conversion to Organic Farming on Greenhouse Gas Emissions

Darko Znaor

Avalon, Associated Expert, the Netherlands/Croatia
Email: darko.znaor@inet.hr

ABSTRACT:

This paper gives an overview of the two studies assessing likely greenhouse gas (GHG) emissions of large-scale conversion to organic farming (in Croatia and the UK) and provides an estimate of the impact a total conversion to organic farming would have on the GHG emissions of the EU-27.

Organic farming does not use synthetic fertilisers. A total conversion to organic farming would thus result in cutting all GHG emissions generated by the manufacture of synthetic fertilisers, their transport, application and emissions from the soil. Besides, since organic farming usually results in the sequestration of carbon in the soil, its wide adoption would provide a substantial carbon sink in the soil. In the case of Croatia, a total conversion to organic farming would decrease GHG emissions arising from farming and farm-upstream linked sectors by 72 percent as compared to the present situation. A total conversion to organic farming in the UK would reduce the environmental and health costs generated by GHG by approximately 60 percent, while the external costs of a food basket (assuming also the use of environmentally-friendly means of transport) would fall tenfold. Finally, by adopting a full-scale conversion to organic farming, the EU-27 would seem to be able to cut its GHG emissions by 5.6 percent. This is exactly as much as the current gap in reaching the GHG reduction policy target, which EU-27 will not be able to bridge even by implementing all its planned policies and by employing best available technological means presently known.

1. Agriculture and greenhouse gas emissions

Agriculture is probably the most climate-dependent human activity, but contrary to most other sectors, agriculture is both the source of greenhouse gas (GHG) emissions and a victim of climate change. Being the main source of two major greenhouse gases - nitrous oxide and methane - agriculture is a significant source of GHG emissions (PICCMAT, 2008). Agricultural soils and livestock directly emit GHG, while agriculture's indirect emissions include fossil fuel use in farm operations, the production of agrochemicals and the conversion of land to agriculture (Bellarby, *et al.*, 2008). Taking into account the direct emissions only, in 2004 agriculture globally made up 13.5 percent of all anthropogenic GHG emissions (IPCC, 2007). However, the total global contribution of the agricultural sector, including all direct and indirect emissions, is 8.5-16.5 Pg CO_2-eq, which represents between 17 and 32 percent of all global human-induced GHG emissions (Bellarby, *et al.*, 2008). Manufactured (mineral) nitrogen fertilisers emit 0.4-0.6 Gt CO_2-eq, accounting for about 10 percent of all direct emissions from agriculture and 1 percent of all global human-induced GHG emissions (EFMA, 2008b; FAO, 2009; Williams, *et al.*, 2006).

In the EU-27, agricultural direct emissions contributed 9.2 percent of the total GHG emissions in 2007, of which more than 5 percent was nitrous oxide and nearly 4 percent methane (EEA, 2009a). Some 49 percent of all methane emissions and 65 percent of all nitrous oxide emissions in the EU-15 comes from agriculture (Duchateau and Vidal, 2003).

Livestock farming and fertiliser use are by far the two most significant sources of GHG deriving from agriculture. Through enteric fermentation in the rumen, ruminant livestock (cattle, sheep and goats) produce methane, contributing about 60 percent of all global methane emissions (Bellarby, *et al.*, 2008). Besides, the storage, application and decomposition of livestock manure in the soil, emit both methane and nitrous oxide. Fertilisers applied on agricultural land emit nitrous oxide, and are a major direct source of nitrous oxide from agricultural soils. Beside livestock farming and fertilisers, agriculture emits GHG through the production of legume crops, residue burning and land use change (e.g. conversion of carbon-rich grassland soils into arable land).

So far, carbon losses from agricultural soils are not reported in the national GHG inventories under the UNFCCC. However, these are substantial and in case of the EU-15 have been estimated at 10-20 Tg C y^{-1}, adding 4-8 percent to the EU-15's anthropogenic GHG emissions (Freibauer, *et al.*, 2004).

2. Organic farming and greenhouse gas emissions

The Food and Agriculture Organisation of the UN (FAO) recognises organic farming as one type of sustainable farming method (FAO, 1998; FAO, 1999; FAO, 2007; Scialabba El-Hage and Hattam, 2002). Organic farming contributes to the reduction of greenhouse gas (GHG) emissions because it reduces the consumption of fossil fuels, reduces emissions of CO_2, CH_4 and N_2O and reduces vulnerability of soils to erosion, while at the same time increasing carbon stocks in the soil (Niggli, *et al.*, 2007). Consequently, conversion to organic farming is believed to be a viable way of reducing GHG emissions (Wood, *et al.*, 2006). However, comparative data on GHG and other related gas emissions between organic and non-organic systems are sparse (Niggli, *et al.*, 2007).

The German Öko Institut (2007) reports that organic farming, depending on the commodity produced, emits 6-31 percent fewer GHG than non-organic farming production, which is somewhat less than the reduction of 48-60 percent previously reported by Haas and Köpke (1994) and Burdick (1994). Swiss organic farms were found to be able to reduce GHG emissions by 18 percent (Niggli, 2007). The reduction in GHG emissions by Dutch organic dairy farms is 14 percent, for organic peas 41 percent, while organic potatoes and leeks result in emissions of 10 percent and 22 percent more GHG than conventional production (Bos, *et al.*, 2007). Küstermann *et al.* (2007) found that Bavarian organic farms emit 2 percent more GHG, while stockless organic farms of the German Scheyern region emit up to 53 percent more GHG than conventional farms. However, when the carbon sequestration effect was included in the calculation, their net GHG emissions were 26 percent and 80 percent lower than of the conventional farms. Average CO_2 emissions per unit area from organic beef are 57 percent lower than for non-organic production (Casey and Holden, 2006). Nemecek *et al*. (2005a; 2005b) found that on a per hectare basis emissions of GHG in organic farming are 29-37 percent lower than in integrated agriculture. However, when calculated per kg of product, organic farming resulted in a higher global warming potential. This contradicts the results presented by Bos (2007) who found that organic dairy production also emits less CO_2 per yield unit. Organic farming was found not be an option for sequestering C in soil in the cold Swedish climate (Kirchmann, *et al.*, 2007).

Data on methane (CH_4) and nitrous oxide (N_2O) emissions from organic farming do not seem to exist (Niggli, *et al.*, 2007). According to Niggli *et al*. (2007) N_2O emissions in organic farming are expected to be lower than in conventional farming because the soils at organic farms:

- Have lower concentrations of easily available mineral N (which highly determines N_2O emissions);
- Have a better soil structure and are less compacted, which reduces denitrification;
- Tend to be under plant cover for longer, which reduces N_2O emissions.

CH_4 emissions from organic production of ruminants are the same as in conventional farming, but because organic livestock lives longer, the ratio between the unproductive and productive period is more favourable for organic ruminants (Niggli, *et al.*, 2007).

3. Large-scale conversion to organic farming

Organic farming is a rapidly growing sector in many countries. In 2006, globally 30.4 million hectares were managed organically on more than 700 000 farms, representing 0.65 percent of the agricultural land (Willer, *et al.*, 2008). In 2006, organic farming accounted for 13% of the total agricultural area in Austria and for 11% in Switzerland (Willer, *et al.*, 2008). If the expansion of EU organic farming continued at the same pace, in two decades organic farming would account for some 50% of the total agricultural area (Znaor, 2008).

From the environmental point of view, a further spread of organic farming seems to be desirable. However there is some concern about the impact of this spread on society as a whole and the exact costs and benefits of this scenario and its associated trade-offs remain unknown (EC, 2005a; EC, 2005b; EC, 2007). As farming is linked to many other economic activities, the widespread adoption of organic farming could have broader impacts. The consequences might include effects on employment and the overall economic performance of some sectors (e.g. the fertiliser and pesticide industry and their distribution chains). In economically developed countries, the widespread adoption of organic farming is most likely to result in lower yields, threatening national/regional food productivity and security.

To date, hardly any research has been carried out to assess the cross-sectoral effects of organic farming on the entire economic system and policy makers lack studies providing a detailed insight into the corresponding economic, environmental and social impacts of both the present level of organic farming and scenarios involving its expansion on a larger scale (EC, 2005a; EC, 2005b; EC, 2007; Znaor, 2008). This paper gives an overview of the two studies assessing likely greenhouse gas (GHG) emissions of large-scale conversion to organic farming (in Croatia and the UK) and provides an estimate of the impact large-scale conversion to organic farming would have on GHG emissions of the EU-27.

4. GHG emissions under large-scale conversion to organic farming in Croatia

Assessments of the environmental and economic consequences of large-scale conversion to organic farming in Croatia have been performed for the period 2001-2003 (Znaor, *et al.*, 2005) and 2001-2005 (Znaor, 2008; Znaor, *et al.*, 2007). These studies examined the consequences of the conversion of a substantial portion of Croatian agricultural land to organic farming in relation to national agricultural output (food productivity/security) and related environmental (soil, water, climate/air and energy use) end economic performance. The results dealing with climate change only have been presented by Legro *et al*. (2008), Znaor (2009) and Landau and Znaor (2009).

4.1. Methodology

Farming is closely linked with a range of economic activities. Thus, when measuring the impact on climate change, the assessments - besides farming - also took into account the impact a large-scale conversion to organic farming would have on farm-upstream linked sectors. These include energy production and supply, manufacturing of agri-chemical inputs, trade, transport and research, education, advisory, veterinary and administrative services. Thus, the GHG emissions associated with energy use and production, transport and application of farm input raw materials and the final farm input products were assessed both for the farming and farm-upstream linked sectors (Figure 1).

The GHG emissions of the baseline scenario (average of 2001-2003 and in a later study 2001-2005) were compared with fourteen development scenarios involving various shares of agricultural land under organic management: 10, 25, 50 and 100 percent. For the each scenario, the environmental costs associated with the corresponding GHG emissions were assessed in monetary terms, applying a methodology developed by the ExternE programme (Droste-Franke, 2005; IER, 2004; IER, 2007), an EC-funded multi-year and multi-million EUR environmental accounting research programme. A detailed description of the methodology used in the Croatian studies can be found in Znaor *et al*. (2005) and Znaor (2008).

Based on the long-term organic experiments in temperature regions (Mäder, *et al.*, 2002; Pimentel, *et al.*, 2005), the sequestration rate of 180 kg C ha^{-1} yr^{-1} for arable land under organic management is taken as a realistic estimate for the carbon sequestration potential in Croatia. Several studies report much higher sequestration rates (400-1,800 kg C ha-^{1} yr^{-1}) in temperate regions (Hepperly, *et al.*, 2008; Hülsbergen and Küstermann, 2008; Raupp, *et al.*, 2006; Teasdale, *et al.*, 2007), but in order to remain conservative, a sequestration rate od 180 kg C ha^{-1} yr^{-1} was applied.

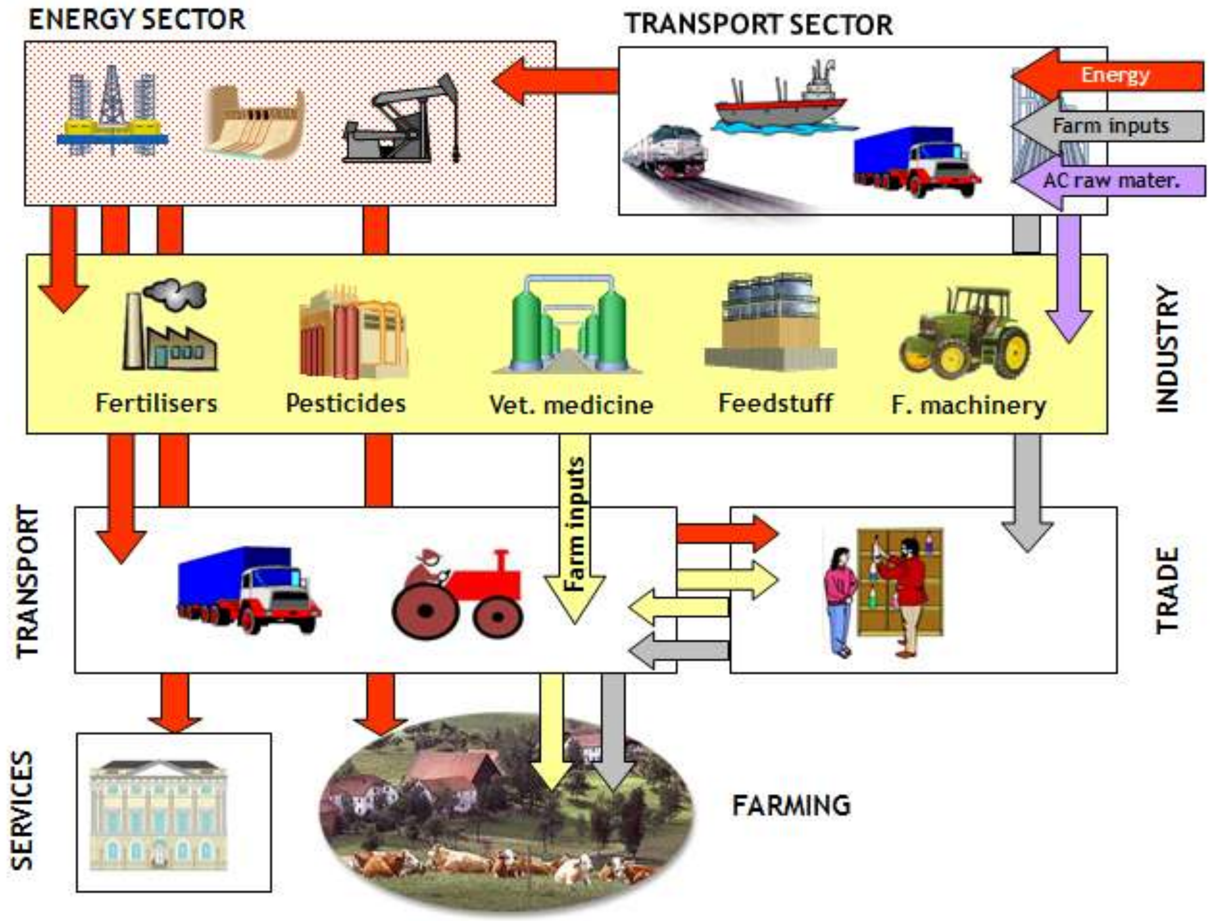

Figure 1: Services and goods flow between farming and farm-upstream sectors (modified after Znaor, 2008)

4.2. Results

In the baseline scenario (2001-2005), farming and farm-upstream linked sectors emitted 5,027 Gg CO2-eq per year, of which N_2O contributed with 53 percent. The corresponding environmental damage is estimated to be 96 million EUR per year, which is equal to about 10 percent of the gross-value added generated by farming and farm-upstream linked sectors. The vast majority (79 percent) of GHG emissions (and environmental damage) arise from farming, while only 21 percent is generated by other sectors (Table 1). Fifty three percent of the GHG emissions from the farming sector originate from manure and soil management.

Compared to the baseline, the GHG emissions are reduced in all organic scenarios and the reduction depends on the surface area under organic management: the greater the organic area, the greater the reduction (Table 1). In the case of a total conversion to organic farming, GHG emissions (CO_2-eq) arising from the farming sector are 19 percent lower in than in the baseline. However, when measured throughout the entire farming and farm-upstream chain, the GHG emissions generated by the total conversion scenario are reduced by 35 percent as compared to the baseline. Consequently, the total conversion scenario generates 35 percent less environmental costs than the baseline (Table 1). The higher the area under organic management, the higher the share of the farming sector in total GHG emissions. Farming accounts 81 per cent of all GHG in the scenario with 10 percent organic area, while in the scenario with 100 percent of agricultural land under organic farming all GHG emissions arise from the farming sector. This is because this scenario assumes that farmers will refrain from the use of nearly all products manufactured by the farm inputs industry, leading also to cuts in farm inputs industry-related emissions from energy and transport sectors.

Table 1: GHG emissions and environmental damage arising from different organic farming scenarios for Croatia (Znaor, 2008)

	Baseline		Area under organic management							
			10%		25%		50%		100%	
Economic activity	CO_2-eq (Gg)	Damage (MEUR)	CO_2-eq (Gg)	Damage (MEUR)	CO_2-eq (Gg)	Damage (MEUR)	CO_2-eq (Gg)	Damage (MEUR)	CO_2-eq (Gg)	Damage (MEUR)
Farming (excl. soil C)	3,989	76	3,914	74	3,802	72	3,615	69	3,240	62
Energy sector	201	4	199	4	183	3	157	3	0	0
Farm inputs industry	822	16	740	14	617	12	411	8	13	0
Transport	9	0	5	0	4	0	3	0	0	0
Others	5	0	5	0	5	0	5	0	0	0
Total	5,027	96	4,863	92	4,610	88	4,191	80	3,252	62
% of baseline	100	100	97	97	92	92	83	83	65	65
Soil C loss	1,179	22	910	17	507	10	-166	-3	-1,510	-29
Total incl. soil C	6,206	118	5,773	110	5,117	97	4,025	76	1,742	33
% of baseline	100	100	93	93	82	82	65	65	28	28

However, if the soil carbon loss/accumulation is taken into account, the calculation becomes even more favourable for organic farming. Assuming an average carbon sequestration rate of 180 kg C ha^{-1} yr^{-1} for arable and permanent crops, and applying the same carbon sequestration rates for forage crops as in the baseline (1.3 t C ha^{-1} yr^{-1} for alfalfa and 1.0 t C ha^{-1} yr^{-1} for grass-clover mixtures, permanent meadows and pastures), the total conversion results in an accumulation of 1.510 Gg CO_2-eq yr^{-1}. Thus, if soil carbon sequestration is taken into account, the total GHG emissions arising from farming and farm-upstream linked sectors in the scenario assuming a total conversion to organic farming are 1.742 Gg CO_2-eq yr^{-1}, or just 28% of the baseline emissions (Table 1).

5. GHG emissions under large-scale conversion to organic farming in the UK

A study from Pretty *et al*. (2005) compared the external costs of the current UK agriculture with those that would arise were the whole of the UK farmed organically. The assessment included also costs imposed by GHG emissions.

5.1 Methodology

Applying various methods of environmental accounting already employed in the previous studies assessing external costs of UK agriculture (EA, 2002; Hartridge and Pearce, 2001; Pretty, *et al*., 2000) and adjusting some previous assumptions, the study assessed total environmental and health costs associated with UK agriculture in 2000. This served as the baseline scenario. Using standard protocols for organic farming, the study estimated GHG emissions under a total conversion to organic farming.

The aggregate costs for the baseline and the organic scenario were used to calculate the costs for each of the twelve major arable, horticulture and livestock food commodities produced in the UK (cereals, potatoes, oil seed rape, sugar beet, fruit, vegetables, beef/veal, pork, poultry, mutton/ lamb, milk and eggs). For each of these twelve commodities, environmental and health costs generated by GHG (and ammonia) emissions are calculated to the farm gate, for their transporting to retail outlets, and then to consumers' homes, as well as the cost of disposal of wastes. By doing this, the relative contribution of each commodity to the overall GHG (and ammonia) emissions was taken into account. For instance: as some 89 percent of agricultural methane emissions arise from enteric animals (75 percent from cattle, 25 percent from sheep), milk is calculated to contribute 35 percent to methane costs, beef/veal 35 percent, mutton/lamb 25 percent, and pork and poultry 2.5 percent each. Nitrous oxide costs were allocated in proportion to area of crops and grassland. Carbon emitted from fossil fuel use (mostly for vehicles) was in proportion to area of crops and grassland, with costs adjusted up (double their proportional contribution) for pigs, poultry and eggs (owing to energy used in housing), and down by half for sheep (which are mostly outdoors). Indirect energy costs arising from the manufacture of pesticides and fertilizers were allocated in proportion to the areas of crops and grassland.

5.1 Results

Environmental and health costs associated with the UK agriculture in 2000 are estimated to be £1.514 million. Emissions of carbon dioxide, methane, nitrous oxide (and ammonia) account for 35 percent of the total cost.

In the organic scenario, methane from livestock is estimated to be reduced by 5 percent and nitrous oxide by 80 percent. Carbon dioxide emitted from farm machinery is estimated to remain the same as in the baseline, while indirect carbon dioxide emissions arising from the use of fertilizers and pesticides are estimated to fall by 88 percent. Consequently, under a total conversion to organic farming the environmental and health costs generated by GHG (and ammonia) are reduced by 61 percent. The GHG emissions generated from the loss of soil organic matter (carbon) are estimated to fall by 75 percent in the organic scenario, reducing the associated environmental costs by 59 percent as compared to the baseline.

Costs arising from food transport to retail outlets and then to home outweigh those generated by farming. Transport to retail outlets in the baseline scenario is estimated to cause environmental damage of £2.348 million and the transport to home additional damage of £1.276 million. If all UK food were organic and if food were locally-sourced or predominantly transported by rail, and then transported home by walking/cycling, bus or home delivery, external costs would fall from 11.8 percent of the food basket to 1.1–1.8 percent, saving each person in the UK £2.41–2.65 per week.

6. GHG emissions under large-scale conversion to organic farming in the EU-27

5.1 EU and GHG emission reduction targets

The EU-27 does not have a joint target under the Kyoto Protocol but the Kyoto emission reduction targets are set as follows (EEA, 2009b):

1. By 2008–2012 the pre-2004 EU Member States (EU-15) are obliged to jointly reduce their GHG emissions by 8 percent below 1990 levels.
2. Most EU Member States that joined the EU in 2004 (EU-12) are obliged to reduce their GHG emissions by 6 to 8 percent from their base years (mostly 1990).

In 2007, the EU Member States endorsed an ambitious GHG emissions reduction plan to limit their GHG emissions by at least 20 percent by 2020 (from 1990 levels) (EEA, 2009b). In 2007, total GHG emissions were 9.3 percent lower than the 1990 level and in the 2008 emissions were estimated to be 10.7 percent below the 1990 level (4,971 vs. 5,564 Tg CO_2-eq) (EEA, 2009c). Therefore the EU still has a long way to go in order to achieve its target of 20 percent emissions cut by 2020. But the current projections indicate that with the implementation of all planned measures, emissions could be further reduced just by some 14.3 percent below the 1990 level (EEA, 2009c). Therefore the EU still has to find a way for reducing its GHG emissions for an additional 6 percent. In this respect it is interesting to assess whether (at least a hypothetical) total conversion to organic farming would be able (and how such) to reduce the EU-27 GHG emissions.

5.2 Methodology

The effect of the potential large-scale conversion to organic farming in the EU-27 on GHG emissions is notoriously difficult to estimate. This is not just because of a number of hypothetical uncertainties, but also because of the sparse and reliable data required for such an assessment. Besides, some data required to perform this assessment are not available at the aggregated level of EU-27, are contradictory, or in the possession of private industries.

A potential reduction of GHG emissions from total conversion to organic farming is calculated by assessing:

1. GHG emissions arising from fertiliser manufacturing, transport and application, as well as from the production of energy required for those operations;
2. GHG emissions from direct and indirect N_2O emission from soil;
3. GHG emissions from urea fertilisation;
4. Potential of organic farming to sequester soil carbon.

The baseline year for all calculations was 2007.

The first step in calculating the GHG emissions generated by fertiliser manufacturing was to determine the quantity of N synthetic fertilisers consumed in the EU-27. Since Eurostat has no data on fertiliser consumption for 2007, the data was taken from the International Fertilizer Industry Association (IFA, 2009). The GHG emissions generated by the ammonia and nitric acid production for 2007 were taken from the European Community greenhouse gas inventory for 1990–2007 (EEA, 2009a) and their sum is assumed to be equal to all GHG emissions resulting from fertiliser production. The CO_2-equivalent of these emissions was divided by the quantity of N fertiliser produced in 2007, which was taken from the International Fertilizer Industry Association (IFA, 2009). This was done in order to calculate the amount of CO_2-eq required for the production of 1 t of N fertilisers, which was then multiplied by the quantity of N fertiliser used.

The GHG emissions associated with the transportation of fertilisers was estimated by multiplying the road freight GHG emissions in 2007 (EC, 2009) by 9.2 percent, which was the share of fertilisers in the total EU-27 road freight tonne-kilometres in 2007 (EUROSTAT, 2009). This was adjusted (increased) by 27.1 percent, which is the EU average truck empty running factor (Piecyk and McKinnon, 2009).

The GHG emissions from the application of N fertilisers were estimated by multiplying the quantity of N consumed with an energy equivalent of 2 GJ per tonne of N, as suggested by the European Fertilizer Manufacturers Association (EFMA, 2008a). Standard IPCC factors (IPCC, 2009) were used to calculate the GHG emissions equivalent to 1 GJ of energy stored in diesel fuel used by tractors.

The GHG emissions resulting from the energy in fossil fuels burnt for fertiliser manufacturing, transport and application was calculated by multiplying EU-27 fugitive CO_2 emissions from oil and natural gas (EEA, 2009a) with the share (percentage) of fertiliser manufacturing, transport and application in the total GHG emissions (calculated in the previous steps).

The direct and indirect N_2O emissions from soil were calculated by multiplying the amount of N fertilisers consumed (IFA, 2009) with the standard IPCC N_2O soil emission factors (IPCC, 2009).

The contribution of urea application to CO_2 emissions was calculated by multiplying the default CO_2 emission factor of 20 percent with the quantity of the urea applied by EU-27, which was taken from the database of the International Fertilizer Industry Association (IFA, 2009).

Following the findings of the long-term organic farming trials in temperature regions (Mäder, *et al.*, 2002; Pimentel, *et al.*, 2005), the average amount of carbon which could be sequestered under organic farming is estimated to be 180 kg C ha^{-1} yr^{-1}, multiplied by 160,827,000 ha (EUROSTAT, 2009) of agricultural land in the EU-27.

5.3 Results

A total conversion to organic farming in the EU-27 would result in an annual GHG emissions reduction of 175,364 Gg CO_2-eq, which is equal to 3.48 percent of all GHG emissions of the EU-27 (Table 2). Fertiliser manufacturing, transport and application account for 52.6 percent, and N_2O emission from soil for 46.1 percent of this reduction. In addition, organic farming management practices could annually sequester 105,953 Gg CO_2-eq in the soil (Table 2). The GHG emissions reduction and carbon sequestration make 281,317 Gg CO_2-eq, representing 5.58 percent of all GHG emissions in the EU-27.

Table 2: Estimated annual GHG emissions avoidance under a total conversion to organic farming in the EU-27

	CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)	CO_2-eq (Gg)	% of all GHG
Fertilisers manufacturing, transport and application					
Manufacturing	-	-	-	61,472	1.22
Transport	29,210	-	1	29,553	0.59
Application	1,259	-	0	1,259	0.02
Total fertilisers manufact., transport and application	30,469	0	1	92,284	1.83
Energy production					
Energy required for fertilisers manufacturing	201	22	-	655	0.01
Energy required for fertilisers transport	99	5	-	212	0.00
Energy required for fertilisers application	4	-	-	4	0.00
Total energy production	305	27	0	871	0.02
N_2O emissions from soil					
N_2O direct emissions from soil	-	-	204	63,250	1.25
N_2O indirect emissions from soil					
Deposition	-	-	17	5,406	0.11
Run-off and leaching	-	-	39	12,163	0.24
Total N_2O emission from soil	0	0	261	80,819	1.60
CO_2 emission from urea fertilisation	1,390	0	0	1,390	0.03
Total fertilisers emissions	32,164	27	262	175,364	3.48
C sequestration	105,953	-	-	105,953	2.10
Emissions + C sequest.	138,117	27	262	281,317	5.58

7. Conclusions and recommendations

Organic farming does not rely on the use of synthetic N fertilisers. Nitrogen fertiliser manufacturing and transport require substantial fossil energy emitting GHG. In the case of a total conversion to organic farming, there would be no need for N synthetic fertilisers and the GHG emissions deriving from the N fertiliser life-cycle (production, transport, application and presence in soil) would be cut to zero. Besides, organic farming seems to be able to increase carbon stocks in the soil as this is part of organic management practices.

Results from the three cases presented in this paper (Croatia, UK and the EU-27) suggest that a total conversion to organic farming could make a significant contribution in reducing national and regional GHG emissions.

The case of Croatia suggests that conversion of as much as 50 percent of the agricultural land to organic farming management still reduces GHG arising from farming and farm-upstream linked sectors relatively little: 35 percent as compared to the present situation. However, a 100 percent shift to organic farming seems to be able to cut the GHG emissions arising from farming and farm-linked upstream sectors by as much as 72 percent as compared to the present situation.

The UK case shows that under a total conversion to organic farming, the environmental and health costs generated by GHG (and ammonia) could be reduced by 61 percent and those associated with the loss of soil carbon by 59 percent as compared to the baseline. It also suggests that if all UK food was organic and if food were locally-sourced and transported with less polluting means, external costs of a food basket would fall tenfold.

By employing the best available technological means and by implementing all planned policy measures, the EU-27 would still be short of reaching its GHG reduction targets by some 5.7 percent. A total conversion to organic farming in the EU-27 would be able to cut the GHG emissions by 5.6 percent and would enable the EU-27 to reach the missing GHG reduction percentage target.

The results of the three cases presented in this paper suggest that a total conversion to organic farming seems to be favourable from the GHG emissions reduction point of view. However, these pioneering assessment efforts should be complemented with more detailed studies before their preliminary findings can firmly be confirmed. The real impact of organic farming on GHG emissions can be fully judged only when some additional aspects and their interactions are taken into account. These include: crop (notably the land area under N-fixing crops) and livestock mix (notably the number of ruminants); land area required to produce the same quantity of food as the baseline; sequestration potential of grassland; the time horizon required to reach the soil carbon sequestration climax, etc. Finally a thorough analysis of a spectrum of environmental and economic trade-offs associated with a large-scale conversion to organic farming should be taken into account, as well as their external costs and benefits.

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Organic Livestock: Good or Bad for Climate Protection?

Kathleen L. Hewlett

Policy Researcher, the Soil Association, UK
Email: KHewlett@SoilAssociation.org

ABSTRACT

While already a significant climate change problem, demand for meat and dairy products is projected to double by 2050. Reducing meat consumption overall is an important goal, but strategies to minimise the climate impact of remaining livestock production need careful consideration. This paper explores some of the issues around intensive and organic approaches to livestock production with respect to climate change and the need to feed a growing population with finite resources. Conclusions suggest that a switch from intensive grain-fed to extensive grass-fed meat and dairy may provide benefits through maintaining and building soil carbon stores while reducing pressure on arable land.

1. Introduction

Meat production is one of the largest single contributors to anthropogenic climate change. A recent FAO report entitled Livestock's Long Shadow (FAO, 2006) estimated that livestock farming was responsible for 18% of global greenhouse gas emissions – a contribution larger than that of the transport sector. The major sources of greenhouse gases in livestock farming are enteric fermentation from ruminants, manure storage, feed production and the resulting land-use change. To date, methane from enteric fermentation has got by far the most attention. While already a significant climate change problem, as the meat-heavy western diet becomes more popular throughout the world, demand for meat and dairy products is projected to double by 2050. This means that in 2050 there would be 9 billion people, but 25 billion livestock to feed them.

The current approach of many policymakers, the UK government included, is to ramp up production to meet growing demand, while focusing on high-tech methods to increased productivity, thus aiming to reduce the carbon-intensity per kilo of meat or dairy product. A climate case for intensive systems has been built on the premise that the faster an animal can be brought to slaughter weight, the less time it has to emit methane, and if a cow can produce higher volumes of milk, the methane emissions per litre are lower. With the aim of maximising the efficiency with which feed is converted to meat or eggs, indoor systems of production have developed that tightly control temperature and lighting, while restricting movement of the animals to avoid wasting calories. Based on this viewpoint, organic systems of livestock have been criticised on climate change grounds as the animals typically live longer before slaughter, fewer animals are produced per farm, and dairy cows typically produce lower yields of milk.

This paper explores some of the issues around intensive and organic approaches to livestock production with respect to climate change and the need to feed a growing population.

2. Monogastrics

With the climate change case firmly focused on methane-emitting ruminants, monogastrics such as pigs and poultry are viewed by many as the climate-friendly option. The fact that pigs and poultry do not emit methane and the efficiency with which they convert feed to meat, makes them seem a good way to keep meat in the diet in the face of climate change.

Intensive non-organic systems have developed to produce huge amounts of very cheap pig and poultry meat through the use of large indoor industrial farms. The majority of white meat in Europe is now produced this way. Fed a diet of soya and cereals, and kept tightly packed in sheds, the animals fatten quickly, and it is argued that the high stocking density in the houses means that they use less land than their free-range counterparts.

As organic farms do not use these indoor systems, they simply cannot supply the same quantity of cheap white meat. The animals are free to range and forage outside on pasture and the much greater space per animal means that fewer can be produced on any given farm. While LCA studies have shown that organic pork has 17% lower greenhouse gas emissions per kilo (Williams et al, 2006), due mainly to the lower energy demands of free-range systems, organic livestock farming has been criticised as a poor solution to the climate issues since it is unable to produce white meat cheaply and in sufficient quantities to meet the current growing demand. However, more thorough analysis calls the climate credentials of intensive pig and poultry production into question.

First is the issue of efficiency. Monogastrics are largely grain-fed, and therefore, in simple terms, convert food into less food. While abundant supplies of cheap oil and artificial fertiliser have made it easy to grow huge yields of grain, feeding it to animals to produce meat has provided a way to convert a relatively low value commodity into a higher value food product. However, as oil, and consequently fertiliser, prices escalate and supplies of rock phosphate decline, intensive grain production is going to get more expensive. A rising population and the competition with biofuels is further adding to the demand for grain. Soon, feeding it to animals is not going to seem such an attractive option.

Second are the emissions from the expanding areas of arable land that produce the imported high-protein feed grain. The increase in synthetic fertiliser use is a significant source of emissions and energy use, but even more concerning are the massive carbon emissions from soil and biomass that occur as forests and grasslands are cleared, ploughed up and converted to soya. Land use change has not yet been factored into most life cycle analysis (LCA) studies of meat, but accounted for more than a third of the FAO figure of livestock’s 18% contribution to global warming.

Third are the vast lagoons of liquid animal excreta that these indoor systems produce. As the animals are disconnected from the land, and often the other side of the world to the fields in which their food was produced, this manure is not put back on the land to replace nutrients taken off in the harvest. Nutrients are instead replaced with finite stores of mined rock phosphate and nitrogen produced from fossil fuels. Rather that being a valuable fertiliser, the manure becomes a serious waste problem, emitting methane and nitrous oxide while causing environmental pollution. Anaerobic digestion systems are beginning to be used in an attempt to reduce methane emissions and use this waste as an energy source, but some might say this constitutes as a sticking plaster solution only, limiting damage in one area but doing nothing to address the underlying problem.

3. Ruminants

The major advantage of cattle and sheep is their ability to convert food that humans can’t eat, namely grasses, into food that we can eat – meat and milk. Through grazing livestock we can produce food from land unsuitable for arable farming, diversifying and building resilience into our food supply by reducing our dependence solely on lowland annual crops.

A significant difference between intensive and organic cattle production is the amount of grass in the diet. Under European legal standards, fresh or preserved grass must make up at least 60% of the diet for organic cattle, and in practice often makes up far more (Butler et al, 2008). Ruminants are a useful part of an organic rotation since they are put to graze on the grass-clover stage and fed by hay and silage from these pastures during the winter months. This makes the solar-powered, nitrogen-fixing clover pasture doubly productive, as not only is it adding fertility to the soil, augmented by manure deposits from the animals, but it also producing meat or milk.

In contrast, in non-organic systems there has been a move to a greater use of grain to feed dairy and beef cattle, as the sector has intensified production in recent years. Non-organic dairy farming has been increasingly using feed grain, instead of grass, to raise milk yields per cow (Cormack & Metcalfe, 2000). Similarly in the beef sector, grass is being supplemented with grains for quick weight gain - in America ‘feedlot’ beef is becoming the norm, where cattle never go anywhere near grass, but instead are closely packed in yards and given high protein feed. Even for upland beef and sheep production which relies more on grazing than the dairy sector, supplementary feed of concentrates (high-energy/protein feed substances) and cereal grain are being used (ibid). This entails all the problems of soya and cereal production discussed above.

4. Soil Carbon

Organic grass-fed systems largely avoid the carbon emissions associated with arable expansion. However, they actually go one step better than this. When we consider that ruminants make grasslands productive, it's not just food that they are producing. They are also building carbon stores in the soil.

Soil contains vast amounts of carbon. Depending on the way that it is managed farmland soil can either be a source or a sink for carbon. Many intensively farmed arable soils are either losing carbon to the atmosphere, or have reached a low plateau. Grassland however, tend to increase the soil carbon levels (Jones & Donelly, 2004), taking carbon dioxide out of the atmosphere and into its roots where, in conjunction with mycorrhizae and other soil organisms, a proportion of it is converted into a more stable buried carbon store. Putting cattle and sheep on this land means that it is producing both food and soil carbon and there is less incentive to plough it up for grain. What is exciting about grazing though is that it has the potential to speed up the process by which carbon is pumped out of the air and into the soil. As grasses balance their above and below ground biomass, this means that cleverly grazed pastures are regularly shedding roots and growing new ones, building the level of carbon in the soil and reducing the level of carbon in the atmosphere (Harner, 2009). Direct measurements suggest that grasslands are sequestering 450-800kgC/ha/yr (Jones & Donelly, 2004). If kept in permanent pasture, biodiverse grasslands can build large carbon stores over time (ibid). If used as part of a rotation, grass clover leys can rebuild soil carbon losses (Arden-Clarke & Hodges, 1987) that may have occurred during the arable phases, and incrementally build a well structured, fertile, carbon rich soil.

In addition to their climate change mitigation potential, grasslands and carbon-rich soils can also help farming adapt to the more extreme weather patterns predicted. High carbon grasslands can soak up heavy rainfall and act as a buffer against floods (Huntington, 2006), while in drought periods, the carbon-rich soil stores moisture for longer (Olness & Archer, 2005). In addition, the deep-rooting species of a biodiverse pasture can access water further below the surface, meaning that fields stay green and keep producing food when artificially fertilised grass monocultures and arable crops have died off.

5. Methane

It seems that organic cattle and sheep can have a beneficial effect on carbon sequestration. But how do they fare on methane emissions? There are two main sources of methane from livestock systems: manure, which in the UK accounts for 16%, and enteric formation, which makes up the other 84%.

Aspects of organic farming substantially reduce the methane emissions from livestock manures. Non-organic indoor livestock farms tend to have concrete or slatted floors so produce a massive quantity of liquid slurry but slurry produces far more methane than solid manure (Stolz et al, 2000). Approximately 10% of slurry is converted to methane while only 1% of solid manure on pasture is converted to methane, a ten-fold difference (Gibbs & Woodbury, 1993). This means that the organic system of outdoor (free-range) grazing and straw-based housing produce far lower methane emissions. The greater use of grazing means that a larger proportion of the manure is directly deposited on the land and the use of straw-based housing produces 'farmyard manure' (FYM), a drier, denser manure product with lower methane emissions than slurry. This in turn provides fertility and soil improvement for arable stages of the rotation, avoiding the need for synthetic fertilisers as the manure provides nitrogen and phosphates, and also builds soil carbon stores –FYM builds greater and more stable quantities of soil carbon than slurry application (Foereid & Høgh-Jensen, 2004).

On enteric fermentation emissions, the case is not quite as favourable for organic, but there are reasons to believe that organic methane emissions here may be similar, or slightly worse than non-organic farming. Organic beef cattle typically live slightly longer, as a diet based on forage means that they put on weight more slowly than those fed a grain-based diet. As organic and non-organic cattle emit similar amounts of methane per day, a longer life would mean that more methane is released per kilo of organic beef. Similarly, organic dairy cows produce lower yields of milk per lactation than intensively managed non-organic cows, which can mean more methane per litre of organic milk. However, there are a few counterpoints that need exploring.

For the dairy sector, the better health and longer productive life-span of organic animals has benefits for reducing methane and other GHG emissions. A negative side-effect of high-yielding dairy systems is that the animals need to be replaced by new young animals much faster. This is because of the metabolic stress that very high-yielding animals are under, which shortens their productive lives. In the UK, the average non-organic dairy replacement rate is once every three years, compared to once every 5 years in UK organic dairy farming (Eblex, 2009). This means that many more non-productive replacement animals are present in non-organic dairy herds which increase the methane emissions per unit of milk produced.

Early stages of research suggests that when legumes are included as part of the diet, methane emissions may be slightly reduced (Beauchemin et al, 2008). This methane reduction would be present in organic systems as pastures typically contain a large amount of clover for fertility building. However, any emissions reductions through diet modification are likely to be relatively small.

Net methane emissions are affected by the speed at which the methane is broken down, as well as released. Methane–digesting (methanotrophic) bacteria in the soil can break down a certain amount of the gas, thereby offsetting that from grazing livestock and their manure. Populations of methanotrophs are highest in undisturbed soils such as woodland and permanent pasture, and lowest in arable land (Willison et al, 1995). There is also evidence that the use of N fertiliser causes a major reduction in soil oxidation rates. Research by Rothamsted (ibid) found that ammonium based N fertilisers (but not nitrate- (NO_3) based fertiliser), significantly suppressed soil methane oxidation rates in proportion to the amount of fertiliser applied. In contrast, the repeated application of cattle manure that contained more N than the fertiliser had no inhibitory effect. The effect may also be long-lived. According to a US study, a single N fertilisation inhibited methane oxidation for more than a decade (Mosier et al, 1996). So, the higher levels of permanent grass and the non-use of inorganic N fertilisers in UK organic farming may imply a small benefit of organic farming in reducing agricultural methane emissions.

6. Conclusions

An exploration of the issues around livestock and climate change suggests that organic production is better in many, but not all cases. A high level of livestock production, organic or not, is very damaging to the planet and is not an efficient use of resources. Reducing meat consumption overall is an important goal but strategies to minimise the climate impact of remaining livestock production need careful consideration.

Productivity-based approaches that aim to reduce impact through intensification have major flaws. Firstly, they will do little address the dietary trend towards more meat consumption and therefore any climate gains will be inadequate to balance out the growth in production. More importantly, the total reliance on feeding animals with increasing quantities of soya and cereals means that such approaches are likely to increase, not decrease, greenhouse gases through the displacement of forest and natural grasslands. This strategy, based on increasing fertiliser use and irrigation, is also in denial of impending resource constraints and price hikes for key inputs like oil, phosphorus and water. Furthermore, an approach based on ever-increasing productivity gains through more intensive farming ignores the fact that animal health and welfare limits have been reached. As dairy cows have been bred and managed to produce high volumes of milk, conditions such as lameness, infertility and mastitis have become extremely common. As we have seen recently with swine flu, indoor pig and poultry units create the perfect conditions for dangerous diseases to spread, and the routine use of antibiotics as a replacement for decent animal welfare has led to resistant viruses such as MRSA.

In contrast, an organic approach is one based on ecological constraints. It would not support a doubling of grain-fed livestock as has been projected, and this can only be a good thing for both the health of people and the climate. The most resource-efficient way to keep meat and dairy products in the diet is to make use of what animals are good at in order to contribute to twin goals of feeding ourselves and reducing climate change, and this is in line with organic methods. In terms of sheep and cattle this means that they are extensive, grass-fed and make use of land unsuitable for crops or add productivity by grazing clover in a nitrogen-fixing organic rotation. Also, they could be used at low stocking levels to preserve and build large carbon stores in biodiverse permanent grasslands. Low numbers of free range pigs and poultry could make up part of a farm's rotation, adding fertility and supplementing their diet through foraging on pasture and making use of by-products, but the number raised on purpose grown grain needs to fall very significantly. This type of system has potential to provide a healthy diet containing moderate levels of high welfare livestock products, with minimal resource inputs and minimum climate impact.

7. Acknowledgements

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International Carbon Market Mechanisms and Agriculture: Is there any role for (Organic) Farming

Matt McCandless

International Institute for Sustainable Development, Canada
mmccandless@iisd.ca

1. Introduction

Earth's finite land resources provide us with the majority of food produced globally. Much of this land is under extreme pressure due to production demands, as well as land use conflicts, population pressures, and increasing deforestation. This can lead to loss of natural lands, with a resulting decrease of biodiversity and release of greenhouse gas emissions.

At present nearly half of the earth's surface is under agricultural production. Agriculture accounts for the release of between 5.1 and 6.1 gigatonnes (Gt) of greenhouse gases (GHG), measured as carbon dioxide equivalents (CO_2e). Agriculture's share is around 12% of GHG emissions (Smith et al., 2007).

Besides being a sector that contributes to climate change, agriculture will be profoundly affected by the effects of climate change. Yields are expected to decrease significantly throughout the world. Yields of maize in the USA's corn belt may decline up to 40% due to expected climatic changes. Yields of rice in Asia may decrease up to 30% (IPCC WG1, 2007). Similarly the global output of soybeans will decline. The decline of output in traditional farming areas will increase agricultural development pressure on marginal and sensitive lands, and may drive further deforestation and overfishing to compensate for decreased agricultural output.

2. Ecosystem goods and services

Ecosystem goods and services (EGS, see Figure 2) are the benefits arising to humankind from the functioning of healthy ecosystems (Millennium Ecosystem Assessment, 2005). Agriculture produces high levels of EGS for both public and private benefit, but the prime ecosystem service is the provision of food and fibre. Increased pressure will bear on agriculture to produce more food as a result of climate change impacts, and also because of increasing human populations. However unique with agriculture is that practices aimed at mitigation of GHG emissions can also foster other economic and environmental benefits. The top mitigative actions for agriculture are cropland management, grazing land management, restoring cultivated organic soils, and restoring degraded soils (see Figure 3). The restoration of degraded soils can also help farmers in countries impacted by degradation.

Agriculture (and forestry) is among the most cost-effective ways of reducing net carbon emissions. According to estimates from the IPCC, at a carbon price of $50 per tonne, agriculture and forestry can accomplish 20% of the global emissions reduction necessary to halt global warming at 2 degrees Celsius (Smith et al, 2007). Approximately 90% of agricultural mitigation will take place through removal of carbon dioxide from the atmosphere into the soil.

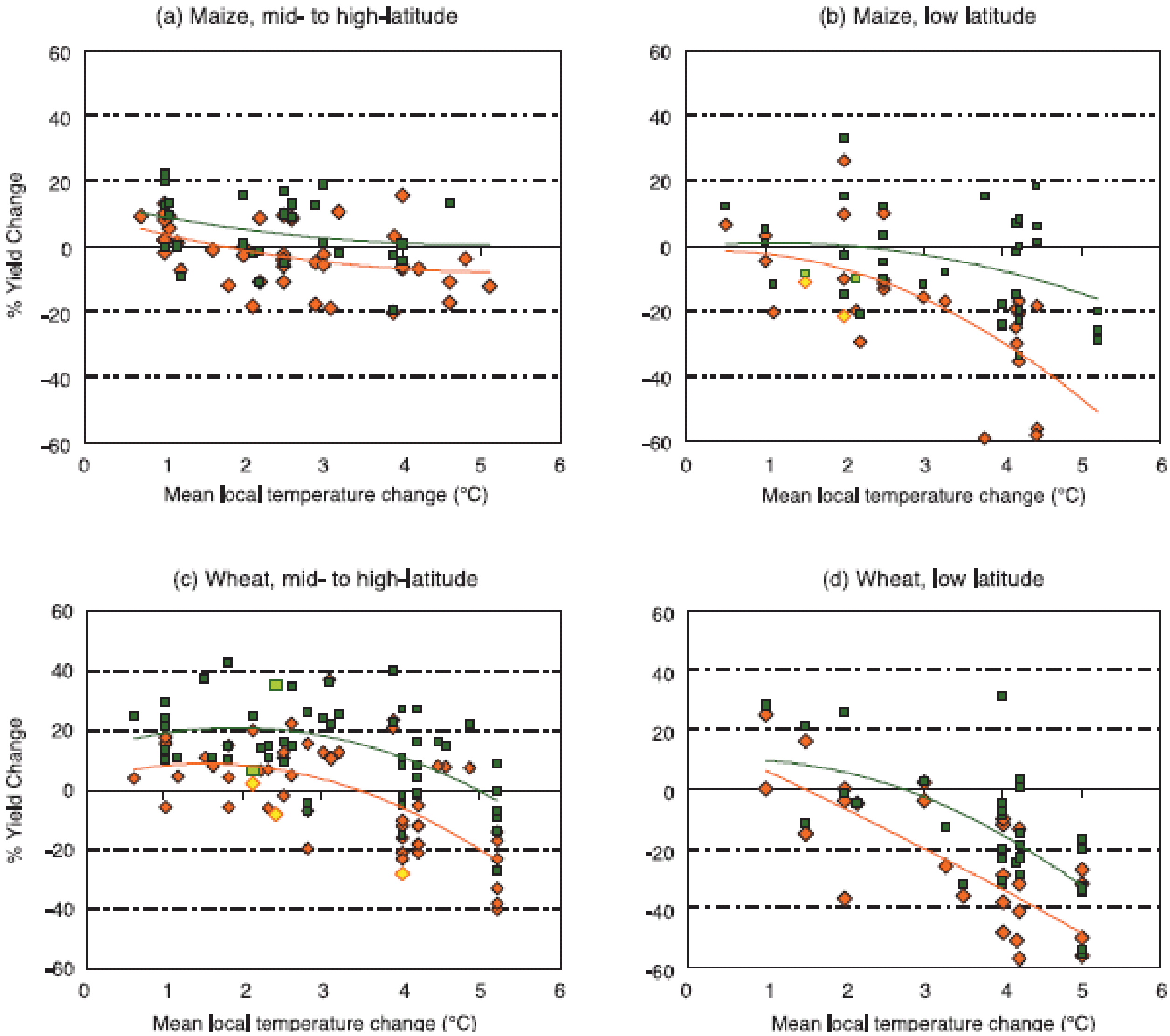

Figure 1: Projected agricultural yields under climate change (IPCC WG1 2007)

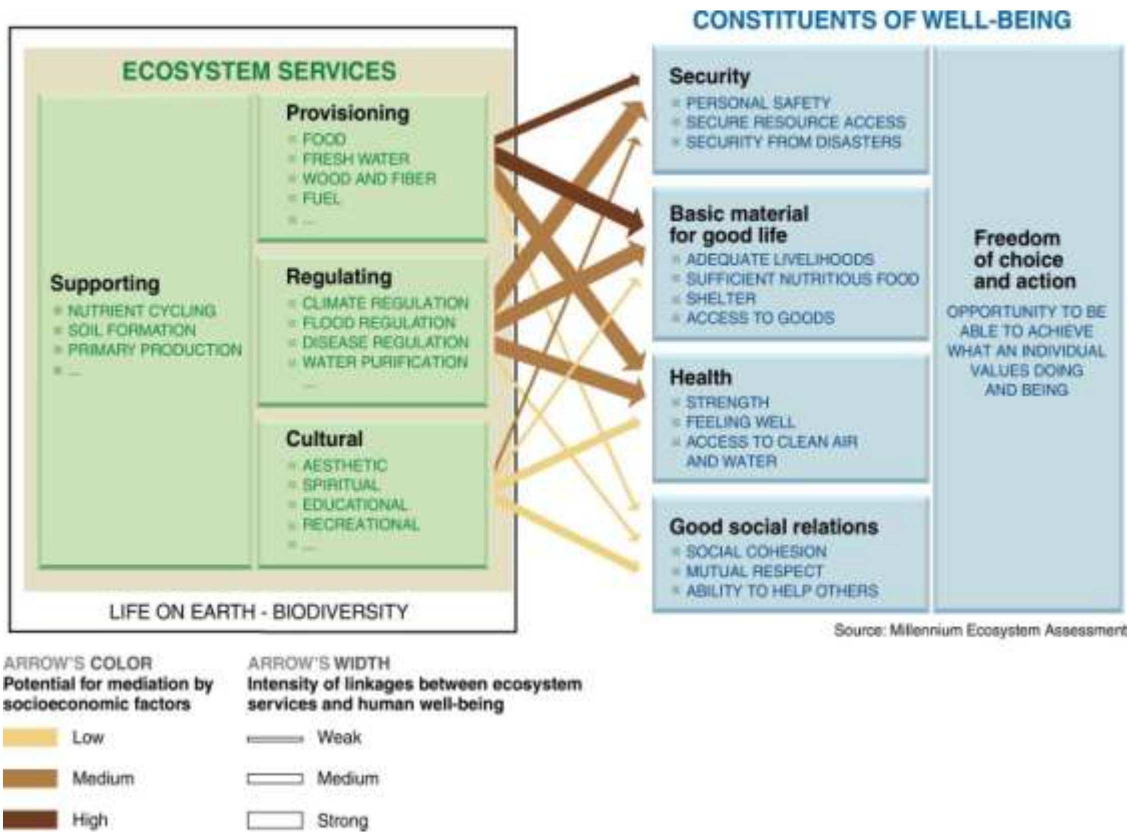

Figure 2: Links between ecosystem services and human well-being (Millennium Ecosystem Assessment, 2005).

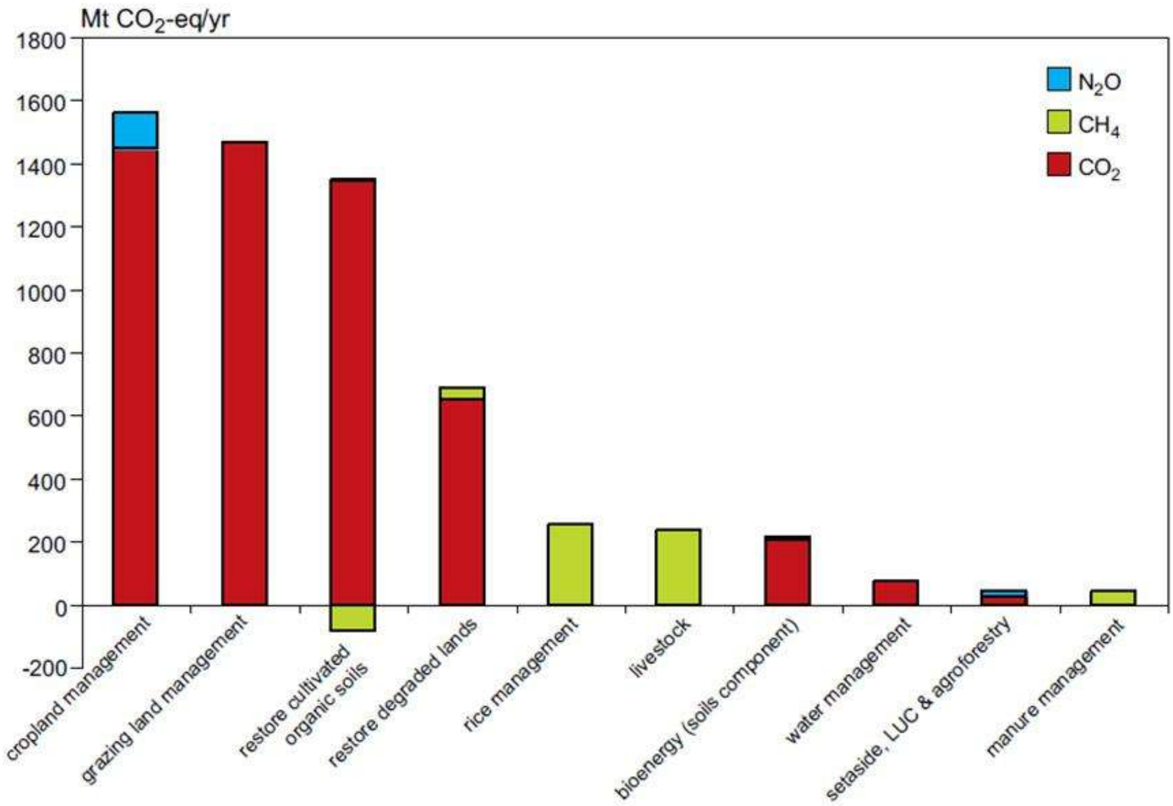

Figure 3: Agricultural practices with global mitigation potential (Smith et al, 2007),

3. Agriculture sector and UNFCCC's GHG emissions accounting

At present, the agriculture sector is included for climate change mitigation only for developed (Annex 1) countries by the UNFCCC. Reporting of agricultural emissions takes place under two categories. The agriculture category comprises methane and nitrous oxide emissions, while agricultural carbon dioxide emissions fall under the cropland heading in the Land Use Land Use Change and Forestry (LULUCF) category. Agricultural emissions are generally not tracked and reported for non-annex 1 countries. Forestry is included in the clean development mechanism (CDM), but the uptake of forestry CDM credits has been quite low. Of around 4000 approved or pending CDM projects, only around 30 pertain to forestry (UNEP, 2009). This is likely due to the high cost of measuring and verifying such projects.

At the upcoming UNFCCC Conference of the Parties in Copenhagen, Denmark in December, 2009; It is expected that agreement will be reached on how to proceed with a global accord aimed at reducing emissions. Many developed and developing countries have announced their intentions to reduce emissions, either in absolute or intensity terms by 2020. This includes the world's two biggest emitters, China and the United States. While the Copenhagen meeting will likely not result in a detailed accord with specific action items, it is widely expected that agriculture will see a larger role in GHG emissions reduction.

Obstacles to increased inclusion of agriculture and forestry offsets include renewable energy interests that require a high carbon price to make their investments viable, environmentalists who prefer to see behavioural reductions that result in decreased industrial and transportation emission, and challenges in measuring and verifying agricultural emissions.

Organic farming is not given specific attention in the UNFCCC negotiations; however, it may factor in individual countries' actions taken to reduce emissions. Actions to reduce agricultural emissions are typically based on specific practices rather than overlying strategies. Organic farming typically describes a farming philosophy, or a suite of practices, and opinions are mixed as to whether the practice is more efficient in terms of GHG than conventional agriculture. Generally it is perceived to be more efficient on a per hectare basis, but less efficient per unit of production (UNCTAD/WTO 2007).

4. Conclusion

In order to increase the participation and recognition of organic agriculture in global mitigation efforts it is important to continue researching the benefits of organic farming, publicize research findings, develop robust protocols for measuring, and lobby governments for inclusion of the protocols in climate change policies.

Organic farming can positively affect many EGS, and can lead to additional adaptation and sustainability benefits, such as preserving and improving soil quality, minimizing water use, preserving biodiversity, and halting the use of chemicals. By linking productivity with ecology, organic agriculture will play a role minimizing climate change through mitigation and adaptation. Through organic farming, increases in agricultural output to meet rising populations can be done sustainably and efficiently.

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Capitalizing on the Competitive Advantage of Sustainable Agriculture in Egypt
Sekem and Soil & More – a partnership for sustainable development

Thomas Bandel

Soil & More International BV, Waddinxveen, The Netherlands
tobias.bandel@soilandmore.com

ABSTRACT

Soil & More International BV further developed existing composting technologies towards a methodology to produce high quality compost at large scale, which has been successfully validated and verified as an emission reduction project through TÜV-Nord, an UNFCCC accredited certification body. Apart from its facilities in India, Mexico and South Africa, Soil & More established jointly with Sekem a project in Egypt where annually about 110,000 tons of compost are produced and almost 100,000 tons CO_2e are reduced. Through the revenues of the carbon credit sales, the compost is subsidized and can be made available for a broader market and land reclamation projects. In addition, through the development of carbon and water footprinting services, growers but also other stakeholders of the organic supply chain, are now able to quantify and communicate their footprint and capitalize in the market.

1. Introduction

According to latest FAO numbers the worldwide average availability of arable land per person reached 2137 m^2 per person in 2007 where it was 4307 m^2 per person in 1961. This is of course caused through the rapid growth of the world's population from 2 to almost 7 billion people in the last 50 years. But due to non sustainable agricultural practices such as over fertilisation, intensive monocultures etc.. each year about 12 Mio. hectar of fertile top soil are lost which only speeds up this trend. Only synthetic fertilizers and the related nitrous oxide emissions contribute with almost 8% to global warming. The entire agricultural sectors emissions accumulate to 30% of the global greenhouse gas emissions taking into consideration the CO_2 released through the deforestation which is necessary to compensate the loss of arable land due to erosion caused by non sustainable farming. In development countries the agricultural sector consumes more than 70% of the available fresh water sources, while specifically in these regions, potable water is one of the scarcest resources.

Climate change, food and water security, biodiversity animal welfare, jobs, education, peace all these issues are directly or indirectly linked to agriculture, meaning irresponsible agricultural practices present a threat to our natural as well as socio-economic environment. On the other hand, adapted and sustainable farming methods have the capacity to tackle those issues by not only maintaining but developing our planets most vulnerable resources.

Sensibilised through recently published reports of all leading business consultancy firms such as McKinsey, Boston Consulting Group, Ernst & Young etc. many large scale global players such as Walmart, Nestlé, Unilever, Starbucks, Tesco, Carrefour, Rewe discovered that more and more consumers start to care about the environmental and social footprint of a product: fair, organic, CO_2, water. The challenge for the organic movement is to identify and develop the differentiation criteria, the uniqueness of the sustainable excellence of an organic product compared to the often single issue sustainability claims for multi national corporations.

The Sekem initiative in Egypt and Soil & More International BV took the lead and developed a scaleable project and business model where the competitive advantage of sustainable agriculture regarding climate change, water management, soil fertility and food security can be measured and proven.

2. Sekem – an Egyptian Initiative

In 1977 the Sekem initiative was founded by Dr. Ibrahim Abouleish, about 60km northeast of Cairo in the Egyptian eastern desert. His vision of integrating economic, cultural and social activities into a holistic, sustainable development project was anchored from the very beginning in the principles of biodynamic farming.

Since then, more than 400 small and medium sized growers joined the Egyptian biodynamic association and supply Sekem's processing companies with high quality biodynamic raw materials. Under the Sekem Group, the following 8 companies were established. Atos, produces plant based pharmaceuticals, food supplements and health care products. Naturetex, manufactures ready-made garments primarily for babies and school children. Libra manages Sekem's own farms and composting facilities. Mizan produces grafted vegetable plant seedlings, Lotus processes herbs and spices for teas and food and cleans, sorts and packs a wide range of cereals. Hator manages the supply-chain of Sekem's fresh fruits and vegetables and Isis produces a wide range of foods and drinks, specifically for the local and regional market. From the beginning it was the intention to develop a local organic market in Egypt for which today represents almost 70% of Sekem's turnover. During the last 30 years, Isis became a well known brand in Egypt, available in most local retail chains and health food shops. The quality and values communicated through and associated with the Isis brand represent Sekem's vision: it stands for healthy food, environmental friendliness, professionalism and state-of-the-art performance, fairly traded and produced, supporting sustainable development from soil to the consumer.

Apart from its agricultural and commercial activities, the Sekem Development Foundation was established, which is the umbrella organization for all Sekem's cultural activities such as a kindergarten, a school, a hospital, a vocational training centre, an education centre for handicapped and underprivileged young children, the Heliopolis Academy and Heliopolis University. Beside the 2,000 employees working in Sekem's companies, directly benefiting from these services, about 45,000 people from the neighboring villages have access to these educational and health care services provided by the Sekem Development Foundation. The recently established Heliopolis Academy and University carries out research and development projects and trains students on sustainable development in the field of medicine, agriculture, arts, economics and engineering.

For its comprehensive efforts, Sekem was awarded with the Right Livelihood Award (Alternative Nobel Price) and was rewarded as an outstanding social entrepreneur at the World Economic Forum for being a sustainable business model for the 21st century. Also locally and regionally Sekem advises various public and private institutions in the field of sustainable development, specifically on agriculture.

In order to realize its development targets, Sekem recently developed about 1500 hectares of plein desert on the Sinai peninsula, in one of the oasis in the western desert and in the Nil valley in upper Egypt. For the first time in Sekem's development history, new projects are developed and managed decentralized, spreading the vision and experience of Sekem in the region.

Including these new land reclamation projects, over 4,500 hectares are now cultivated in Egypt applying biodynamic farming methods, providing healthy and environmentally friendly food primarily for the local market but as well for export markets in Europe, USA, Asia and Africa.

Agricultural Production at Sekem

Cultural Activities at Sekem

3. Soil & More International BV

Soil & More International BV was established early 2007 to advice on, establish and manage medium to large scale composting facilities in the developing world.

Soil & More was founded initiated through Eosta, a Dutch trader for organic fruits and vegetables, as more and more suppliers of Eosta continued to ask for more and better quality compost for their own organic farms but also for the neighboring conventional farms. During the last years, more and more conventional, large-scale growers, facing decreasing yields due to depleted soils from intensive chemical fertilizer applications got interested in this approach and started to ask for this high quality compost. Through its technical assistance to grower programs Eosta always facilitated technology transfer to growers also in the field of composting and soil management but this rapidly increasing demand went beyond a technical assistance capacity – Soil & More as a separate company was established.

The composting technology Soil & More applies is based on Dr. Ehrenfried Pfeiffers controlled microbial composting methodology (CMC) which tackles various challenges. Applying a unique compost inoculant in an aerated, controlled microbial compost process, the different input materials, mainly farmyard wastes such as greens, wood and manures are decomposed and transformed into a stable humus complex within 6 – 8 weeks. This high quality compost product provides the plants with all required nutrients and micro-elements. Due to the special humus structure the water holding capacity of the soils is increased up to 70% which is an important added value for growers in arid and semi-arid areas. Initiated through the inoculant, the final compost contains millions of micro-organisms, a tightly knitted soil-food-web, creating a natural immune system for the plant, acting as natural predators against most known soil born diseases and other pathogens. This disease suppression is one of the outstanding unique selling points of Soil & More's compost. As stated below, various studies did prove that soils, enriched with compost not only have the capacity to reduce soil emissions but to actually act as a carbon sink as these soils store carbon.

Besides the compost production and selling activity, Soil & More submitted its composting technology for approval as an emission reduction methodology to the concerned United Nations authorities. Following this, Soil & More's initial partner project at the Sekemfarm in Egypt, was taken through the entire cycle of assessment, 3rd party validation and verification required for emission reduction projects. Finally this project, implementing Soil & More's composting technology was approved by TÜV-Nord Germany as a greenhouse gas emission reduction project according to the guidelines of the UNFCCC. Soil & More was the first company who has developed a technology for this type of composting that qualifies for generating carbon credits.

That means Soil & More can offer a cooperation model for the production and sales of high quality compost but provides at the same time a technology which qualifies as a emission reduction methodology under the regulations of the Kyoto protocol, generating an additional income stream for the project, as the CO_2e emissions reduced, can be sold as carbon credits to offset companies and products emissions.

So far, Soil & More has established composting facilities with Sekem in Egypt, with Fairtrasa in Mexico and with Reliance in South Africa, to produce and sell high quality compost to small, medium and large-scale farms. All three projects are successfully registered as emission reduction projects. Together with its local partners Soil & More annually produces worldwide over 200,000 tons of compost and by doing so, avoiding more than 150,000 tons of CO_2e per year. Additional projects are under development in Brazil and India.

Since early 2008, Soil & More offers as well carbon footprinting services to agricultural producers, processors, traders and retailers around the world: AlnaturA, Dole, Dovex, EOSTA, IFOAM, Lebensbaum, Ritter Sport, Sekem, Weleda to mention just a few. Like the carbon credits obtained from organic composting, also the carbon footprints carried out for above mentioned companies and organizations are certified by TÜV-Nord according ISO standards, the WRI/WBCSD and PAS2050 guidelines. Since mid 2009, Soil & More is working on its first water footprinting assignments. In order to maintain and further develop these innovative products and services, Soil & More cooperates with various leading research institutes such as Louis Bolk Institute, FIBL, Heliopolis Academy and other experts dedicated to the topic of soil science, composting, emission reductions and footprinting.

4. Composting, emission reduction, footprinting – joint efforts for sustainable development and responsible competitiveness in the agricultural sector

Sekem and Soil & More took the initiative to capitalize on their regional and international experience and developed and implemented a business model, where they jointly offer products and services in the field of composting, soil, carbon and water management to a broader audience.

As one of the first, the jointly managed composting facility at Sekem was validated and verified as an emission reduction project by TÜV Nord from Germany. Since May 2007, Sekem's composting facility annually avoids about 60,000 tons of CO_2e. These carbon credits are used to offset the carbon emissions of a wide range of regionally produced agricultural products, generating a second revenue stream for the composting business, allowing Sekem to further develop and offer the compost at competitive market prices.

Currently there are 2 large scale composting facilities operational in Egypt, managed by Sekem and Soil & More which produce about 110,000 tons of compost and generate about 100,000 carbon credits per year.

At the same time Soil & More's standardized carbon footprinting methodology was implemented on several agricultural supply-chains, assessing the products carbon footprint and highlighting emission reduction potentials. So far a full product cycle carbon footprint assessment has been carried out for the following products of Egyptian origin: Beans, Citrus, Cotton, Flowers, Fresh & Dry Herbs, Grapes, Peppers, Potatoes, Tomatoes and Strawberries. Others are in progress. More and more large scale conventional farming businesses decided to gradually replace their synthetic fertilizer application with compost in order to lower their products carbon footprint. High quality compost has proven to be the more competitive agricultural input compared to chemical fertilizers, which not only force farmers in to dependency of multi-national companies but especially in times of rising oil prices turn out to be an in-efficient solution as application rates increase while yields are not improving proportionally.

Sustainable soil management became the key factor for long term competitive farming strategies. Healthy and vital soils promote healthy plants, stable and increasing yields, secure income, food production, considerably reduce the amount of water needed for irrigation and produces healthy food for healthy people.

Together with the Dutch Louis Bolk Institute, Sekem and Soil & More experts carried out a study on carbon sequestration and storage in organically managed soils on reclaimed desert farms in Egypt. Through continuous compost applications, the carbon stocks in the assessed soils accumulated to over 26 tons of carbon per hectare over a period of 30 years compared to the originally plain desert at neighboring sites. In line with other studies already during the first 5 years a rapid increase of carbon stocks was discovered. This small scale research project has proven the assumptions made by most of the leading climate change institutions that adjusted soil management is a major solution to mitigate climate change.

Currently this pilot trial is being scaled up towards more farms, incorporating the analysis of a change in the water holding capacity, also comparing carbon stock and water holding capacity development in organically managed soils with the once of conventional farms.

Soil & More and Sekem were asked to contribute to Egypt last competitiveness report with a chapter on the performance of Egypt's agricultural sector regarding climate change.

More and more medium and large scale agricultural producers and exporters receive from their overseas importers and retailers the request to transparently communicate and reduce their carbon footprint.

Sekem and Soil & More now consult these companies in order to comply with these new environmental regulations which became an issue of competitiveness and market share. In order to remain competitive and to secure future market shares the trend is clear, development towards sustainable agriculture.

Soil & More and Sekem's joint initiative has been identified and acknowledged to be a scaleable solution to prove the capability of the agricultural sector to remarkably contribute to the mitigation of climate change. Both Sekem and Soil & More are now advisors in several committees such as COP15, the World Future Council, Seal the Deal etc. on the topic of agriculture and climate change.

Together with their worldwide partners in the organic agricultural movement, Soil & More and Sekem did and will continue to implement this concept and promote and communicate the importance of healthy soils to contribute to sustainable soil fertility and food security, the mitigation of climate change and the reduction of water usage in agriculture on producer and consumer level. The related social-economic benefits are clear.

Compost Production at Sekem and Consultancy

Land Reclamation in Egypt: Inauguration Event, Compost application and first harvest after 14 months

5. Conclusions

Our current agricultural activities are one of the main reasons for climate change, water scarcity, food insecurity, migration and other socio-economic problems but the sustainable farming offers a wide range of solutions to these challenges. Organic farming has been pushed for years to be a solution for a niche market, accessible only for a selected group of people who can afford to buy organic products. In times of peal oil, climate change, water scarcity, soil erosion and insufficient food supply, the question is not which agricultural system provides the cheapest food today, where all environmental costs are still externalized, but the real question is which system is able to provide healthy food on the long run, guaranteeing stable yields, low emissions, less water consumption in marginal areas where the population growth and demand for food is the highest? It is time to act for the organic movement. There are measures to assess, reduce, improve and communicate our footprint beyond carbon and water. In times of shrinking resources it's not enough to sustain the planet, we need to develop the resources in a sustainable way and organic agricultural offers various solutions to do so. It is possible using existing tools such as CDM, carbon and water footprinting, sustainability reporting. None of these tools are perfect or complete, but they are good enough to start and to be further developed.

It is of utmost importance to promote and communicate success stories, organize educational events and practical training workshops to further spread the concept and know-how and to allow development partnerships to happen.

Together with its worldwide partners, Sekem and Soil & More currently produce over 200,000 tons of compost per year and avoid 150,000 tons of CO_2e annually. That's not enough. The know how is there. The only way to success is to setup cooperation's between private sector companies, governmental and non-governmental organizations and the civil society, the consumer to secure further product development, implementation and marketing. The environmental and socio-economic challenge is there as well as a consumer willing to support. It's time for partnerships.

6. Acknowledgement

Mr. Helmy and Dr. Ibrahim Abouleish, Mr. Bob Baars, Ms. Miriam Bogatzki, Mr. Aart van den Bos, Mr. Volkert Engelsman, Mr. Joris van der Kamp, Ms. Boki Luske, Ms. Natasa Sicirica

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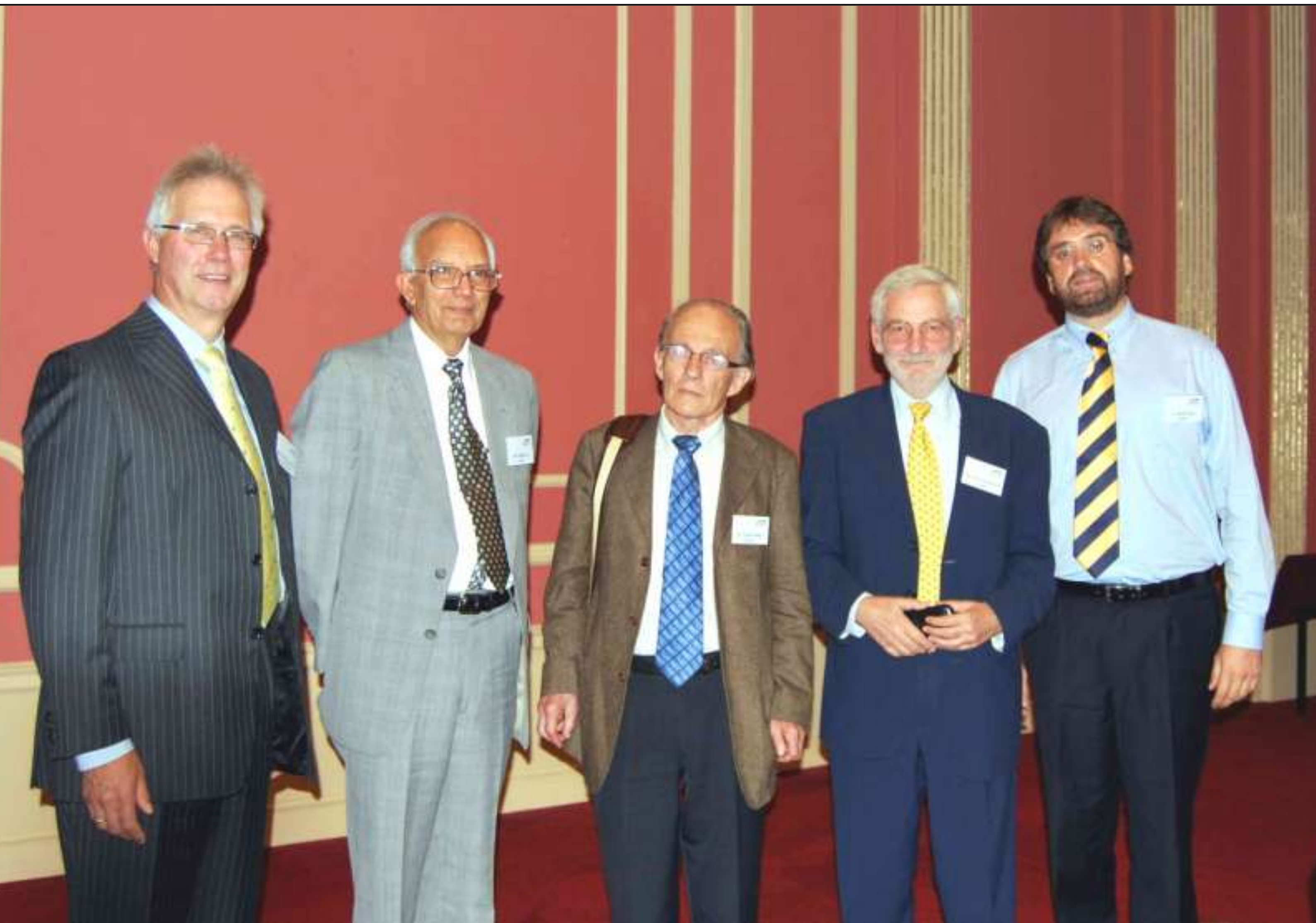


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Food Secure Farming
IFOAM
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FOAM

International Organic Farming Movement and Climate Change Policies

Markus Arbenz

IFOAM (International Organisation of Organic Agriculture Movements), Germany
Email: m.arbenz@ifoam.org

High Sequestration, Low emission Food Secure Farming

IFOAM
International Federation of Organic Agriculture Movements

Avalon Conference,
Sofia 28-9-09

The International Organic Farming Movement and Climate Change Policies

Markus Arbenz, Executive Director of IFOAM

IFOAM

Content

Organic farming as response to recent challenges of agriculture

from Commodity to Farming System
from Food Production to Food Security
from Fashion to Sustainability

Or
Why is Organic Agriculture an asset in present climate policy setting?

UNITING THE ORGANIC WORLD

IFOAM

The world is challenged!!

There are:

A Unsolved development gaps
B Unsustainable (agriculture) practices
C Economic crises

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e.g. Unsustainable practices

Ecological Footprint

LARGEST AND SMALLEST ECOLOGICAL SHOE SIZES

Rank	Territory	Value	Rank	Territory	Value
1	United Arab Emirates	10.6	191	Nepal	0.61
2	United States	9.7	192	Democratic Republic of Congo	0.58
3	Greenland	7.7	193	Zambia	0.58
3	Bahamas	7.7	194	Congo	0.58
5	Canada	7.5	195	Malawi	0.57
6	Kuwait	7.4	196	Haiti	0.57
7	Australia	7.0	197	Cambodia	0.55
8	Finland	6.8	198	Bangladesh	0.47
9	Estonia	6.1	199	Somalia	0.23
10	New Zealand	6.1	200	Afghanistan	0.11

*ecological footprint in global hectares per person, 2002**

"People consume resources and ecological services from all over the world, so their footprint is the sum of these areas, wherever they may be on the planet." The Living Planet Report, 2006

www.worldmapper.org Map 322

UNITING

SUSTAINABILITY: unfortunately misused, but in its core a convincing concept

DEFINITION: Sustainability is development that meets the needs of the present without compromising the ability of future generations to meet their own needs*

- The Bruntland Commission:
  - Sustainability is about survival of our communities & economies*
  - Environmental, social and economic sustainability are intertwined*

IFOAM's vision is the worldwide adoption of ecologically socially and economically sound systems that are based on the Principles of Organic Agriculture

-> A development into depth (more sustainability) and width (more expansion)

-> Full SUSTAINABILITY is in the centre of the

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Organic Agriculture much more than fulfilling the demands of a niche market

UNITING THE ORGANIC WORLD

Scaling up Organic Agriculture: An opportunity to address global challenges

- In more than a 100 countries, Organic Agriculture provides implemented well tired opportunities to address global challenges.

- It deserves intergovernmental, Governmental and NG Organizational support on local, national, regional and international level to help it scale up

Positions and attitudes of Organic Agriculture towards global challenges:

- From man-made problems to man-made challenges to man-made solutions - adoption of OA as an alternative agriculture concept
- People and sustainability are at the center of our farming systems and solutions

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Vision & Purpose

The principles of Health, Ecology, Fairness, and Care are the roots from which organic agriculture grows and develops. They express the contribution that organic agriculture can make to the world, and a vision to improve all agriculture in a global context.

- OA hasn't evolved accidently
- OA is purpose driven intending to create sustainable agricultural systems with people's needs at its centre
- Real sustainable development that puts people first

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Climate Change

- OA practices deliver significant and proven
  - mitigation benefits
  - adaptation benefits
  - development 'co-benefits'
  - systems, global recognition and demand

OA practices can drive scale-up & accelerate realization of bene

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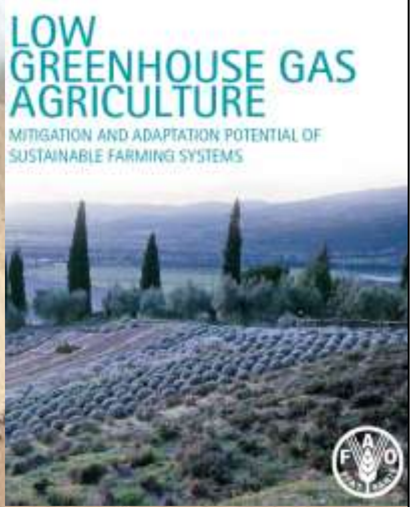
Agriculture is also responsible for greenhouse gas emissions

Issues

- Mitigation (low Emissions, high Sequestration
- Adaptation

Discussion Levels

- Standards
- Present System
- Potential/Offers to policy makers



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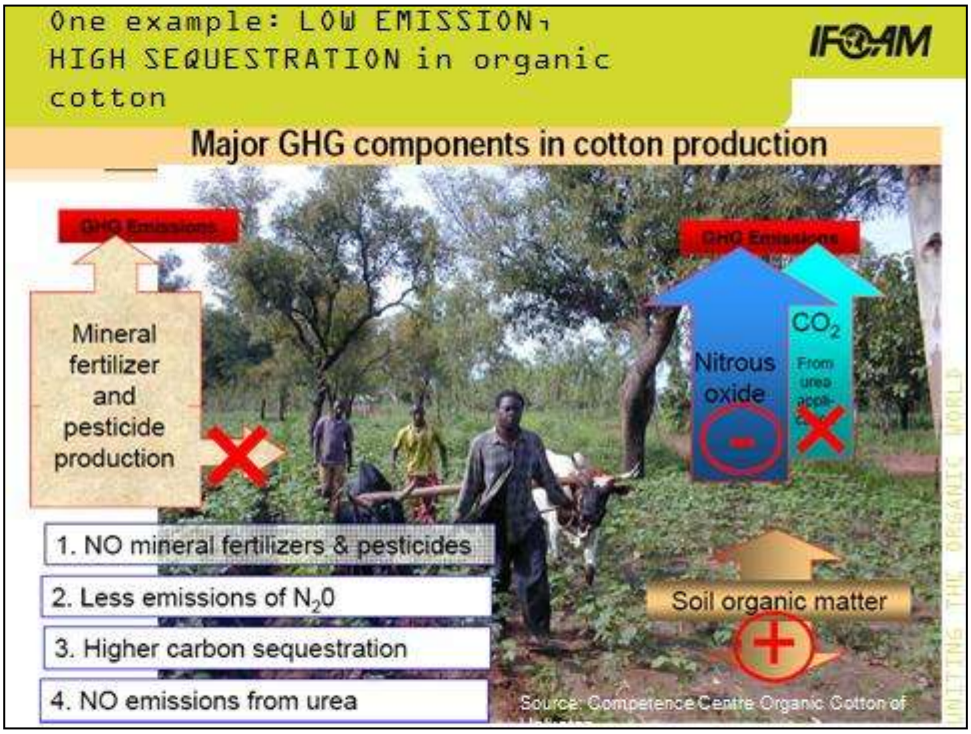
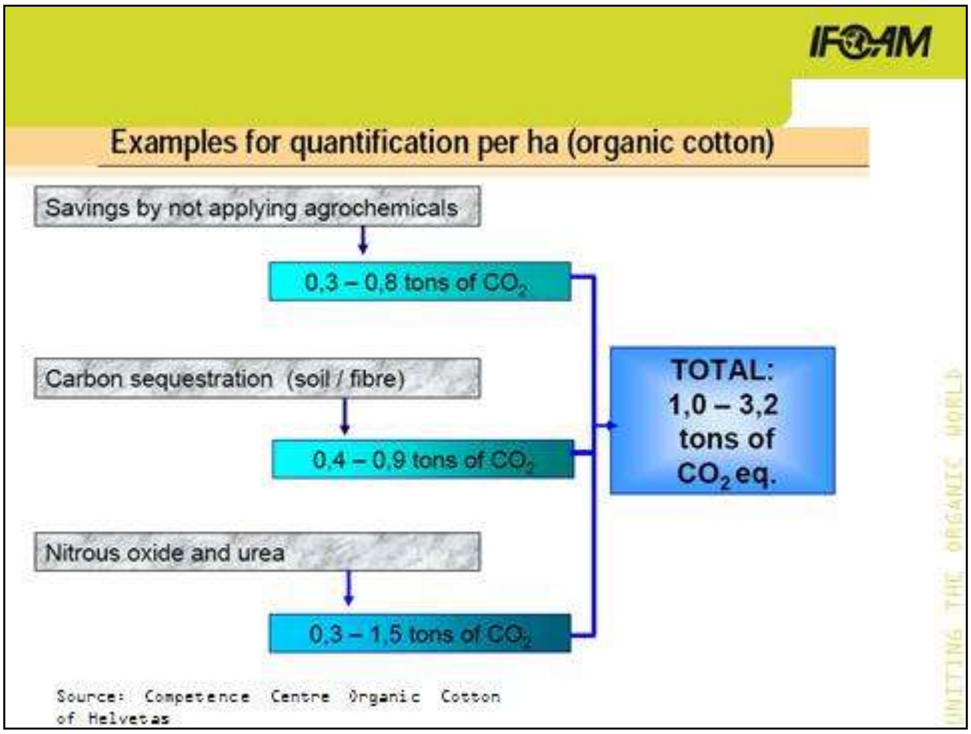

One example: LOW EMISSION, HIGH SEQUESTRATION in organic cotton
IFOAM
Major GHG components in cotton production
GHG Emissions
Mineral fertilizer and pesticide production
GHG Emissions
Nitrous oxide
CO_2
From urea
1. NO mineral fertilizers & pesticides
2. Less emissions of N_20
3. Higher carbon sequestration
4. NO emissions from urea
Soil organic matter
Source: Competence Centre Organic Cotton of
UNITING THE ORGANIC WORLD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Examples for quantification per ha (organic cotton)
Savings by not applying agrochemicals
0,3 – 0,8 tons of CO_2
Carbon sequestration (soil / fibre)
0,4 – 0,9 tons of CO_2
Nitrous oxide and urea
0,3 – 1,5 tons of CO_2
TOTAL: 1,0 – 3,2 tons of CO_2 eq.
Source: Competence Centre Organic Cotton of Helvetas
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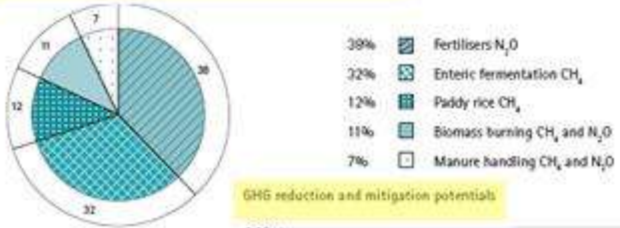
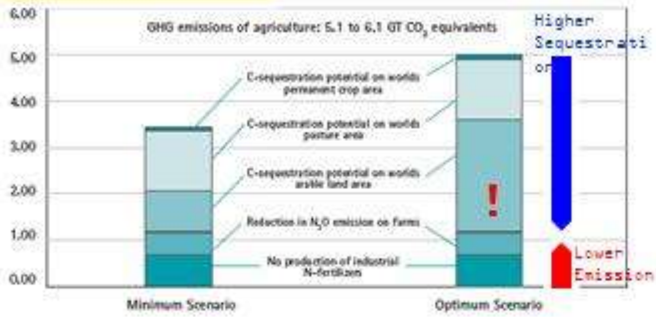
Agriculture emissions and reduction potentials

GHG emissions of the agricultural sector (Smith *et al.*, 2007)



GHG reduction and mitigation potentials



Minimum: No N fertilizer

Optimum: No N fertilizer, no tillage

Yield reduction?

Eventually, a 100 percent conversion to organic agriculture could decrease global yields. According to various studies, this yield reduction could be 30 to 40 percent in intensively farmed regions under the best geo-climate conditions. In less favourable regions, yield losses tend to zero. In the context of subsistence agriculture and in regions with periodic disruptions of water supply brought on by droughts or floods, organic agriculture is competitive to conventional agriculture and often superior with respect to yields. Numerous case studies show that in comparison to traditional subsistence farming, organic yields were 112 percent higher due to crop rotation, legumes and closed circuits.

Minus 30-40% in intensive farmed regions

Plus 12 % in difficult environments

Source

LOW GREENHOUSE GAS AGRICULTURE

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High Sequestration ⬇ Low Emission ⬆

Mitigation – Carbon Sequestration:

- OA has the potential to reduce total CO_2 concentrations in the atmosphere by 3.5 - 4.8 Gt of CO_2 per year or 55% to 80% of total greenhouse gas emission from agriculture
  - increased applications of manures, intercrops, green manures
  - higher shares of perennial grasslands ... d hedges
  - use of intensive cropping systems su... forestry etc

Mitigation – Emission Avoidance:

Source: Niggli et,al 2008

- Organic inputs reduce

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Food Secure

Adaptation – key to farming for sustainability & development:

- Robust and highly productive farming systems
- Soil quality and water holding capacity
- Protect against erosion and desertification & regenerates degraded lands
- Minimize barriers to farming for individuals, families and communities
- Set local solutions and own consumption as priorities
- Facilitate crop diversity including cash crops for trading, value adding, rural enterprise development and energy security
- Provide guarantee systems, market access & fair trade partners
- Provide real sustainable benefits & development outcomes

Conclusion

Organic farming as response to recent challenges of agriculture

from Commodity to Farming System
from Food Production to Food Security
from Fashion to Sustainability

Or

Organic Agriculture is an asset in present climate policy settings! Agriculture is heavy GHG emissive and has to develop better farming systems. Mitigation and Adaptation are key to keep food security for all and there is no alternative to sustainability. The way there includes the smallholders and their environment.

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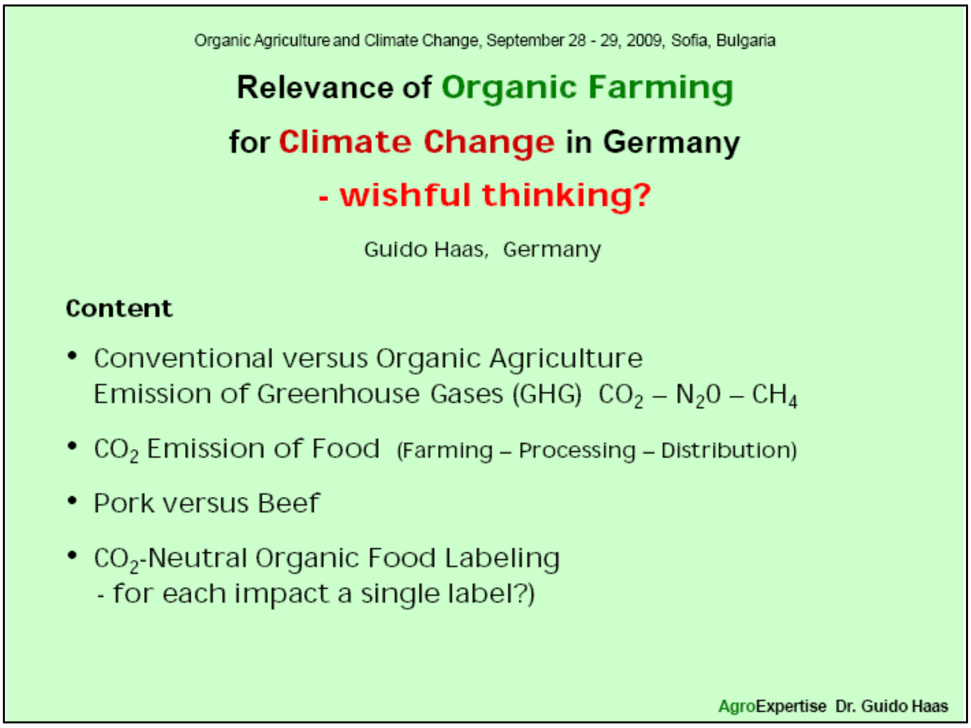
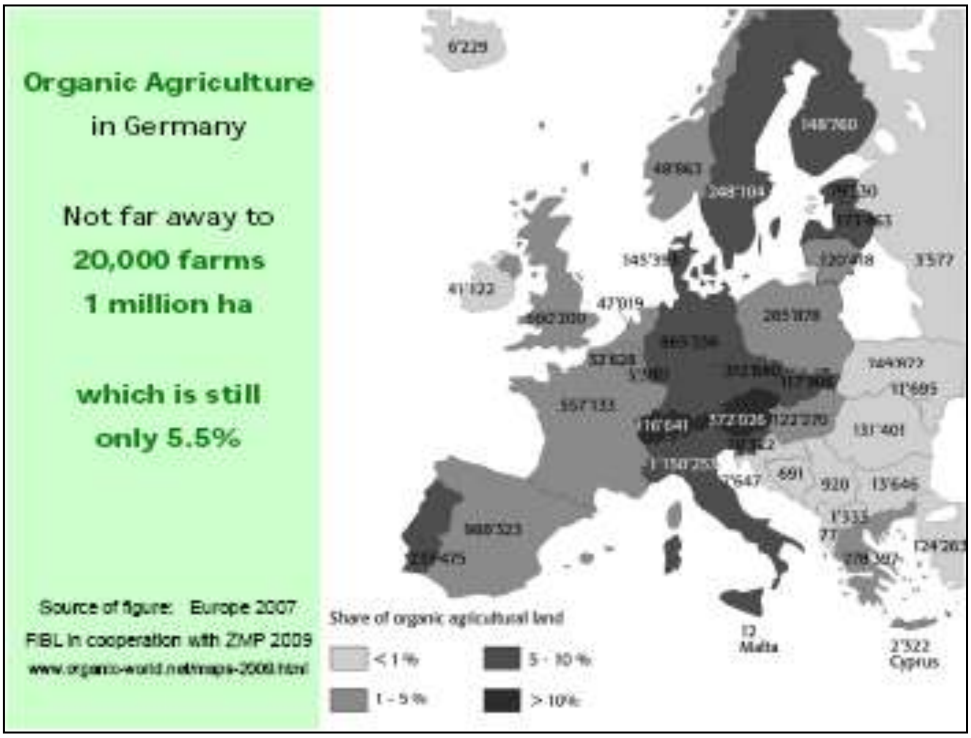
Relevance of Organic Farming for Climate Change in Germany

Guido Haas

Organic AgroExpertise Consultancy, Germany
Email: g.haas@agrarhaas.de





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CO_2-emission

predominantly due to fossil energy use

in Germany land-use change took place in former times

Comparision of conventional and organic farming

- Several studies since 1994
- All show clear advantages for organic

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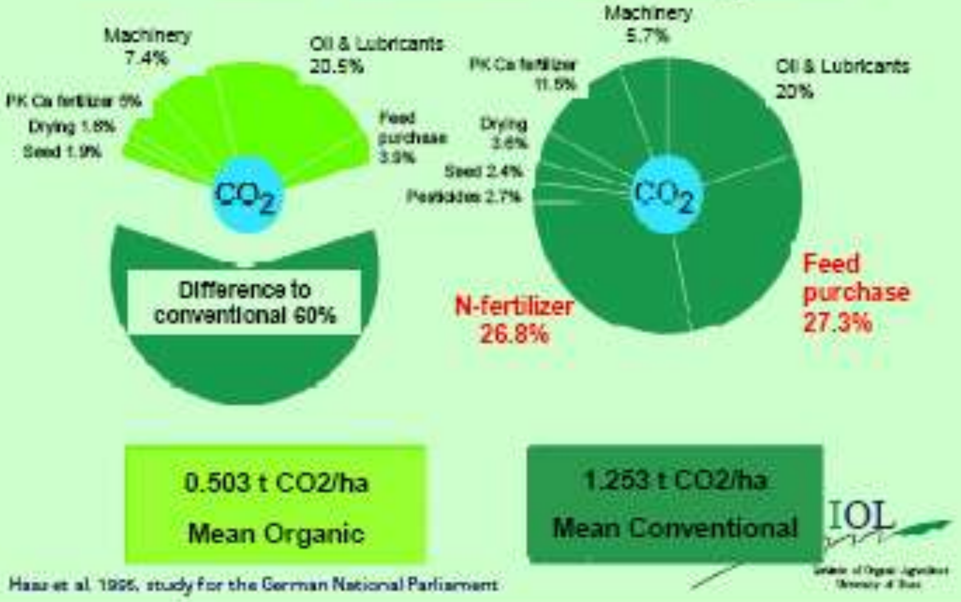
CO2 Comparing Farming Systems

Lower CO_2-emission in organic farming due to non-use of mineral N-fertilizer and lower feed purchase



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

N_2O-emission

predominantly due to field N input and turnover

Comparision of conventional and organic farming

- No representative on sight field measurements (Modeling is not enough)
- but indirect indication by comparing
  - N-surplus / N-input
  - Nitrate content in soil, subsoil and groundwater

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N_2O-emission

90% of emission results due to the turnover of nitrogen in the soil and groundwater

(Nitrification (org-N -> NH_4); denitrification of nitrate)

depends on **N-input** (with no difference)

- commercial fertilizer
- farm manure,
- grazing (excrement/urine),
- biological N_2-fixation,
- harvest- and root residues.

natural process – always occurs.

1.25% of total N input is calculated as N_2O emission (rough IPCC-factor)

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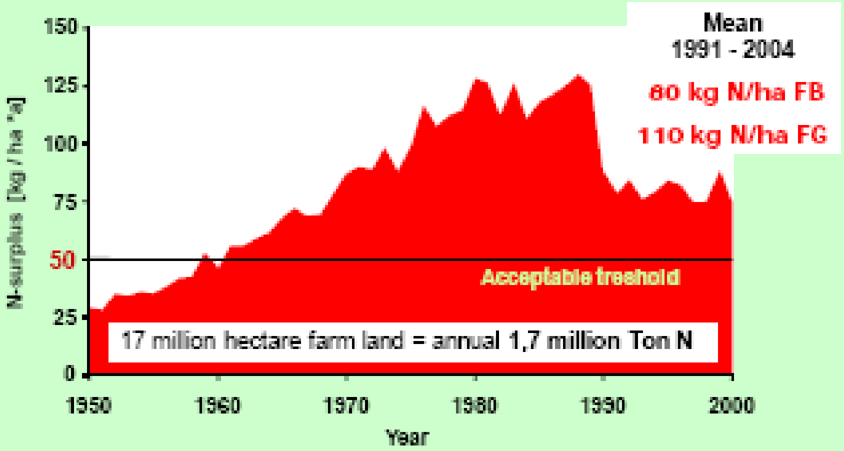
N-balance Germany

Environmental burden caused by intensifying conventional agriculture: Nitrogen surplus at field level in Germany



Haas et al. 2004/2005, data source: Bach & Frede 2002

IOL

Review

40 publications listed:

Nitrate leaching or leaching potential in organic compared to conventional agriculture was

28 lower

3 higher

9 similar

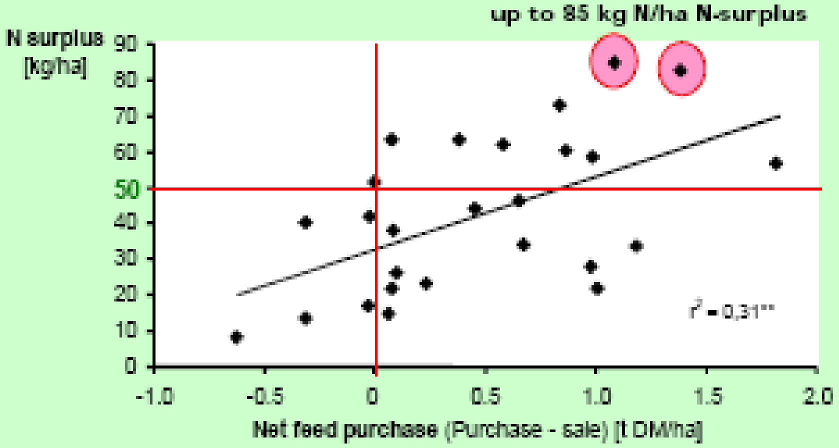
Haas 2002

IOL

ÖkoMiB I

As higher net feed purchase as higher nitrogen surplus (farm gate balance)

26 Organic dairy farms in north-west and southern Germany



=> up to 58% of N-input due to external sources - still organic?

IOL

Haas et al. 2007, RAFS

ÖkoMiB I

N-Surplus of Dairy Farm Comparisons

Reference, Region/ land and year of investigation	Organic	Conv. optimized integrated	Conventional
Scheringer Niedersachsen 1998/99	68 kg ha^{-1} 5,300 kg milk	77 kg ha^{-1} 6,660 kg milk	148 kg ha^{-1} 6,900 kg milk
Taube et al. Schleswig-Holstein 2005	31 kg ha^{-1}		117 kg ha^{-1}
Jonsson Schweden 1990 - 2001	27 kg ha^{-1} 7,892 kg milk		90 kg ha^{-1} 8,038 kg milk
Cederberg and Flysjoe Schweden 2002	71 kg ha^{-1} 9,400 kg milk	114 kg ha^{-1} 9,130 kg milk	158 kg ha^{-1} 10,100 kg milk
Halberg et al. Denmark 1989-1991	103 kg ha^{-1} 5,600 kg milk		221 kg ha^{-1} 6,200 kg milk
Kristensen, Denmark 2002	104 kg ha^{-1} 6,958 kg milk	112 kg ha^{-1} 7,764 kg milk	174 kg ha^{-1} 7,764 kg milk
Leach and Roberts, Scotland, (1989-)1996-1998	90 kg ha^{-1} 5,717 kg milk		258 kg ha^{-1} 8,000 kg milk
Veer & Pinxterhuis et al. Netherland 1997 conv. - 2000 organic	101 kg ha^{-1} 6,930 kg milk		253 kg ha^{-1} 8,450 kg milk
Smolders and Wagenaar; Beldman et al.; Netherland, 1997 / 2002	102 kg ha^{-1} 7,350 kg milk	153 kg ha^{-1} 8,073 kg milk	237 kg ha^{-1} 7,837 kg milk

Full table including more comparision Germany and Austria see publication.

Haas et al. 2007, RAFS

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CH$_4$

Emission of Methane (CH_4)

94% of emission caused by cattle;

since 1990 decrease due to 20% lower number of heads

- **in the rumen of the ruminant**

  depends on performance and feed;

  natural process – always occurs

- **during slurry & manure storage**

  depends on housing and storage and feeding:

  natural process – always occurs

= > Likely that organic farming has higher emission

UBA Umweltdaten 2006;

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Klima & Ldw

Organic Agriculture and Climate Change, September 28 - 29, 2009, Sofia, Bulgaria

Agriculture causes Climate Change

- CO_2 – Carbon dioxide
- N_2O – Dinitrogen oxide
- CH_4 – Methane

Overall comparision

– choosing appropriate reference unit

= > considering productivity?

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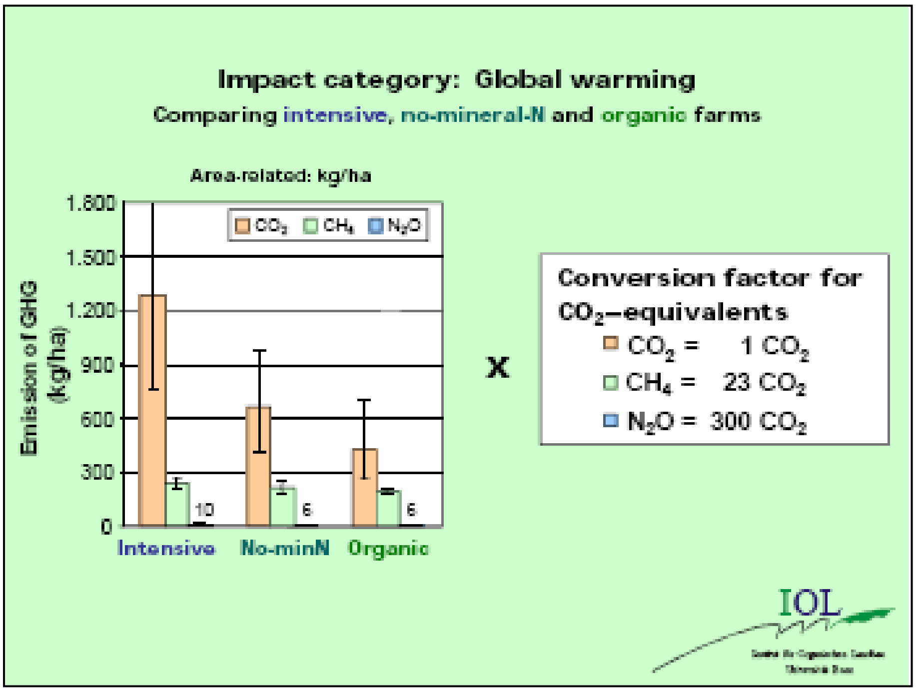
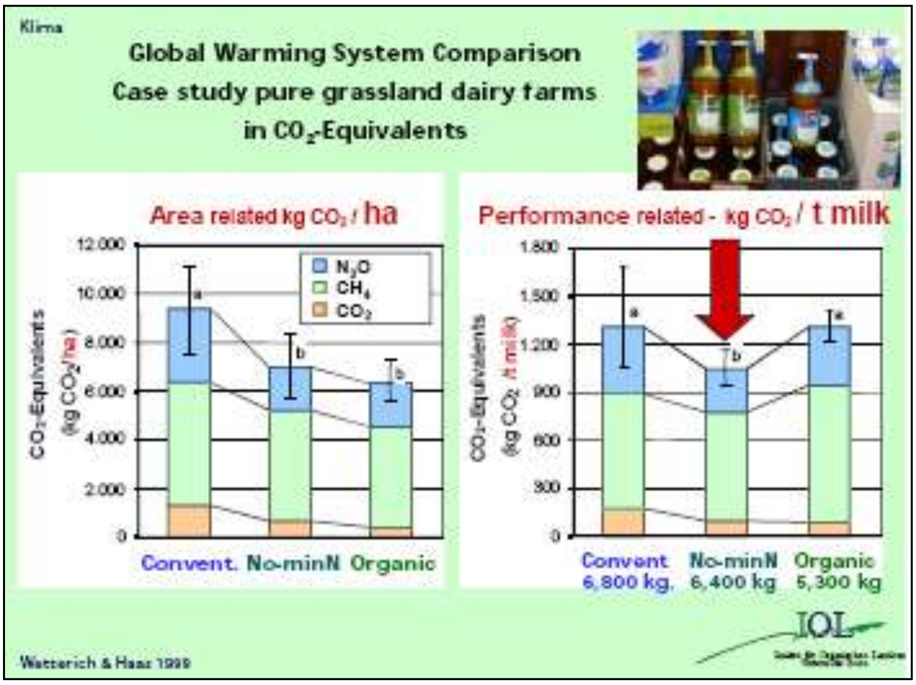


Impact category: Global warming
Comparing intensive, no-mineral-N and organic farms
Area-related: kg/ha
Emission of GHG (kg/ha)
CO2 CH4 N2O
Intensive No-minN Organic
x
Conversion factor for CO2–equivalents
CO2 = 1 CO2
CH4 = 23 CO2
N2O = 300 CO2
IOL



Klima
Global Warming System Comparison
Case study pure grassland dairy farms
in CO2-Equivalents
Area related kg CO2 / ha
CO2-Equivalents (kg CO2/ha)
N2O
CH4
CO2
Convent. No-minN Organic
Performance related - kg CO2 / t milk
CO2-Equivalents (kg CO2 /t milk)
Convent 6,800 kg
No-minN 6,400 kg
Organic 5,300 kg
IOL
Watterich & Haas 1999

Allgäu LCA FU Options

Options of reference units of the Allgäu LCA

Indicator / Impact category	Farm	Functional unit Area [ha]	Livestock [LU*]	Product [t milk]
Global impact				
Primary energy (resource use)	X	X	X	X
P-fertilizer (resource use)	X	X		X
Emission of CO_2-equivalents (global warming potential)	X	X	X	X
Regional to international impact				
Emission of SO_2-equivalents (acidification)	X	X	X	X
N-balance (groundwater) P-balance (surfacewater)	X	X		(X)
Local to regional impact				
Biodiversity - estimation score	X	(X)		
Landscape image - score	X	(X)		
Animal husbandry - score	X		(X)	

* LU - livestock-unit (each 500 kg liveweight of cattle);
(X) - restricted, only for certain indicators possible or in general not very meaningful

Haas et al. 2000

Klima

Not only Source also Sink = Humus (Sequestration), but

- timeframe limited

- reversible process

Ensuring and if possible increasing humus content

- Forage legume crops (e.g. grass/red clover, lucerne etc.)
- Soil rest (no tillage for awhile)
- Using farm yard manure / compost

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Climate Change:

of Organic Farming is relevant,
has some benefit

but

lower yields,
thus would not be able
to produce the current food basket

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Calculation of Value Chain Emission
CO_2-neutral "Bratwurst" sausage

4 kg CO_2/kg Sausage

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Trace gas emission of food items

conventional farming + processing + distribution

CO_2-equivalents g / kg food

Animal food		Vegetable/crop food	
Cheese	8.350	Tofu	1.100
Sausage	8.100	Pasta	930
Cream	7.700	Bread 1	820
Beef	6.450	Bread 2	780
		Bread 3/buns	700
Eggs	1.950		
Cream cheese	1.950		
Pork	1.900	Fruit	460
Poultry meat	1.250	Tomatoes	330
Yoghurt	1.240	Potatoes	240
Milk	950	Vegetables	150

Nr. 7 **Umweltauswirkungen von Ernährung, Stoffstromanalysen und Szenarien**, Kirsten Wiegmann, Ulrike Eberle, Uwe Fritsche, Katja Hünecke; September 2005

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Organic Agriculture and Climate Change, September 28 - 29, 2009, Sofia, Bulgaria

Less livestock food

for healthier people and healthier environment

- Healthier and sufficient to meet the physical requirements
- to take only **1/3** of the meat
  2/3 of the milk
  1/2 of the eggs of current consumption
- For this only **half** of the current livestock would be needed and
- The global warming gas emission by the German agriculture could be cut off to only **half**.
- If 100% OA only 15 – 20%, considering full food chain only 5%
- Full conversion to organic farming would be possible despite lower yields.

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culture and Climate Change, September 26 - 29, 200

Beef or Pork?

- 17 million farm land, whereof 5 million is permanent grassland
- Main ecosystem function of ruminant livestock is to convert "useless" (grass) fiber into high value protein (milk, meat)
- Additionally n organic farming need to grow legumes for the nitrogen input via N_2-fixation, predominately forage legumes
- Pigs are fed with almost 2/3 of total the cereal harvest
  => cereal for feed or bred?
- Environmental sound would be = low intensive cattle production on low intensive grassland use

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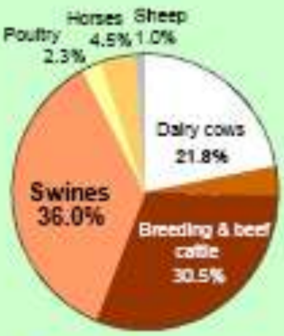
State Level: Comparing livestock farming

Livestock Farming in NRW:

In O.A. cattle is much more important

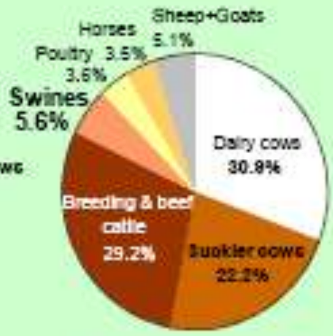
in contrast to pigs for several (good) reasons

Conventional



Mean = 1.3 LU/ha

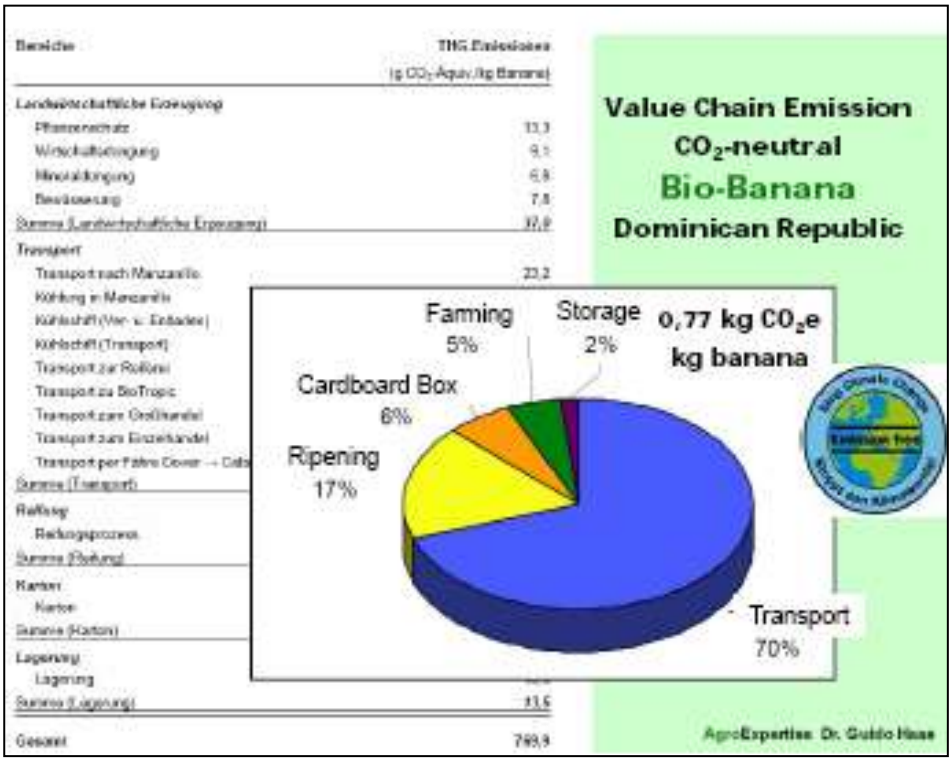
Organic



Mean = 0.7 LU/ha

LU: livestock unit (each 500 kg liveweight)

Zerger & Haas 2005


Value Chain Emission
CO_2-neutral
Bio-Banana
Dominican Republic
0,77 kg CO_2e
kg banana
Farming
5%
Storage
2%
Cardboard Box
6%
Ripening
17%
Transport
70%
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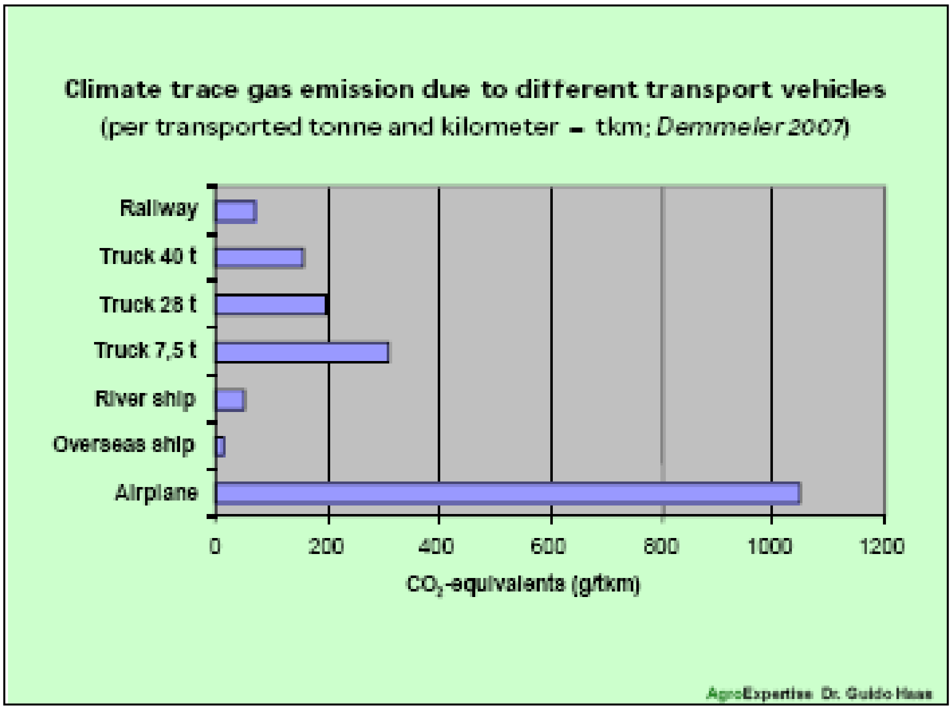
Climate trace gas emission due to different transport vehicles
(per transported tonne and kilometer – tkm; *Demmeler 2007*)
Railway
Truck 40 t
Truck 28 t
Truck 7,5 t
River ship
Overseas ship
Airplane
0
200
400
600
800
1000
1200
CO_2-equivalents (g/tkm)
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Global warming gas emission of food depends on transporting distance and vehicle

(Geographical Reference: Munic g CO_2-equivalents/kg food; *Demmeler 2007*)

	Overseas (boat/plane)		Europa (truck) (Northern Germany)		Region (truck)	
Cereal	USA, Ship	280	Polen	328	Niederbayern	69
Apple	New Zealand Ship	513	Italy Truck	219	Lake Constance Truck	76
Strawberry	Südafrika, Airplane	11.671	Italien	219	Oberbayern	61
Aparagos	Chile, Airplane	16.894	Spanien	359	Schroben-hausen	60
Meet	Argentinien Ship	349	Nieder-sachsen	179	Oberbayern	61
Eggs	-		Nieder-sachsen	179	Niederbayern	60
Milk	-		Mecklen-burg-V.	209	Allgäu	65

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CO_2-neutral labeling - some particular for organic products

Reduce CO_2 emissions?
Reduce costs?
And climate neutral?

CarbonFix Standard
Quality CO_2-certificates from new forests

STOP CLIMATE CHANGE
klimafreundlich

CO_2 Bilanz

Climate Neutral Group

Soil & More
Climate Neutral Product

working with the Carbon Trust
600g CO_2 per wash

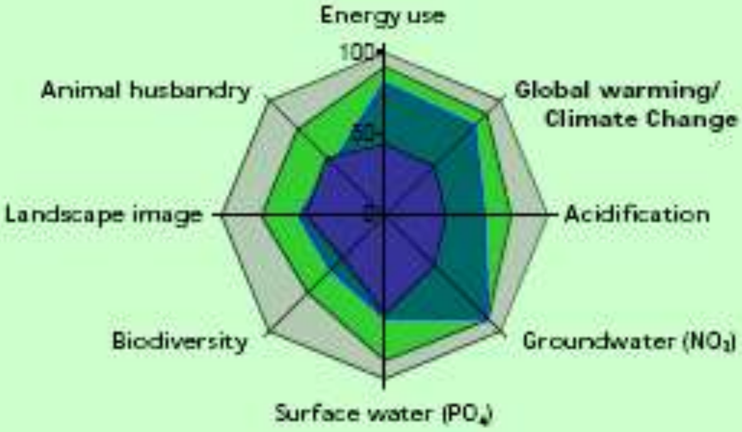
General big discussion in Germany
about easy to get nutrient signpost labeling schemes
recently also a GMO-free label has been introduced by the Federal Government (though not well accepted)

plus many Organic Food Labels in Germany It is too much!

Comparing Environmental Impact

Global Warming is only one Environmental Impact

Case Study of a Process Life Cycle Assessment



Intensive, No-mineral-N and Organic

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

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

IOL

Global Warming is of minor importance among all Environmental Impacts of Agriculture in Germany

Impact category	Agriculture ...
Biodiversity of habitats and species AgroBiodiversity	- 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 since 1950 - is solely responsible for the diversity of crop & lifestock species
Landscape image & soil functions	- farms 55% of the land area - often causes to much soil erosion in hilly areas
Quality of (drinking) water	- has predominantly caused the pollution of many upper ground water aquifers with nitrate. (100 mm = 1 Mill l per ha) - pollutes ground water with pesticides
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 13 % of climate relevant trace gases
Resource	uses about 3% of the primary energy

Environmental assessment has to cover central impacts (ranking).

Geier 2000, Haas et al. 1995, Haas 1997, updated Dr.Ldfr.

Organic Agriculture and Climate Change, September 28 - 29, 2009, Sofia, Bulgaria

Conclusion: Relevance of Organic Farming for Climate Change in Germany

Organic farming has clearly lower CO_2 and N_2O emissions referenced to the farmed area. However, conventionalizing will lower the difference

When considering productivity/yield as a reference unit, GHG emission differences are smaller or diminish.

Highest reduction of GHG emission will be possible by reducing food based on livestock production. Gras fed beef better than pork.

Global Warming is only one of the environmental impacts of farming.

Too many Organic Food Labels in Germany – in general no label possible for each environmental impact (no fashion hypes).

Consumer expect that organic farming is most sustainable environmental friendly in all ways possible.

For any further question do not hesitate to contact me or visit my website particular the site to download publications:

Dr. Guido Haas, Organic AgroExpertise Consultancy, Bonn, Germany

Email: g.haas@agroexpertise.de Internet: www.agroexpertise.de

References (complete list on request, much more available in German)

Haas, G. 2005: Organic agriculture in North-Rhine-Westphalia: empirical analysis of the heterogeneous spatial distribution (in Germany, extended abstract in English available). Agrarwirtschaft 54/2, 119 - 127.

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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.

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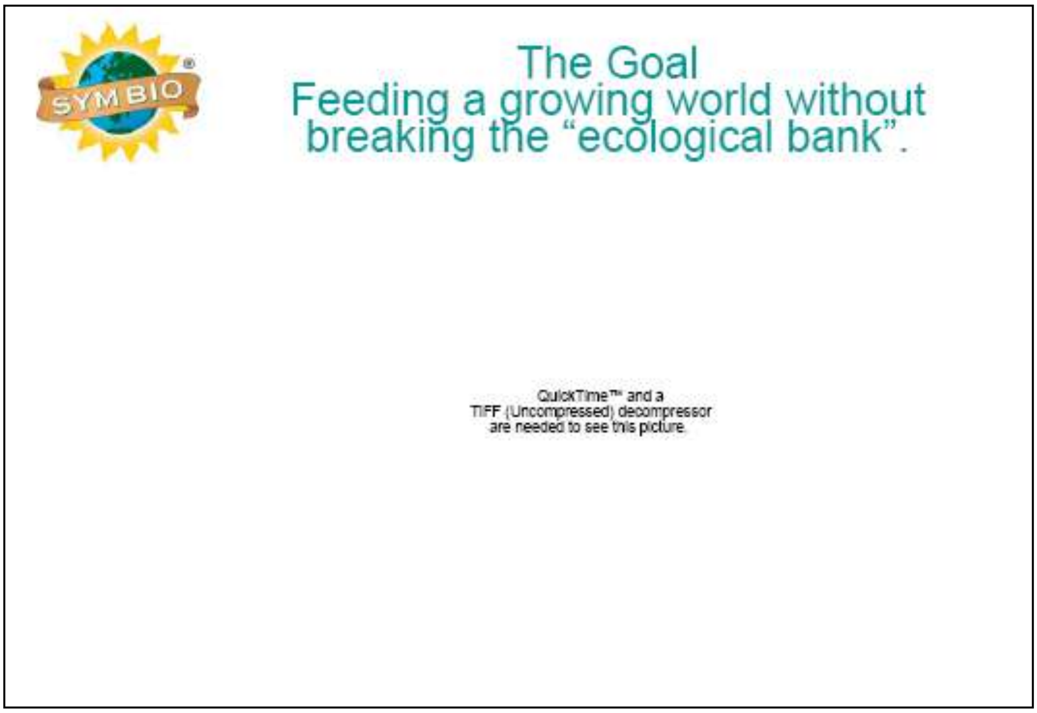
AgrarIngenieurbüro Dr. Guido Haas


Organic Agriculture - the Common Denominator
Good Business
KTBG

Lower Your Carbon Foot Print and Eat Organic: the Case of Poland

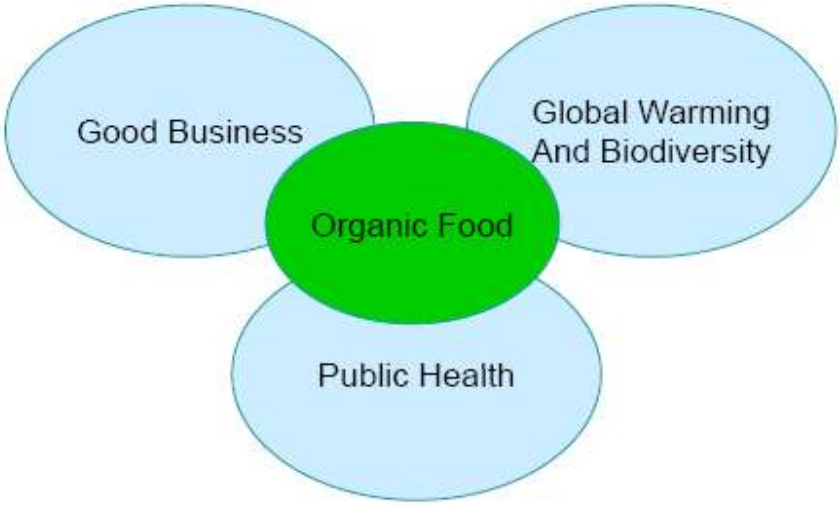
Tokya E. Dammond,

Symbio Polska S. A., Poland/the USA
E-mail: Tokya@SymBio-Organic.com



Organic Agriculture - the Common Denominator

Organic food lies at the intersection of growing markets, global warming mitigations and food security.



Nutritionally Superior - Organic Yields of Key Nutrients higher in Organic Foods

- Organic Foods have on *average* 25% more of the all-important protective phytonutrients like polyphenols and antioxidant pigments.
- Conventional Foods are better at producing *more (but not better)* protein (thanks to Nitrogen) and sugars (phosphorous)

Organic Center - No Free Lunch Chart on nutritional results

Overview of Differences in the Nutrient Content in Organic and Conventional Foods in 191 Matched Pairs

Nutrient	Number of Matched Pairs	Number Organic Higher	Number Conventonal Higher	Percent Organic Higher	Percent Conventonal Higher
Antioxidants					
Total Phenolics	25	18	6	72%	24%
Total Antioxdiant Capacity	8	7	1	88%	13%
Quercetin	15	13	1	87%	7%
Kaempferol	11	6	5	55%	45%
Vitamins					
Vitamin C/Ascorbic Acid	46	29	17	63%	37%
B -Carotene	8	4	4	50%	50%
a- Tocopherol (Vitamin E)	13	8	5	62%	38%
Minerals					
Phosphorus	32	20	10	63%	31%
Potassium	33	14	19	42%	58%
Totals and Averages	191	119	68	62%	36%

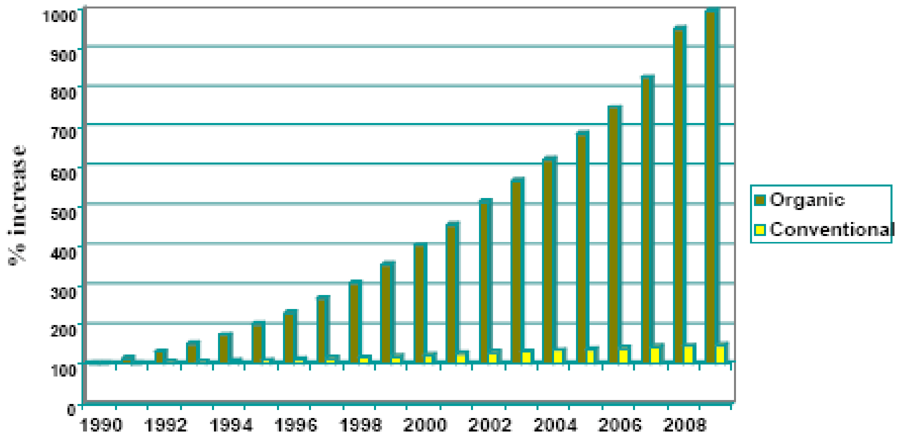
Healthier Diet = Lower Health Cost

- Increasing intakes of polyphenols and antioxidants is a vita to improve public health, since daily intakes of antioxidants and polyphenols are less than one-half of recommended levels.
- The combination of low polyhenols and antixoidants with high sugar outputs are linked high Health Care Costs - as poor diet plays crucial role in diabetes, cancer and obesity

For more information see: Still No Free Lunch - from the Organic Center - http://www.organic-center.org

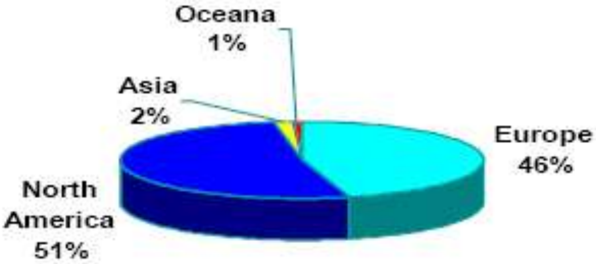
Good Business

Comparing growth rates of the organic to the conventional food industry



TOTAL RETAIL SALES
2009

Retail sales of organic food worldwide reached @USD 50.0 billion in 2009 up from 27 billion in 2004.



Source: Organic Monitor, Organic Trade Association And Natural and Nutritional Productds Center

The Green Consumer - what's behind the growth?

- Education - more and more consumers are thinking and learning about diet and health as well as how their food is grown and processed
- Politically Motivated - once they learn about the link between food, health and the environment, they are very motivated to defend the "green" way
- This in turn is why they continue to spend on Green on Green products and services - even in hard economic times.

SymBio Polska S. A.

A success story in producing organic food in Eastern Europe

- **Legal Form:** **Publically Traded S. A. on Exchange NewConnect**
- **Headquarters:** **Lublin, Poland**
- **Year Formed:** **1998**

Biodiversity Preservation and Global Warming

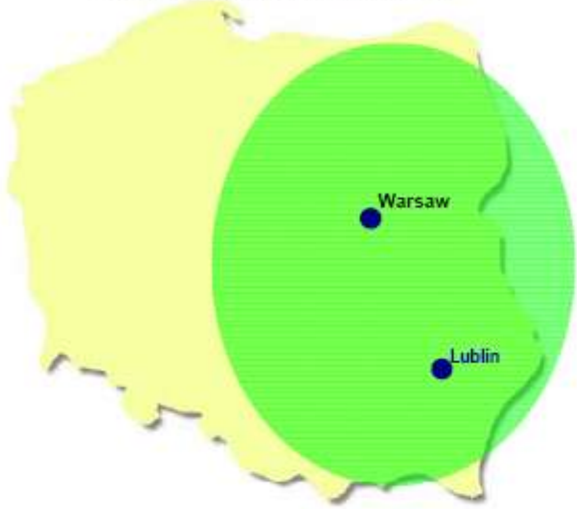
- The **Driving Motivation** behind Symbio is the preservation of biodiversity in and around Polish farms and producing foods to mitigate the impact on Global Warming.
- These objectives can best be reached by rapid expansion of land managed by organic methods. Rapid growth is achieved by efficiently meeting the demands of our farmers and our customers.

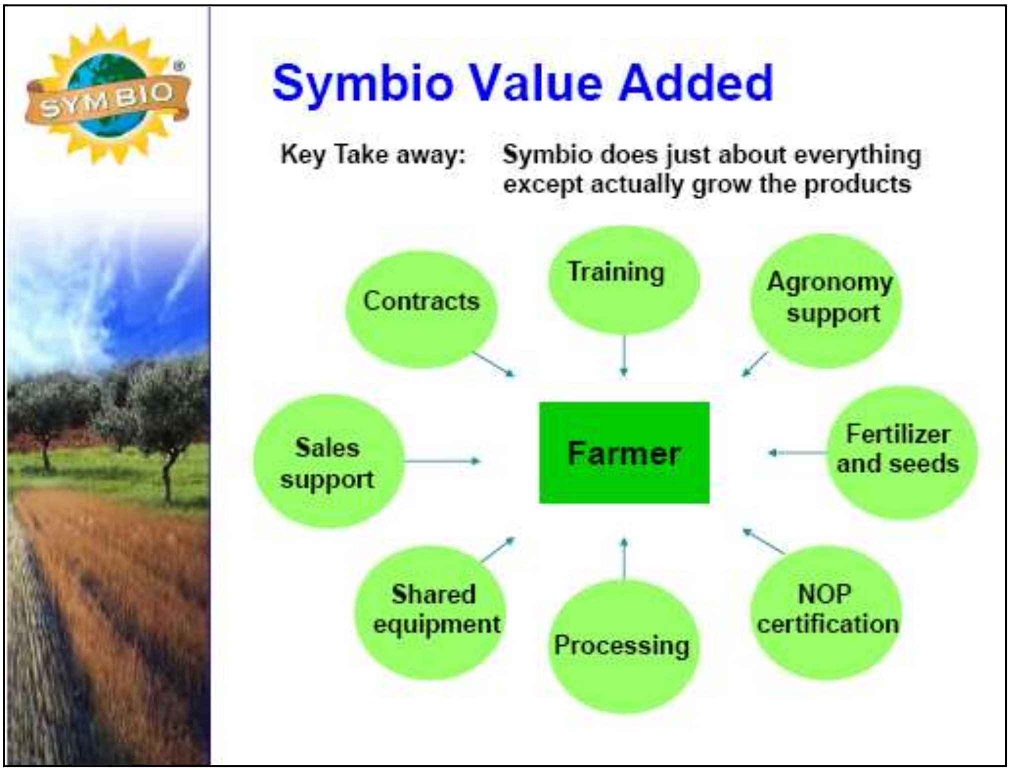
Biodiversity Preservation

- Symbio's farms are concentrated in and around Poland's **National and Landscape Parks** in order to maximize the environmental benefits of Polish organic farming.
- Symbio is partially financed by and is working with the Global Environmental Facility Fund and International Finance Corporation - Environmental Projects Unit to develop a Poland-wide certification and management system for biodiversity preservation on and around Symbio's farms.

Map of Farms

Key Take Away: Symbio works with farms throughout eastern Poland.





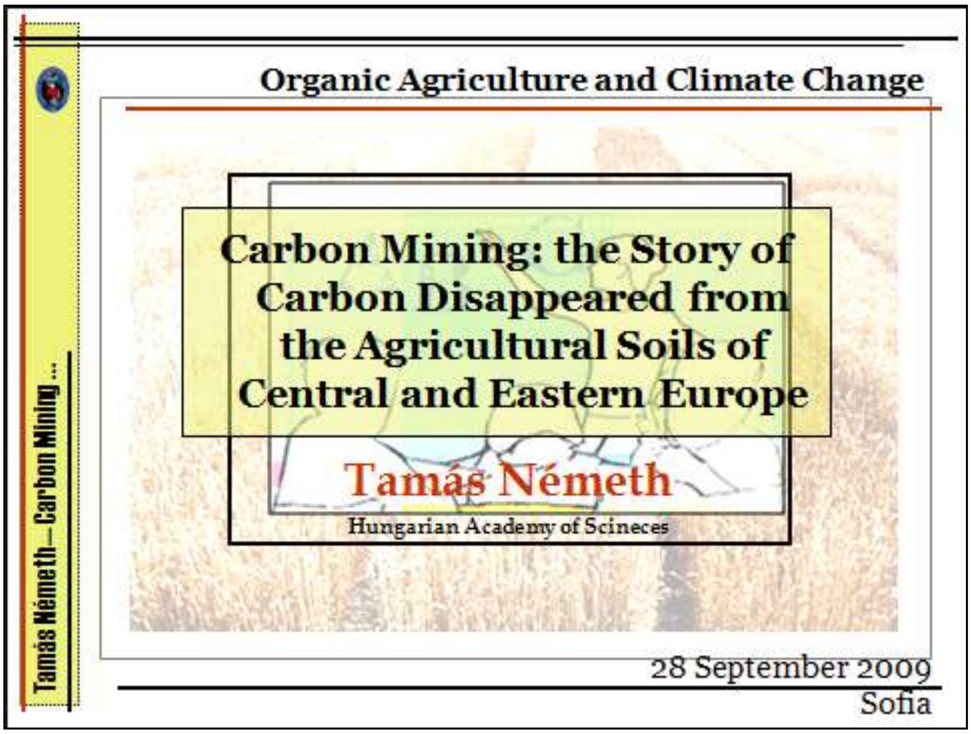
Symbio Value Added
Key Take away:
Symbio does just about everything except actually grow the products
Contracts
Training
Agronomy support
Sales support
Farmer
Fertilizer and seeds
Shared equipment
Processing
NOP certification


EPSON

Carbon Mining: the Story of Carbon Disappeared from the Agricultural Soils of Central and Eastern Europe

Tamas Nemeth

Research Institute for Soil Science and Agricultural Chemistry
of the Hungarian Academy of Sciences, Hungary
Email: nemeth.tamas@office.mta.hu

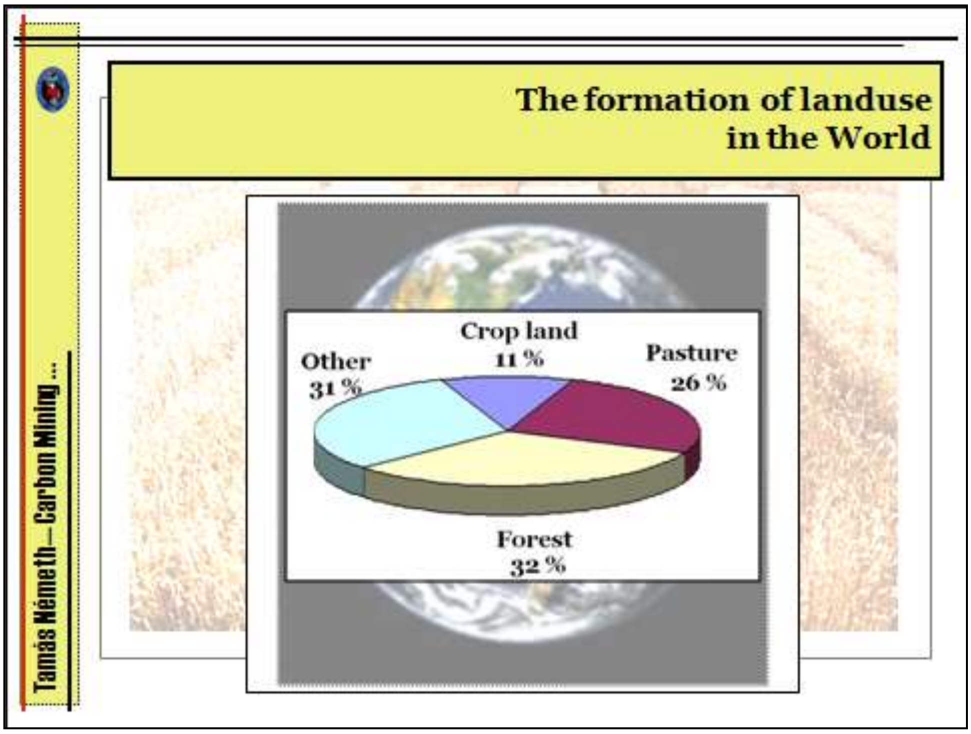


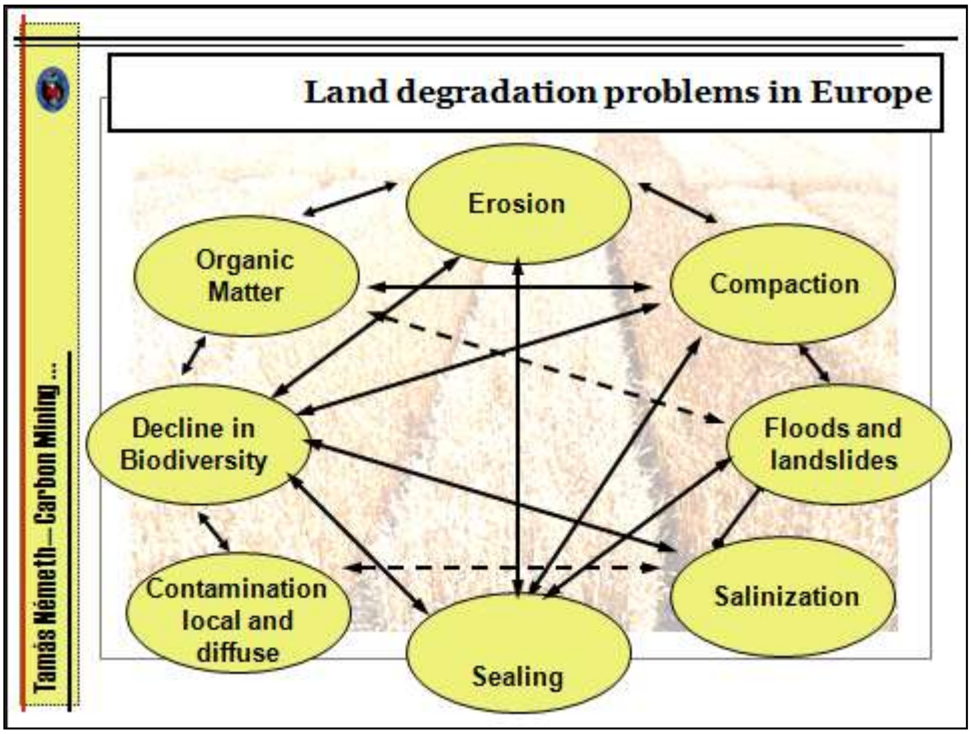
Tamás Németh — Carbon Mining ...

Tamás Németh — Carbon Mining ...

In respect of arable land territory per capita, Hungary is in an advantageous situation among the Eastern European countries, as well as in comparison with West-European countries or the world average. While the average arable land territory per capita is 0.26 ha in the developing countries, 0.23 ha in the West-European countries, 0.30 ha on world average in 1990 (LAL, 1995) the Hungarian average is as much as 0.48 ha. The world trend shows a decrease on average to 0.25 ha in the year 2000, 0.15 ha in the year 2050 and about 0.10 ha in the year 2150. The only way to fullfill the needs of growing demands on 0.10 ha/capita is sustainable land use system that prevent or minimize (even restore) lost of resources and soil degradation processes.

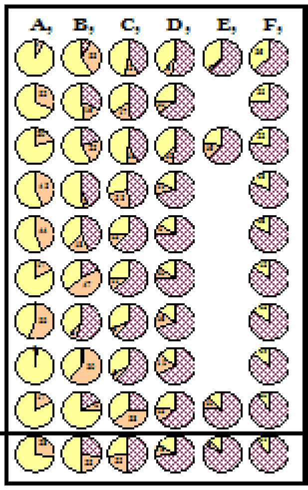
Obviously the above mentioned favourable Hungarian data does not mean that Hungary should not pay particular attention to the maintenance or improvement of soil carbon sequestration and quality.


The formation of landuse in the World
Crop land 11 %
Other 31 %
Pasture 26 %
Forest 32 %
Tamás Németh – Carbon Mining ...


Land degradation problems in Europe
Erosion
Organic Matter
Compaction
Decline in Biodiversity
Floods and landslides
Contamination local and diffuse
Salinization
Sealing
Tamás Németh – Carbon Mining ...

Tamás Németh – Carbon Mining ...

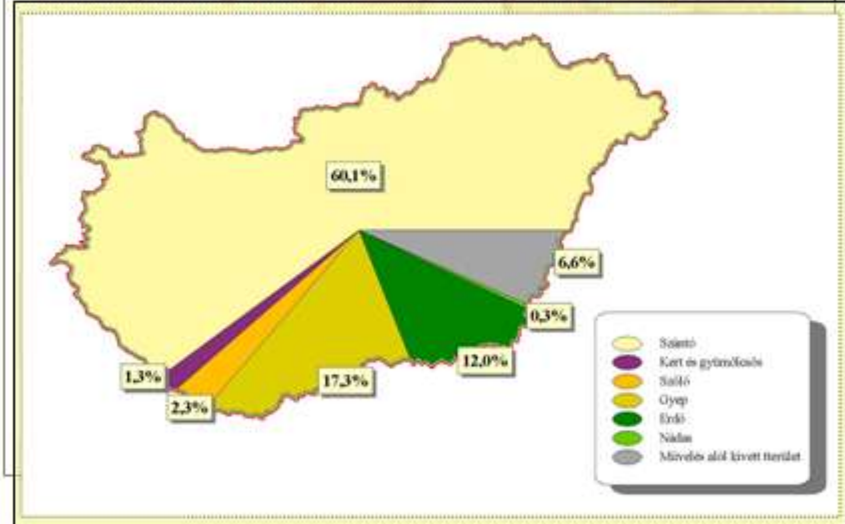
The main limitation factors of the World agricultural production (in the mainland percentage)



A, drought. B, nutrient stress. C, shallow arable layer. D, extreme precipitation. E, permafrost. F, arable soil

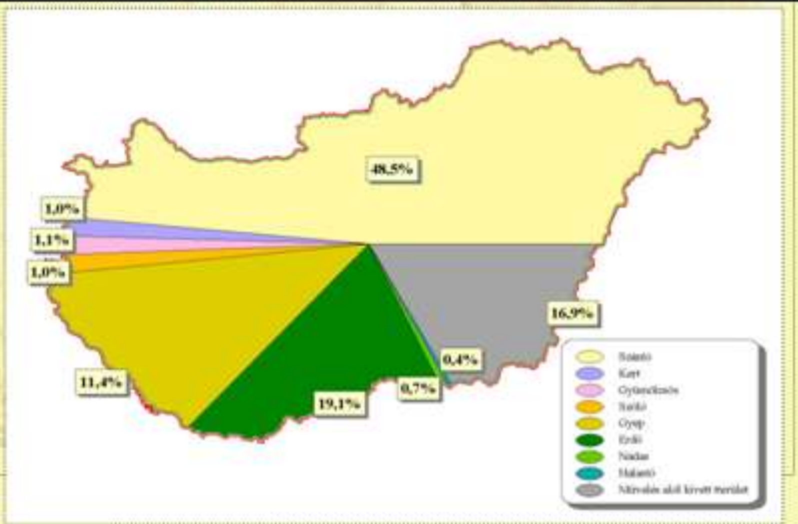
Tamás Németh – Carbon Mining ...

The Landuse of Hungary between 1931 and 1950 (in average)



Tamás Németh— Carbon Mining ...

The Landuse of Hungary
in the year of 2003

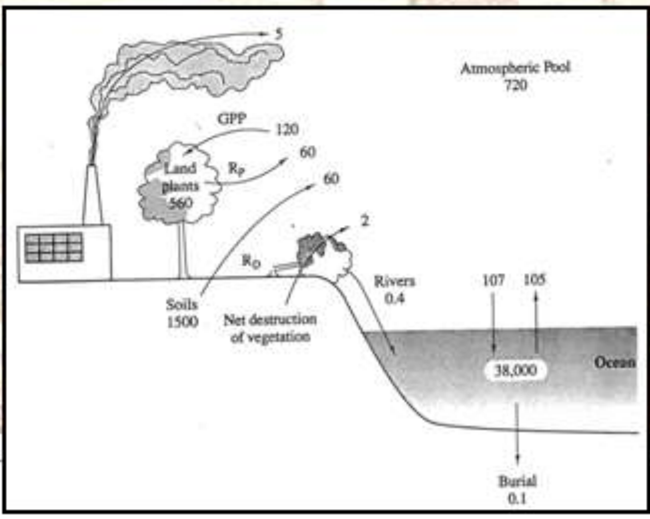


Tamás Németh— Carbon Mining ...

Changes in soil carbon are primarily effected by human activities (agriculture, forestry, etc.). The unproper management practices open way for declines in soil organic carbon content, including one of the most important degradation processes, the water and wind erosion.

The global Carbon cycle

All pools are expressed in units of 10^{15} gC and all annual fluxes in units of 10^{15} g C/yr



Tamás Németh— Carbon Mining ...

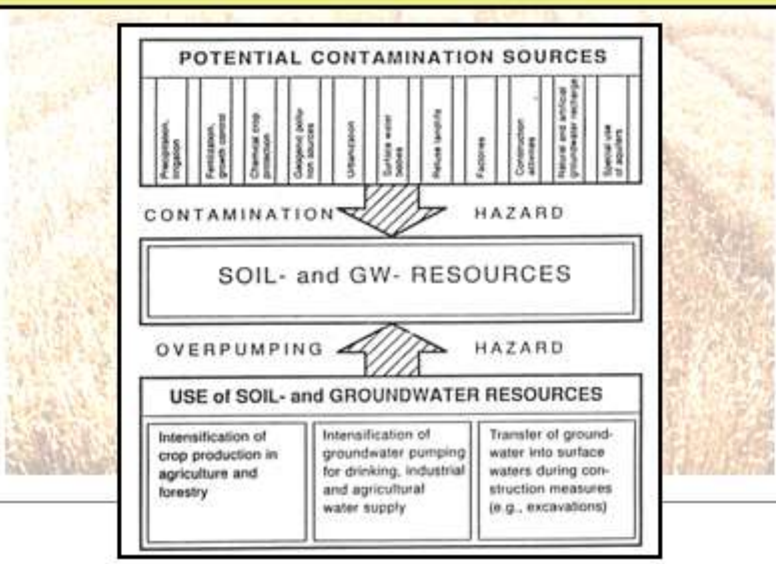
Through different degradation processes the native biologically productive soils became unproductive, can be characterized with slight humuous layer, low SOC, low soil quality, and low biomass productivity.

Tamás Németh—Carbon Mining ...

Soils represent a considerable part of the natural resources in the Central and Eastern European countries as well as in Hungary. Consequently, rational and sustainable land use and proper management practices ensuring normal soil functions have particular significance in national economy and soil conservation is an important element of environment protection.

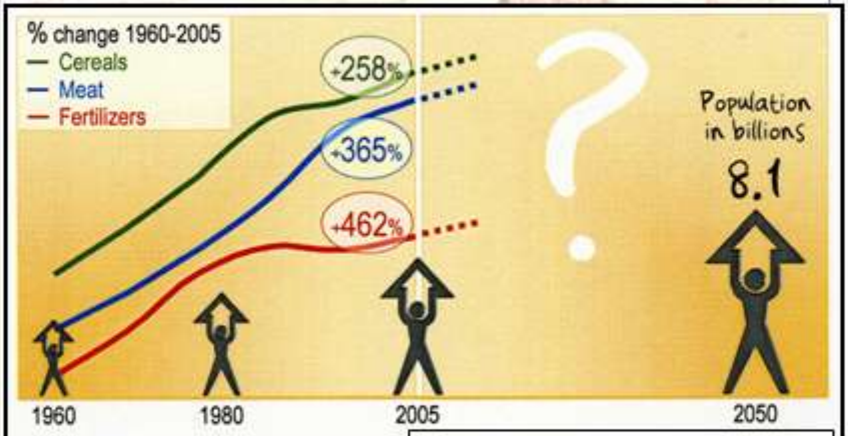
Tamás Németh—Carbon Mining ...

Pressure on soil- and groundwater resources caused by potential contamination sources and overuse



Tamás Németh—Carbon Mining ...

Feeding a Growing Population



Source: L.M. Maene – IFA (FAO)

Tamás Németh—Carbon Mining ...

The evolution of yields in Europe between the XIII and XIX century

Area	period	average yield (discarded cores compared)
England	1200-1249	3,7
France	1200 előtt	3,0
England	1250-1499	4,7
France	1300-1499	4,5
Germany, South-Skandinavia	1500-1699	4,2
East-Midle- and East-Europe	1550-1820	4,1

Source: Slicher van Bath (1963)

The Changes of Cultivated Lands of the World between 1850-1980 (1850 = 100 %)

South Asia	296%
South-East Asia	770%
Europe	96%
North America	409%
China	179%
Latin America	777%
Soviet Union	247%
Tropical Africa	388%
Total	279%

IIED-WRI, 1987

Tamás Németh—Carbon Mining ...

As a consequence of improving agricultural practice in Hungary, the increased use of fertilizers was characteristic of the early 1960's, and reached a rate as high as 250 kg $N+P_2O_5+K_2O$/ha arable land units per year from the second half of the 1970's up to the late 1980's.

Tamás Németh – Carbon Mining ...

As a result of mineral fertilization, the proportion of nutrients given in farmyard manure diminished in the Hungarian plant nutrition system. On the other hand, with the increased application of mineral fertilizers, the average yields doubled or even tripled, resulting higher amounts of stubble and root remains in the soil, thus increasing the quantity of organic carbon.

[The yearly averaged primary biomass production in Hungary in 1980 was 24 970 t (Mg) (Láng, 1985)]

Tamás Németh – Carbon Mining ...

From the early 1990's, however, fertilizer use dropped dramatically down to the level of 30-40 kg ha^{-1} active ingredients (of which 90-95% was N). During the past years the same trend (decrease) was detectable in the farmyard manure application as well because of the dramatic decrease in the number of the breeding stock. The animal unit dropped from 3 million down to 1.5 million in the past 10 years.

Tamás Németh – Carbon Mining ...

Use of mineral fertilizers in EU member states in 1998

Agricultural land area (kg ha^{-1} active ingredients)

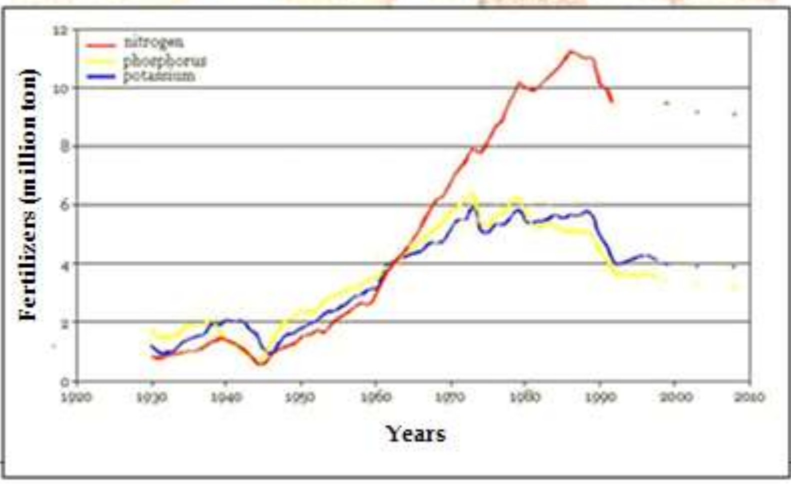
	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)	Total
Austria	33	16	19	68
Belgium/Luxemburg	117	35	61	213
Denmark	107	19	37	163
Finland	81	26	36	143
France	83	37	47	167
Greece	59	26	13	98
Hollandia	188	34	33	255
Ireland	87	28	34	149
Great Britan	79	25	28	132
Germany	103	24	38	165
Italy	55	31	24	110
Portugal	29	13	12	54
Spain	35	18	16	69
Sweden	66	16	17	99
EU 15	**70**	**26**	**30**	**126**

EUROSTAT/FAO, 2000

Tamás Németh – Carbon Mining ...

Fertilizer use in the European Union

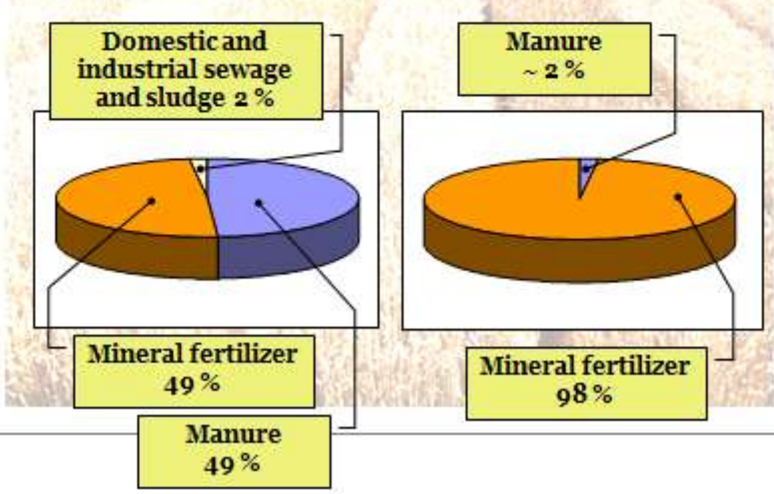
European Fertilizer Manufacturers Association (EFMA)



Tamás Németh — Carbon Mining ...

The application of fertilizers in the EU countries and in Hungary

European Fertilizer Manufacturers Association (EFMA)



Tamás Németh — Carbon Mining ...

Development of the ratios of cultivation types from the total land area (%)

Based on Agricultural Statistical Almanac, 1991

Land use	Hungary	EU-15	OECD	World
Arable land, vegetable garden and fruit plantation	54.5	27.9	13.3	11.1
Grass	12.4	18.6	25.3	26
Agricultural area	66.9	46.5	38.6	37.1
Forestry	19.1	36.3	33.5	31.7
Area (1000 ha)	9 303	313 025	3 352 529	13 045 423

Tamás Németh—Carbon Mining ...

Forecast for mineral fertilizer application in the EU for the period 1999-2009

European Fertilizer Manufacturers Association (EFMA)

It is desirable to decrease:

- **N** utilization by 7%
- **P** utilization by 10%
- **K** utilization by 4%

During the same period, however the wheat yields are intended to be increased from 5.8 t to 6.2 t/ha

Tamás Németh—Carbon Mining ...

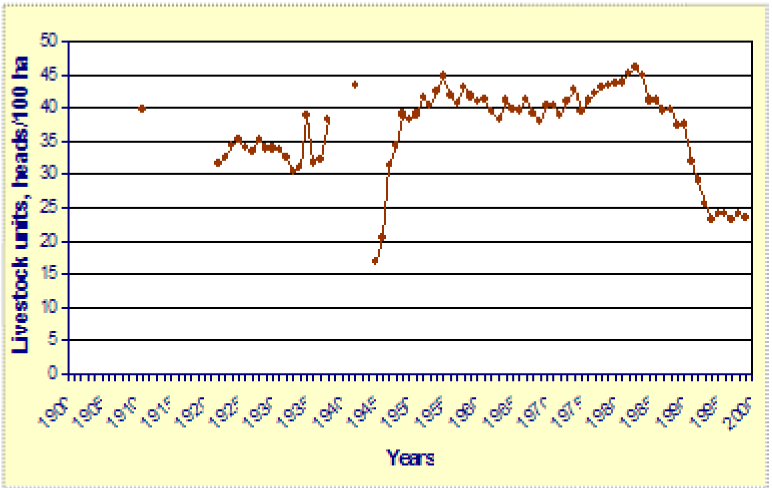
Farmyard manure and fertilizer use in Hungary 1931-2001

(Statistical Yearbooks for Agriculture, KSH)

Year	*Farmyard Manure, Million Mg year⁻¹*	*Fertilizer active ingredients, 1000 Mg year⁻¹*				*For arable lands,*
		N	*P_2O_5*	*K_2O*	Total	*kg ha⁻¹ year⁻¹*
1931-1940	22.4	1	7	1	9	2
1951-1960	21.2	33	33	17	83	15
1961-1965	20.6	143	100	56	299	57
1966-1970	22.2	293	170	150	613	109
1971-1975	14.8	479	326	400	1,205	218
1976-1980	14.3	556	401	511	1,468	250
1981-1985	15.4	604	394	495	1,493	282
1986-1990	13.2	559	280	374	1,213	230
1991-1995	6.0	172	25	26	223	44
1996-2000	4.8	235	40	42	317	63

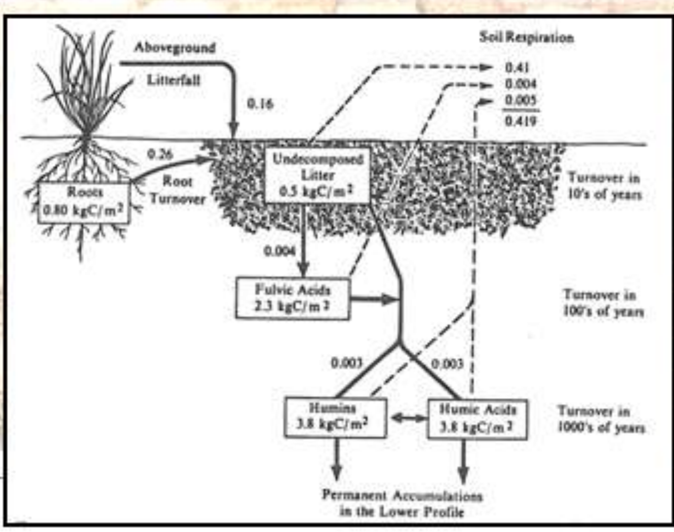
Volume of livestock production in Hungary

1901-2000



Tamás Németh – Carbon Mining ...

Turnower of litter and soil organic matter fractions in a grassland soil – Schlesinger, 1977



Tamás Németh – Carbon Mining ...

The previous intensive land use practice also had some unfavourable effects on soil carbon sequestration: large fields (100 ha or more) were formed for the efficient use of huge machineries. Rows of trees were cut for this reason, which caused an increase in erosion, deflation and soil carbon loss. The huge, over weighted machineries caused disadvantageous soil compaction, too.

Tamás Németh – Carbon Mining ...

Analysing the possibilities of the land use change summarized that Hungary can achieve advantages if the special conditions of the different measures to be taken are precisely determined i.e. a land use zone system can be formed. The zonality characterizes both nature conservation and agriculture and can be grouped as follows:

- *Basic nature conservation zones – nature reserves, strictly protected areas,*
- *Buffer zone of nature conservation and protection zones for water reservoirs – limited land use, areas with priority for protection,*
- *Mixed zones (ecological and other extensive type farming systems) – land use limitations for protective purposes,*
- *Zones for agricultural production – best agro-ecological conditions for intensive land use,*
- *Non-cultivated land.*

Tamás Németh—Carbon Mining ...

Along this lines the available nature and land information were collected by Institute for Environmental and Landscape Management of the Gödöllő Agricultural University (IELM-GAU) and Research Institute for Soil Science and Agricultural Chemistry of the Hungarian Academy of Sciences (RISSAC-HAS). The databases were put into four groups (Ángyán et al., 1998a, b; Németh et al., 1998b):

Variables and databases used

- for evaluation and qualification of the suitability for agricultural production i.e. (i) terrain and soil databases, and (ii) climatic parameters,
- for evaluation of environmental sensitivity i.e. (i) flora and fauna, (ii) soil, and (iii) water,
- database of land use and land cover i.e. (i) CORINE land cover, and (ii) forest areas,

National Ecological Network (NECONET).

Tamás Németh—Carbon Mining ...

The position of Hungary's areas on a scale of environmental sensitivity and agricultural suitability (%)

Standard categories	*Total*	*Agricultural land*
< 60	0.42	0.04
61 – 70	1.09	0.10
71 – 80	2.06	0.56
81 – 90	5.84	2.53
91 – 100	11.78	7.96
101 – 110	18.99	16.76
111 – 120	18.33	19.44
121 – 130	15.08	17.91
131 – 140	12.33	15.62
141 – 150	10.18	13.65
151 – 160	3.88	5.42
> 160	0.01	0.01
Total:	*100.00*	*100.00*

Altogether 28 environmental datasets were classified and weighted according to their role in the determination of agricultural production and environmental sensitivity (the priority standards were given also by certain experts and institutes that developed the databases). The area of the observation unit (cell) was 1 hectare (100x100 m grids).

Tamás Németh—Carbon Mining ...

The values of environmental sensitivity (VES) and agricultural suitability (VAS) varied between 0 and 99, respectively. During the calculation the VES were subtracted from VAS in each cells, then 100 were added to the difference, i.e. (VAS-VES)+100. Using this formula the values varied between 0 and 198, where the values under 100 reflect to the determinant role of environmental sensitivity, the values above 100 of agricultural suitability. At the two extremes of this scale the well-determined areas (agricultural and environmental) can be found, while in the middle of the scale the mixed areas (areas with extensive production limited by environmental features) are situated.

Tamás Németh—Carbon Mining ...

Using the values of this estimation three scenarios (the differences were set up between the extensive and intensive agricultural zone, according to the extensive rank between 100 and 120, 100 and 125, and 100 and 130) were worked out in order to develop a land use zone system, the medium of them was calculating whit the following categories:

- areas with a value less than 100 were ranked into the protection zone,
- areas with a value between 100 and 125 were ranked into the extensive agricultural zone, and
- areas with a value more than 125 were ranked into intensive agricultural zone.

Tamás Németh—Carbon Mining ...

Suggestion for the development of a land-use zone system in three categories

(Second scenario)

Land-use zone	*Total*	*Agricultural land*
	In percentage	
Protection zones (%)	10.38	3.74
Zones for extensive agricultural production (%)	41.15	35.88
Zones for intensive agricultural production (%)	48.47	60.37
Total:	*100.00*	*100.00*
	In hectare	
Protection zones (ha)	966 095	229 257
Zones for extensive agricultural production (ha)	3 827 954	2 196 834
Zones for intensive agricultural production (ha)	4 508 952	3 695 909
Total:	*9 303 000*	*6 122 000*

According to this scenario it can be stated that nearly 4% from the Hungary's existing agricultural land (closely 230 000 ha) can be turned into protection zone, more than 35% (~ 2.2 million ha) can be classed as extensive production, while more than 60% (~3.7 million ha) left for intensive agricultural production. Regarding to the arable land the same scenario showed that 111 300 ha can be moved from the existing arable land (4 714 000 ha) to protection zone, 1 408 900 ha to extensive agricultural production, while more than 67% of it (3 193 800 ha) can remain in the intensive agricultural production zone. The following conversions can be suggested:

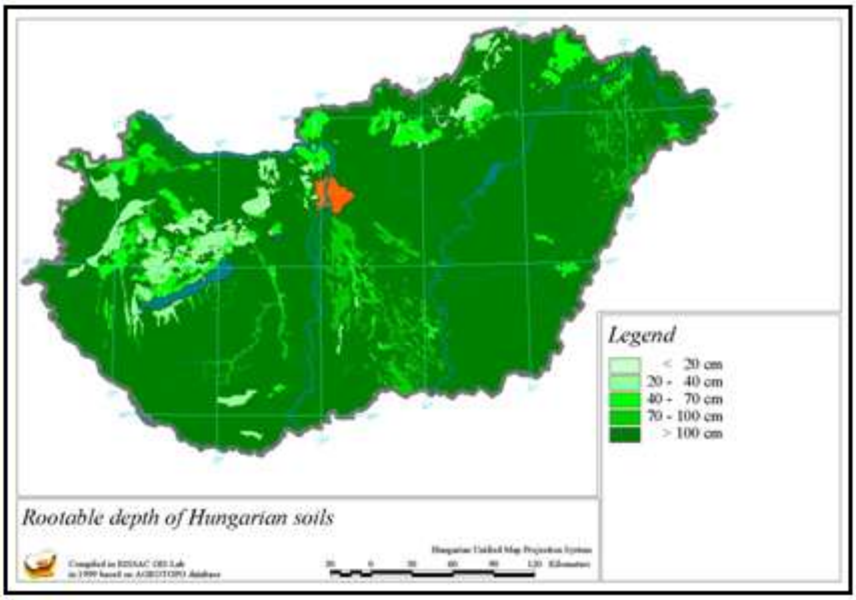
- 533 000 ha of grassland into forest,
- 229 000 ha of arable land into forest,
- 788 000 ha of arable land into grassland, and
- 503 000 ha of intensive arable land into extensive arable land.

Tamás Németh – Carbon Mining ...

Depth of the Soil

The majority (86%) of Hungarian soils is more than 1.0 m deep. Soil depth is between 0.7 and 1.0 m in 4%, between 0.4 and 0.7 m in 5%, and between 0.2 and 0.4 m in 5% of Hungarian soils (Várallyay et al., 1980). Both soil depth and soil organic matter content can strongly determine the amount of organic matter resource in a given territorial unit. On the next slide the rootable depth of the Hungarian soils (1: 100 000) can be seen.

Tamás Németh – Carbon Mining ...



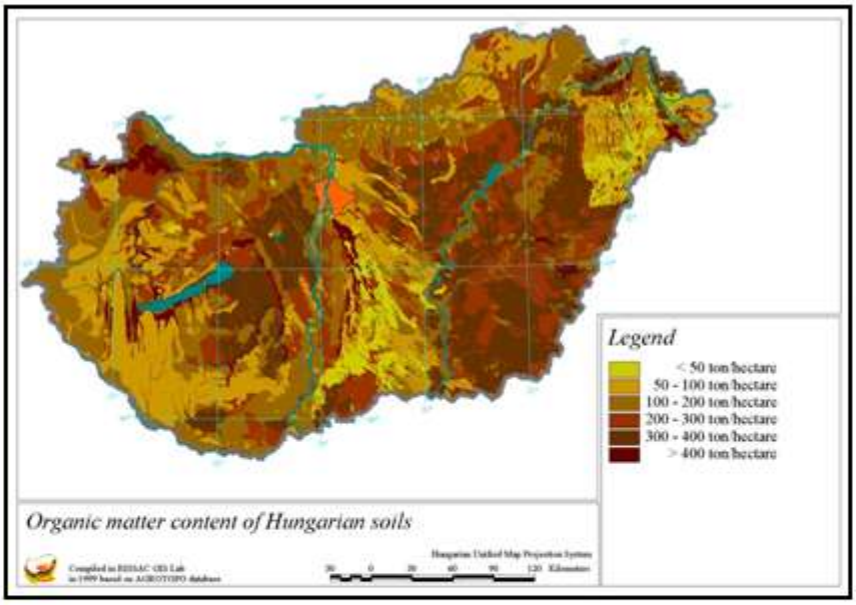
Tamás Németh – Carbon Mining ...

Soil Organic Matter (OM) content

From the distribution percentage of Hungarian soils according to their organic matter content can be seen that it is between 1 and 3% in about 2/3 of Hungarian soils. In sandy soils it is usually below 1% (15% of the area), while in clay loams between 3 and 4% (also 15% of the total area). It is over 4% on about 5% of the territory.

The territorial distribution shows that sandy soils with low original organic matter contents are situated in the south-western, in the central and in the eastern part of Hungary, while those with the highest OM contents are found in the south-eastern part, resp.

Tamás Németh— Carbon Mining ...



Tamás Németh— Carbon Mining ...

Organic Matter and SOC Resource of Hungary

The distribution of Hungarian soils according to their soil organic matter resource groups is shown in Figure 2. In the majority of Hungarian soils soil organic matter resource is between 50 and 400 t/ha, and it is between 100 and 200 t/ha, resp. on about 30% of the total area.

Tamás Németh—Carbon Mining ...

The estimation of the organic matter and soil organic carbon contents and pools was based on the calculation on territorial base with the thickness of the OM layer and the average SOC concentration in two layers (upper 20 cm and under) in the given soil. The biggest OM as well as SOC pools can be found on chernozem, peat, and meadow soils, 182 t/ha, 180 t/ha and 104 t/ha OM, respectively in the upper 0-40 and 0-60 cm (40 cm for meadow soil and 60 cm for chernozem and peat soils). The same calculation shows in average 105,6 t/ha SOC on chernozem soils, while 104,4 t/ha on peat soils and 60,3 t/ha on meadow soils, respectively.

Altogether more than 1102 million t (Mg) OM and more than 639 million t (Mg) SOC is the reserves of the Hungarian soils in the given thickness. App. 53% of the OM and SOC can be found in the arable land.

Tamás Németh—Carbon Mining ...

Distribution of Organic Carbon in Soils of Hungary

Table 4 Distribution of Organic Carbon in Soils of Hungary

Soil Type: Hungarian Classification	Soil Type: U.S. Soil Taxonomy	Soil Type: FAO	Area (ha)	Depth of Roots (cm)	OM % in: Upper 20 cm	OM % in: Below 20 cm	OM (t/ha)	OM in Total Area of Soil Type (t)	OC (t/ha)	OC in Total Area of Soil Type (t)
Skeleton soils	Entisols (Ustipsamments, Udorthents)	Regosols/Leptosols	763,750	10	0.5	0	6.5	4,964,375	3.8	2,679,338
Stony soils	Inceptisols (Ochrepts, Umbrepts)	Regosols/Leptosols	292,906	30	2	1	65	194,835,575	37.7	113,004,634
Forest soils	Alfisols (Ustalfs)	Luvisols	3,195,004	40	2	1	78	249,210,312	45.2	144,541,981
Chernozem soils	Mollisols (Ustolls)	Chernozems/Phaeozems	2,064,731	60	3	2	182	375,781,042	105.6	217,953,004
Salt-affected soils	Inceptisols (Halaquepts)/Vertisols (Salaquerts, Natraquerts)	Solonetz/Solonchak	562,440	20	2.5	0	65	36,558,600	37.7	21,203,988
Meadow soils	Mollisols/Vertisols	Phaeozems/Vertisols	1,987,554	40	3	1	104	206,705,616	60.3	119,889,257
Peat soils	Histosols (Hemists, Saprists)	Histosols	132,983	60	30	30	180	23,936,940	104.4	13,883,425
Wetland forest soils	Inceptisols (Endoaquerts)	Gleysols	8,087	20	1	0	26	210,262	15.1	121,952
Floodplain soils & sediments	Entisols (Fluvents), Inceptisols	Fluvisols, Regosols	254,311	20	1.5	0	39	9,925,929	22.8	5,757,039
Total			9,231,996					1,102,128,652		639,234,618

Distribution of Organic Carbon on Arable Land of Hungary

Table 5 Distribution of Organic Carbon on Arable Land of Hungary

Soil Type FAO	Area (ha)	Depth of Roots (cm)	OM % in Upper 20 cm	OM % in Below 20 cm	OM (t/ha)	OM in Total Area of Soil Type (t)	OC (t/ha)	OC in Total Area of Soil Type (t)
Regosols/ Leptosols	255,392	10	0.5	0	6.5	1,660,048	3.8	962,829
Regosols/ Leptosols	25,961	30	2	1	65	1,687,465	37.7	978,730
Luvisols	1,425,147	40	2	1	78	111,161,466	45.2	64,473,650
Chernozems/ Phaeozems	1,682,506	60	3	2	182	306,216,456	105.6	177,605,544
Solonets/ Solonchak	262,096	20	2.5	0	65	17,036,240	37.7	9,881,019
Phaeozems/ Vertisols	1,280,565	40	3	1	104	133,178,760	60.3	77,243,681
Histosols	50,738	60	30	30	180	9,132,840	104.4	5,297,047
Gleysols	3,908	20	1	0	26	101,608	15.1,	58,933
Fluvisols, Regosols	129,220	20	1.5	0	39	5,039,580	22.6	2,922,966
Total	5,115,535					585,214,463		339,424,389

Tamás Németh—Carbon Mining ...

The predicted change in the land use system give a possibility for calculating the OM and SOC according to the new distribution. Next slide shows that how this change will effects the distribution of the soils in different land use categories, while Table 7 give a scenario for the SOC balance in the next 25 years. This change is only a suggestion from soil suitability point of view, taking into account that the less valuable arable land would be changed. It contains more than 50% of the Regosols/Leptosols, app. 40% of the Luvisols, Solonets/Solonchak and Histosols, and almost all the Gleysols, while includes only few percents from Chernozems/Phaeozems and Phaeozems/Vertisols.

Scenario of Land-Use Change of Arable Land for Next 25 Years

Table 6 Scenario of Land-Use Change of Arable Land for Next 25 Years

Soil Type FAO	Currently Arable Land Area (ha)	Expected Partial Land-Use Change	Change to Area (ha)	Remaining Arable Land Area (ha)
Regosols/Leptosols	255,392	Grassland	74,722	180,670
Regosols/Leptosols	25,961	Grassland	5,324	20,637
Luvisols	1,425,147	Forest	824,501	600,646
Chernozems/Phaeozems	1,682,508	Grassland	1,658,345	24,163
Solonets/Solonchak	262,096	Grassland	171,537	90,559
Phaeozems/Vertisols	1,280,565	Grassland	1,109,887	170,678
Histosols	50,738	Wetland	36,101	14,637
Gleysols	3,908	Wetland forest	1	3,907
Fluvisols, Regosols	129,220	Grassland/forest	64,087	65,132
Total	5,115,535		3,944,505	1,171,029

Tamás Németh—Carbon Mining ...

Scenario for Organic C Content Due to Land-Use Change and Erosion after 25 Years

Table 7 Scenario for Organic C Content Due to Land-Use Change and Erosion after 25 Years

Soil Type FAO	Current OC Status (t)	Expected Increase of OC (t) Due to Land-Use Change	Expected Loss of OC Due to Erosion (t)		Summa Change	Expected OC Status (t) after 25 Years
			On Remaining Arable	On "Changed"		
Regosols/ Leptosols	962,828	3,406	56,340	58,718	−111,652	851,176
Regosols/ Leptosols	978,730	6,224	32,114	53,656	−79,546	899,184
Luvisols	64,473,650	181,155	2,480,695	1,561,680	−3,867,220	60,606,431
Chernozems/ Phaeozems	177,605,544	10,931	3,751,176	37,694	−3,777,939	173,827,606
Solonets/ Solonchak	9,881,019	51,211	646,694	294,317	−889,800	8,991,220
Phaeozems/ Vertisols	77,243,681	77,215	5,021,129	665,644	−5,609,558	71,634,122
Histosols	5,297,047	0	0	0	0	5,297,047
Gleysols	58,933	295	0	0	295	59,227
Fluvisols, Regosols	2,922,956	7,366	289,930	508,030	805,326	3,728,282
Total	339,424,389				−13,530,094	325,894,294


Tamás Németh— Carbon Mining ...

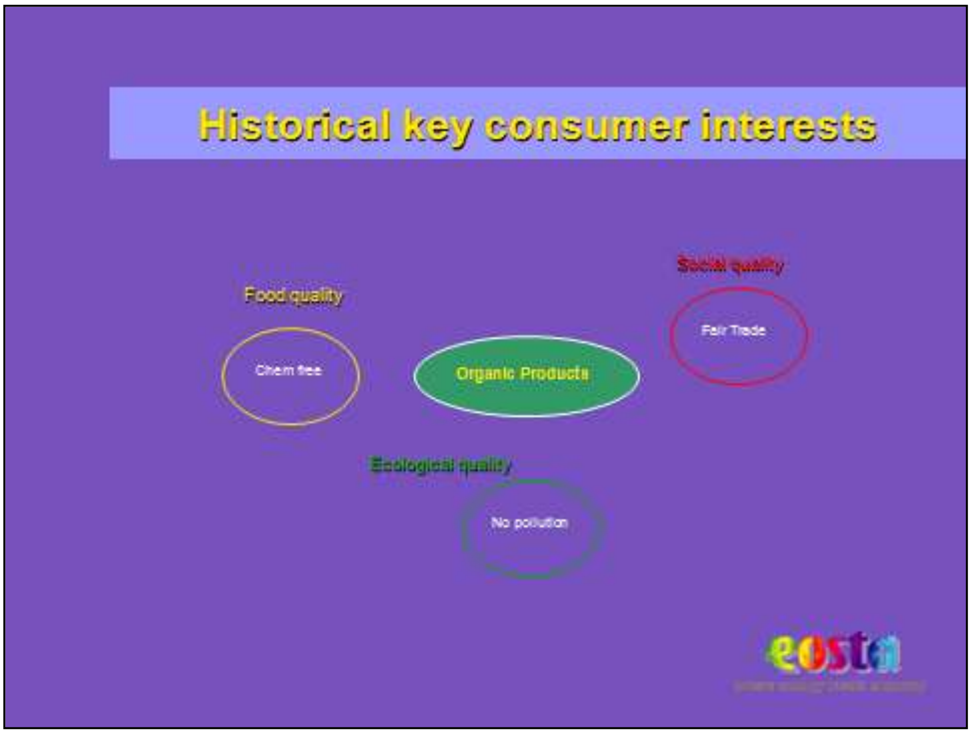

Tamás Németh— Carbon Mining ...
Thank you for your attention!


DEVIN
BOSCH

Carbon Neutral Organic Food and Farming Business

Volkert Engelsman

EOSTA, the Netherlands
Email: Volkert.Engelsman@eosta.com



Historical key consumer interests
Food quality
Chem free
Organic Products
Social quality
Fair Trade
Ecological quality
No pollution
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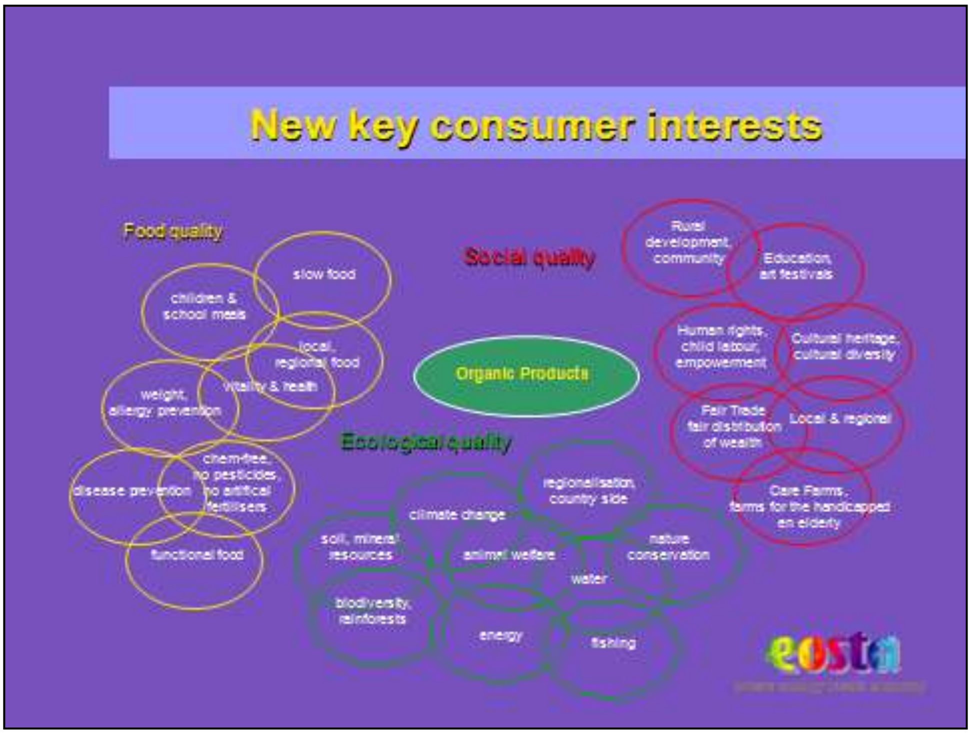

New key consumer interests
Food quality
slow food
children &
school meals
local,
regional food
vitality & health
weight,
allergy prevention
chem-free,
no pesticides,
no artifical
fertilisers
disease prevention
functional food
Social quality
Organic Products
Rural
development,
community
Education,
art festivals
Human rights,
child labour,
empowerment
Cultural heritage,
cultural diversity
Fair Trade
fair distribution
of wealth
Local & regional
Care Farms,
farms for the handicapped
en elderly
Ecological quality
regionalisation,
country side
climate change
soil, mineral
resources
animal welfare
nature
conservation
water
biodiversity,
rainforests
energy
fishing
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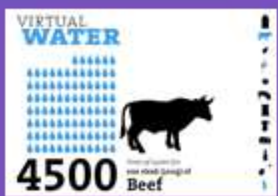
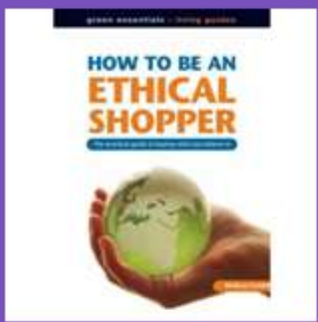
Changing consumer expectations

Changing consumer expectations



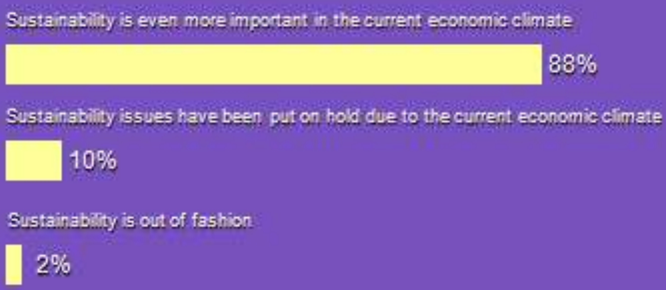
Changing consumer expectations

Changing consumer expectations



Sustainability Wikipedia,
a matter of time

Resilience to recession



Source: IGD Pdl, April 2009

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'Eco-Nomics'

Al Gore
"… the financial crisis and the environmental crisis originate in the same thinking mistake: *exploit today at the expense of tomorrow…*"

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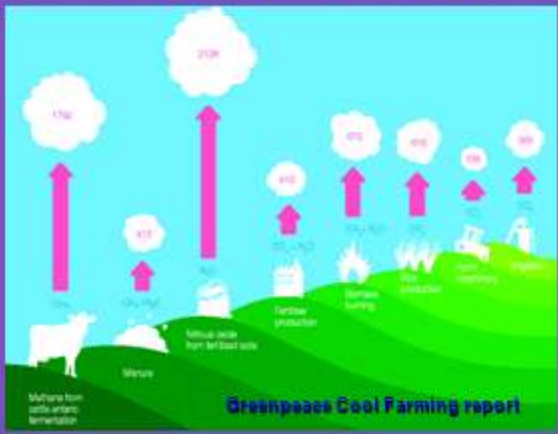
Climate Change

Agriculture with 30% second largest contributor to Green House Gas Emissions



External costs of mineral fertilizer not accounted for in costprice:

- Climate change
- Soil degradation
- Water holding capacity of the soil
- Loss of biodiversity
- Decreasing pest & disease resistance

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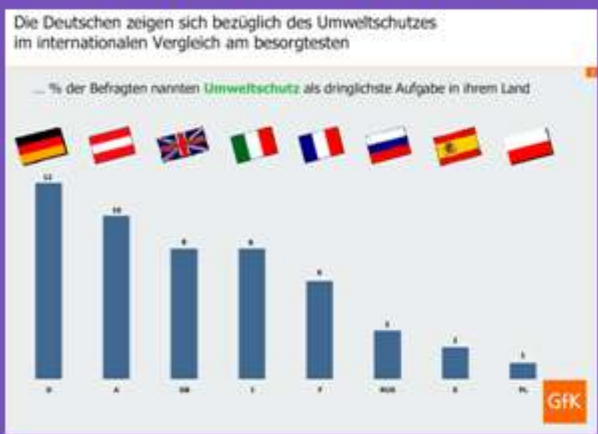
Changing consumer expectations

12% of all Germans consider climate change as *the* most urgent issue



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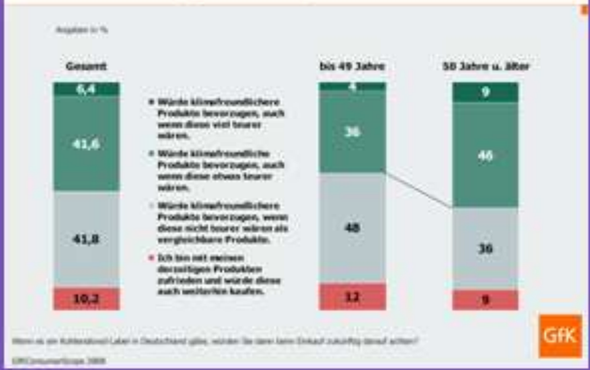
Changing consumer expectations

Almost every second German would pay a premium for climate friendly products

Ein Aufpreis für klimafreundliche Produkte wird von fast jedem zweiten Verbraucher gedanklich akzeptiert -



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EU policy response

Subsidy schemes shifting from price support to multifunctional added value

Food Safety

Food Safety, Food Security, Health,
Traceability & Transparency, Consumer Protection

'Green and Blue' Services

Clean soils, waste, recycling, water, air, emission reduction,
biodiversity, animal welfare, nature conservation, country side

Rural Development

Regional Integration, Community,
Care Farms, Cultural Heritage, Landscaping

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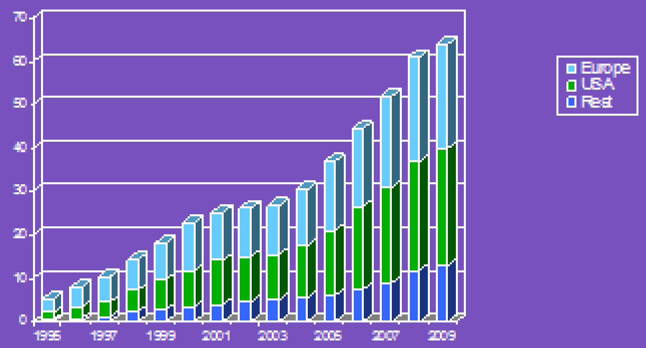
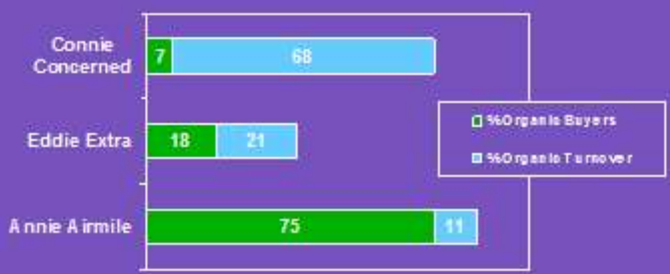
Global organic market in US$ billion



Source: IFOAM Market Data 2008

Who is driving trend



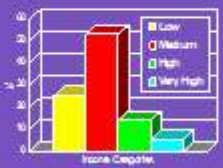
Source: TNS 52 w/e May 2008. Segmentation based on CMA data

Beyond Organic

- Age between 20 and 85
- Females
- Families with young children
- Educated
- Concerned
- Urban
- Cosmopolitan
- Recession resilient

Potential 20-25% of society

- Civil Society
- LOHAS
- Moral Hedonists
- Urban Regionalists
- Cultural Creatives
- Innovaters & early adapters
- Trend setters
- Opinion leaders

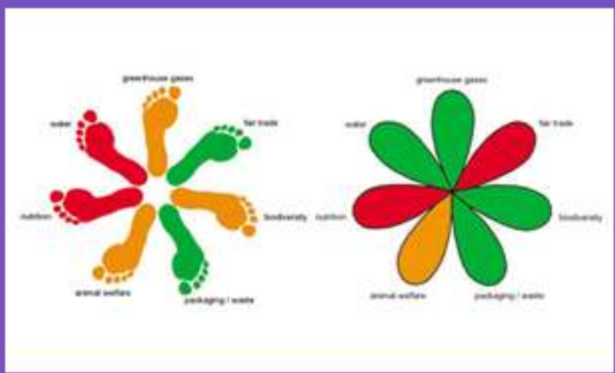


Majority medium income:
awareness elite, no economic elite

Source: CMA 2008

Multi value communication

In anticipation of the sustainability Wikipedia…



Multi value communication

Re-grouping social and environmental Key Performance Indicators

Social Footprint:

- Personal development and culture — Freedom
- Community and equal opportunities — Justice
- Fair distribution of wealth — Solidarity

Environmental Footprint:

- Soil, mineral resources, waste — Earth
- Water resources — Water
- Biodiversity
- Clean air, CO2 — Air
- Animal welfare
- Energy — Fire

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Sustainability Flower

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Sustainability Flower

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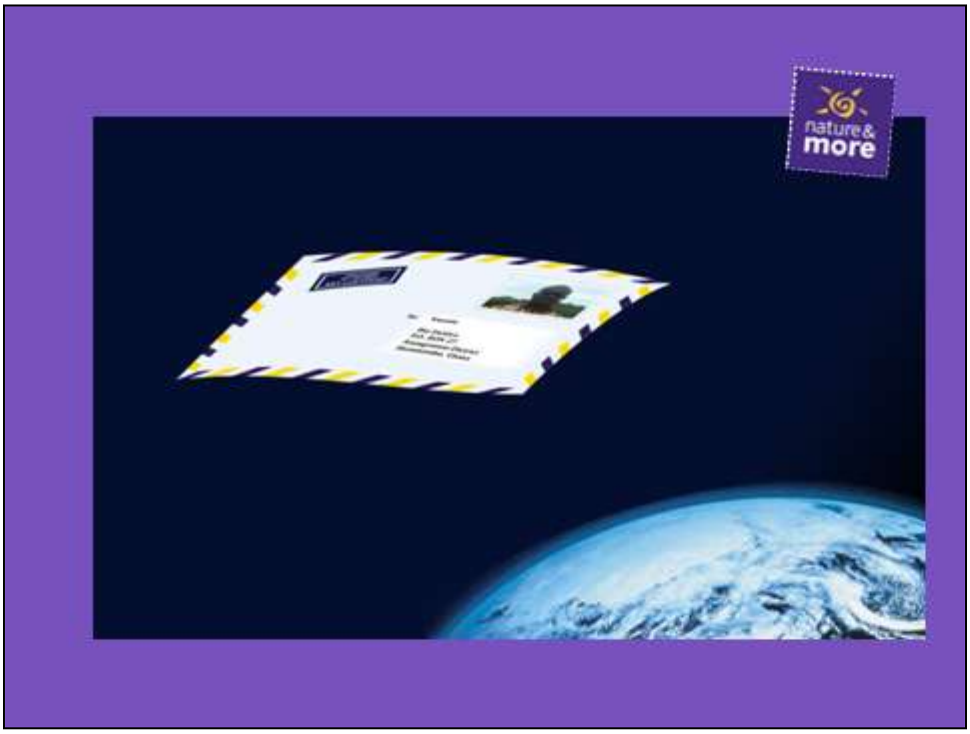
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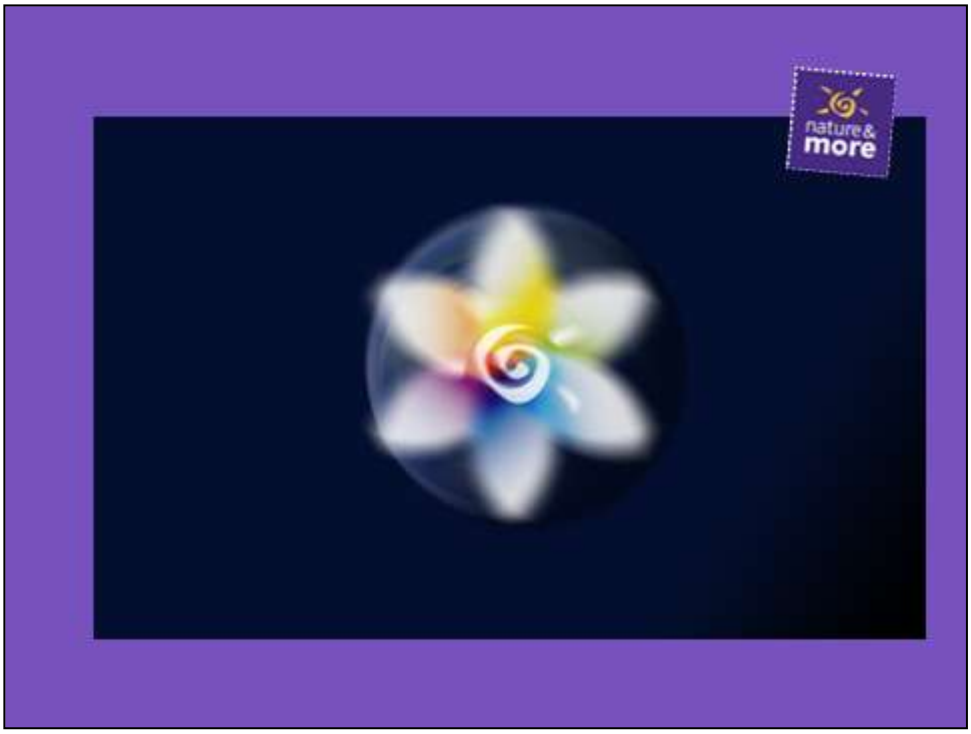
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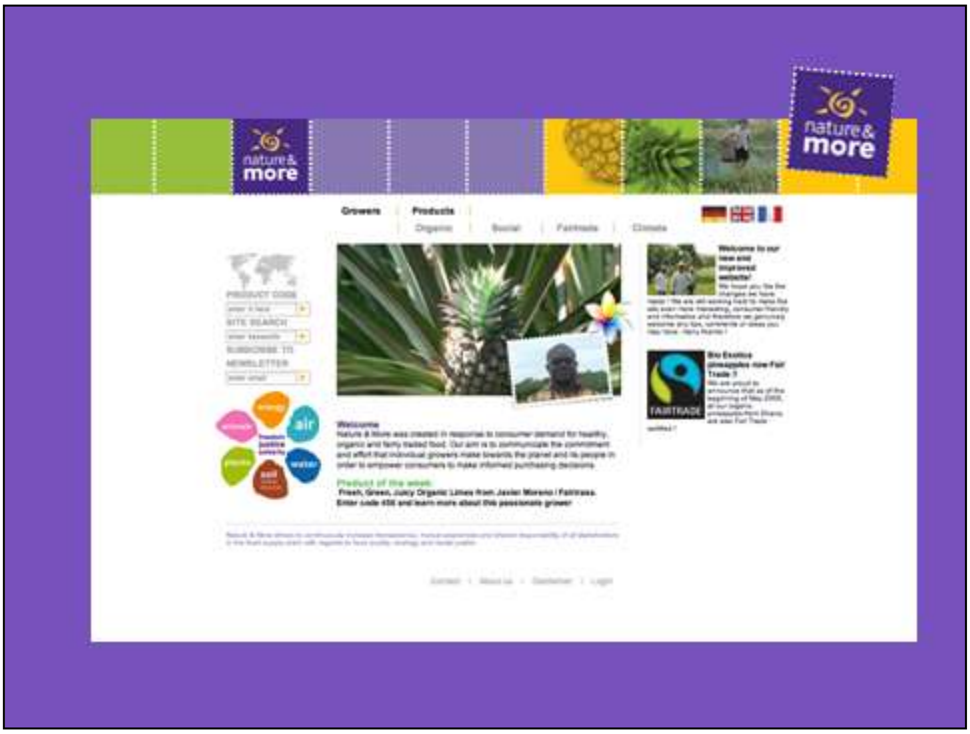
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Check his carbon footprint…
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Climate Neutral Fruit
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Full Product Cycle Assessment
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- Methane gas avoidance
- Nitrous Oxide gas avoidance
- Carbon sequestration

Verified Emission Rights issued by Kyoto Protocol designated authority

TÜV certified climate neutral labelling

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- Inform
- Reduce
- Compensate (with sector internal carbon credits)

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Communicate...

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…and his sustainability flower
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air
animals
freedom
justice
solidarity
plants
water
soil
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Capitalising on sustainability
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you have a unique story to tell !
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The Lessons of the Loess Plateau: Fighting Climate Change in China

John Liu

Earth's Hope, the USA
Email: johnliu@eempc.org

For more information and the video on the Loess Plateau please visit the Web site:
www.earthshope.org/

List of participants

country	name	position / title	organisation / company
Afghanistan	Mr. Barakatullah Rahmati	Chief Executive Officer	Afghan Red Gold Company, Heart
Afghanistan	Mr. Naiqbullah Salik	Horticulture Coordinator	HLp, Kabul
Afghanistan	Mr. Noor Akbari	Project Coordinator	Ministry of Agriculture, Kabul
Albania	Mr. Teofik Tafil Fugarinja	Executive Director	Permaculture & Organic Agriculture, Shkoder
Albania	Mr. Tom Ndoke Marku	Specialist	Permaculture & Organic Agriculture, Shkoder
Albania	Mr. Lavdosh Ferunaj	Executive Director	Organic Agriculture Association, Tirana
Albania	Mr. Ahmetaj Luan	President	AAOH Bioplant Albania, Tirana
Albania	Mr. Ali Coka	Board Member	AAOH Bioplant Albania, Tirana
Armenia	Dr. Nune Sarukhanyan	President	Green Lane Agricultural Assistance NGO, Yerevan
Armenia	Ms. Hripsime Makaryan	Agriculture Economist	Green Lane Agricultural Assistance NGO, Yerevan
Armenia	Dr. Dshkhuhi Sahakyan	Grants Manager	Environmental Survival, Yerevan
Armenia	Dr. Nune Darbinyan	President / Director	NGO Eco-Globe, Yerevan
Armenia	Nune Harutyunyan	Branch Office Director	REC Caucasus, Yerevan
Azerbaijan	Mr. Vugar Babayev	Chief of Program and Service Department	GABA (Ganja Agribusiness Association), Ganja
Azerbaijan	Mr. Elmaddin Namazov	Expert	GABA (Ganja Agribusiness Association), Ganja
Belarus	Dr. Lana Semenas	Board Member / Project Coordinator	Working Group in Organic Agriculture, NGO Ecodom, Minsk
Belarus	Ms. Iryna Sukhy	Chairperson	Ecodom, Komarovo
Bulgaria	Ms. Rumyana Todorova		Bulgarian Association of Herbs and Mushroom Gatherers
Bulgaria	Mr. Svilen Nikolov		Biohotel Moravsko Selo
Bulgaria	Ms. Ivelina Vassileva	Vice Minister	Ministry of EW
Bulgaria	Mr. Zlatanov Stojan		

country	name	position / title	organisation / company
Bulgaria	Mr. Vladislav Popov	Manager Avalon BG office	Avalon Bulgaria
Bulgaria	Ms. Ivanka Popova		Avalon Bulgaria
Bulgaria	Ms. Maryana Todorova Apostolova		ET Aposto-lov, Svilengrad
Bulgaria	Ms. Doriana Hristova Milenkova	Agricultural Assistant	Royal Netherlands Embassy, Sofia
Bulgaria	Dr. Viara Stefanova		Ministry of Agriculture and Food, Sofia
Bulgaria	Dr.Lyudmila Nikolaevna Nikolova	Scientist	Institute of Fisheries and Aquaculture, Plovdiv
Bulgaria	Ms.Zdravka Dimitrova Smilenova	Manager	Amititsa OOD, Kresna
Bulgaria	Mr. Ivan Borisov Djabirov	Member	NGO Ecosouthwest, Blagoevgrad
Bulgaria	Mr. Stoilko Nikolov Apostolov	Manager	FOA Bioselena, Karlovo
Bulgaria	Mr.Georgi Dimitrov Terziyski	Landscape Planning Portfolio Manager	Rhodope Project, Sofia
Canada	Mr. Matthew McCandless	Project Manager	International Institute for Sustainable Development, Winnipeg, Manitoba
Croatia	Ms. Sonja Koroglan Todorovic	Director	Ecologica, Zagreb
Croatia	Ms. Marija Sevar	Head of Dept. of Integrated + Organic Agriculture	Croatian Agriculture Extension Institute, Zagreb
Croatia/The Netherlands	Dr. Darko Znaor	Associated Expert	Avalon, Wommels
Croatia/The Netherlands	Prof. Branko F. M. Bosnjakovic	Member Supervisory Board	Avalon, Wommels
France	Mr. Claude Aubert	Consultant	Paris
Georgia	Dr. Kakha Tariel Nadiradze	President	Association for Farmers Rights Defense (AFRD), Tbilisi
Georgia	Ms.Tea Chitadze	Regional Office Manager	Biological Farming Association Elkana, Tbilisi
Georgia	Mr. Zurab Karbelashvili	Coordinator of Training Centre	Biological Farming Association Elkana, Tbilisi
Georgia	Ms. Mariam Jorjadze	Director	Biological Farming Association Elkana, Tbilisi
Germany	Mr. Bernhard Jansen	Chairman	EkoConnect e.V., Dresden

country	name	position / title	organisation / company
Germany	Mr. Guido Haas	General Manager	Organic AgroExpertise Consultancy, Bad Honnef
Germany	Mr. Tobias Bandel	Managing Partner	Sekem / Soil & More, Waddinxveen
Germany	Mr. Eberhard Gross	Country Manager	Weleda Group / Weleda AG , Schwäbisch Gmünd
Germany	Mr. Rainer Krell	Environment Officer	Food and Agriculture Organization, Rome
Hungary	Prof. Tamás Sándor Németh	Secretary General	Hungarian Academy of Sciences, Budapest
Italy	Dr. Riccardo Bocci	Seed Policy Expert	AIAB, Rome
Kazakhstan	Mr. Aslanbek Tulegenovich Zhakupov	Coordinator	Public Foundation of Continuous Education, Ust Kamenogorsk
Kyrgyz	Mr. Myrzabai Dooranov Bagyshevich	Director	Public Association ULGU, Kerben
Lithuania	Mr. Virgilijus Skulskis	Head of Division	Lithuanian Institute of Agrarian Economics, Vilnius
Lithuania	Ms. Zivile Gedminaite-Raudone.	Junior Researcher	Lithuanian Institute of Agrarian Economics, Vilnius
Lithuania	Mr. Aurelijus Narbutas	Director	Environmental Valuation Projects, Vilnius
Macedonia	Mr. Gordgi Hadzi-Kotarov	Executive Director	Macedonian Organic Producers Federation, Skopje
Macedonia	Mr. Goran Kolev	Member of the Management Board	Macedonian Organic Producers Federation, Skopje
Macedonia	Mr. Fidanco Hristov	President	NGO Aronija, Delcevo
Moldava	Mr. Boris Pavel Boincean	Head of Department	Selectia, Balti
Moldova	Mr. Viorel Gherciu Petru	President	NGO ProRuralInvest, Chisnau
Netherlands	Mr. Fokko Erhart		Free Nature
Netherlands	Mr. Gert J. den Hollander	Senior Project Manager	Avalon, Wommels
Netherlands	Ms. Marianne Hut	Personal Assistant	Avalon, Wommels
Netherlands	Ms. Aukje Eisma	Financial Administrative Assistant	Avalon, Wommels
Netherlands	Ms. Linda Huisman-de Jong	PR and Communications	Avalon, Wommels

country	name	position / title	organisation / company
Netherlands	Mr. Jelle Wiersma	Financial Manager	Avalon, Wommels
Netherlands	Mr. Martien Lankester	Executive Director	Avalon, Wommels
Netherlands	Mr. Nico van der Werf	Executive Director (Projects)	Avalon, Wommels
Netherlands	Ms. Tatjana Razumovsky	Network Manager	Avalon, Wommels
Netherlands	Mr. Volkert Engelsman	Chief Executive Officer	EOSTA, Waddinxveen
Netherlands	Mr. Frank Zanderink	Foreign Projects Coordinator	ARK Nature, Velp
Netherlands	Ms. Natasja Hulst	Senior Consultant	CREM, Amsterdam
Netherlands	Mr. Meindert Brouwer	Founder	Meindert Brouwer Partner in Communications, Bunnik
Netherlands	Ms. Martine van Zijl	Consultant	CREM, Amsterdam
Netherlands	Mr. Herman van Wissen	Agricultural Counsel	Royal Netherlands Embassy, Bucharest
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Netherlands	Prof. Jan Diek van Mansvelt	President	Mans \ Consultancy, Broek in Waterland
Poland	Dr. Anna Izabella Szafirowska-Waledzi	Senior Researcher	Research Institute of Vegetable Crops, Skierniewice
Poland	Dr. Irena Zofia Babik	Senior Researcher	Research Institute of Vegetable Crops, Skierniewice
Romania	Mr. Ben Mehedin		Adept Foundation
Romania	Mr. Razvan Daniel Popa	Agro-Environment Team Leader	Fundatia ADEPT Transilvania, Saschiz
Romania	Dr. Ion Toncea	President	Romanian Association for Sustainable Agriculture, Fundulea
Romania	Mr. Imre Albert	Director Executive	Organic Farming Association Of Romania Bioterra, Luna de Sus
Romania	Mr. Raluca Barbu		WWF Danube-Carpathian Programme
Russia	Ms. Iryna Bezgina	Vice-President	Agrarian Science and Practice, Poltava

country	name	position / title	organisation / company
Russia	Dr. Elena Smirnova	Deputy Director	Transparent World, Moscow
Russia	Prof. Dmitriy Kavtaradze	Head of Laboratory	Faculty of Public Administration, Moscow State University, Moscow
Russia	Ms. Alina Kolesnkova	Commercial Director	KFH IP \ Baksheev D.I., Belgorod
Switzerland	Mr. Andreas Ellenberger	Environmental Manager	Weleda AG, Arlesheim
Switzerland	Ms. Helena Ellenberger		Himmelried
Switzerland	Mr. Markus Peter Arbenz	Executive Director	IFOAM, Bonn
Turkey/U.S.A.	Ms. Gizem Altin Nance	Communications and Strategy Manager	Bugday Association, Istanbul
U.S.A.	Prof. Rattan Lal	Prof. of Soil Science, SENR Director, OARDC/FAES Former President	Carbon Management and Sequestration Center, , Soil Science Society of America, Columbus, Ohio
U.S.A.	Mr. Tokya Dammond	President	Symbio Impex Corp., Woodstock
Ukraine	Ms. Olga Viktorovna Getya	Manager of Ecological Projects	Association of Rural Development of Poltava Region, Poltava
Ukraine	Ms. Viktoriia Vasilievna Tsiupko	Scientist	Institute of Animal Science, Kharkov
Ukraine	Mr. Sergey Olegovych Shapovalov	Vice Director	Institute of Animal Science, Kharkov
United Kingdom	Ms. Kathleen Hewlett	Policy Officer	Soil Association, Bristol
United Kingdom	Dr. Mark Redman	Associated Expert	Avalon Associated Expert
United Kingdom	Mr. Robert Kynaston	Vice Chairman	NGO LEAF, Stoneleigh Park, Warwickshire
Uzbekistan	Ms. Lilya Arturovna Vakhitova	EfSD Expert	Eco-forum of NGO's of Uzbekistan, Tashkent