Reducing Global Warming:
The Potential of Organic Agriculture

Policy Brief

For a successful outcome at COP 15 in Copenhagen in December, viable policy paths for effective climate change mitigation need to be provided. In addition, adaptation is unavoidable. One key point is the integration of agriculture (accounting for 10-12% of global emissions, Smith et al. 2007) in a post-2012 agreement. Its main potential lies in its significant capacity to sequester CO_2 in soils, and in its synergies between mitigation and adaptation. This potential is best utilized employing sustainable agricultural practices such as organic agriculture (OA). Conservative estimates of the total mitigation potential of OA amount to 4.5-6.5 Gt CO_2eq/yr (of ca. 50 Gt CO_2eq total global greenhouse gas emissions). Depending on agricultural management practices, much higher amounts seem however possible.

Organic agriculture complements emission reduction efforts with its major sequestration potential, which is based on the intensive humus production (requiring CO_2) of the fertile soils. In comparison to conventional agriculture, OA also directly contributes to emission reductions as it emits less N_2O from nitrogen application (due to lower nitrogen input), less N_2O and CH_4 from biomass waste burning (as burning is avoided), and requires less energy, mainly due to zero chemical fertilizer use.[I] Its synergies between mitigation and adaptation also exert a positive influence. This in part due to the increased soil quality, which reduces vulnerability to drought periods, extreme precipitation events and waterlogging. In addition, the high diversity of crops and farming activities in organic agriculture, together with its lower input costs, reduce economic risks. OA has additional benefits beyond its direct relevance for mitigation and adaptation to climate change and climate variability, as it helps to increase food security and water protection.

In the following, key points of organic agriculture are briefly listed, together with references for detailed information. The data refer to the annual potential of a global shift of agriculture to organic practices.[II]

Mitigation

1. Increasing soil organic carbon in agricultural systems has been pointed out as an important mitigation option by the IPCC. Organic agriculture has a huge capacity in this respect: its practices further the production of soil organic matter, a process requiring CO_2, which is thus withdrawn from the atmosphere. Conservative estimates for the annual global sequestration potential of OA amount to 2.4–4 Gt CO_2eq, while other estimates point at a potential of 6.5-11.7 or even more.[III]

2. Organic agriculture has lower N_2O emissions from nitrogen application, due to lower nitrogen input than in conventional agriculture. This leads to a potential emission reduction of 1.2-1.6 Gt CO_2eq.[IV]

3. In organic agriculture, biomass is not burned. This reduces the CH_4 and N_2O emissions by ca. 0.6-0.7 Gt CO_2eq in comparison to conventional agriculture, where crop residues are often burnt on the field (Smith et al. 2007).

4. Ca. 1% of global fossil energy consumption is used for chemical nitrogen fertilizer production, emitting ca. 0.23 Gt CO_2eq. Organic agriculture avoids these emissions, as no chemical nitrogen fertilizers are used. In organic agriculture, nitrogen input stems from application of manure and compost, or is fixed from the air by leguminous plants.

5. Conventional stockless arable farms depend on the input of synthetic nitrogen fertilizers, while manure and slurry from livestock farms create additional environmental problems. For both these farm types, high emissions of CO_2, N_2O and CH_4 are likely. Organic farms prevent such problems by on-farm or cooperative use of farmyard manure between both crop and livestock operations.

6. Organic agriculture has a significant potential to cover on-farm energy use (more than 100% on test farms) by biogas production from slurry and compost.

Adaptation

7. Organic agriculture increases soil organic matter. As a result, soils in organic agriculture capture and store more water than soils of conventional cultivation. OA production is thus less prone than conventional cultivation to extreme weather conditions, such as drought, flooding, and waterlogging. Soils under organic management practices are also less prone to erosion. Organic agriculture accordingly addresses key consequences of climate change, namely increased occurrence of extreme weather events, increased water stress and drought.

8. Organic agriculture uses a higher level of diversity among crops, crop rotations and farm activities than commonly employed in conventional, industrialized agriculture, which often leads to monocultures. This improves ecological and economic stability. The diversity of income sources, as well as the resilience to cope with adverse effects of climate change is thus increased. A concrete example of the benefits: the enhanced biodiversity reduces pest outbreaks and severity of plant and animal diseases, while also improving utilization of soil nutrients and water.

9. Organic agriculture is a low-risk farming strategy based on lowering external chemical inputs and optimizing biological functioning. Besides lowering toxicity, reduced input costs make organic agriculture competitive economically. In addition, organic price premiums can be realized. These factors working together lower the financial risks and improve the rewards. They provide a type of low cost but effective insurance against crop reduction or failure.

10. Since the coping capacity of the farms is increased, the risk of indebtedness in general is lowered. Organic agriculture is thus a viable alternative for poor farmers. Risk management, risk-reduction strategies, and economic diversification to build resilience are also prominent aspects of adaptation, as mentioned in the Bali Action Plan.

11. OA has the best premises to utilize local and indigenous farmer knowledge, adaptive learning and crop development, which are seen as important sources for adaptation to climate change and variability in farming communities.

Additional Aspects

a) Organic agriculture can build on well-established practice with decades of use in various climate zones, and under a wide range of specific local conditions. There are other forms of sustainable agriculture, but due to the well-defined standardization of organic agriculture, and to its strong acceptance, we focus on this.

b) Necessary practice and knowledge for OA are thus readily available. There is no need to develop new technologies, and OA does not depend on technology transfer from the north. This is of particular importance in the context of empowerment of the most vulnerable rural population that largely lives from agriculture.

c) Financial requirements of organic agriculture, as an adaptation or mitigation strategy are low. Additional costs come from extension services, providing information, and, if certified, certification costs.

d) Critical points are training, extension services and information provision, and institutional structures, such as market access.

e) Of particular relevance are yields and food security. Doubts have been frequently expressed about the capacity of OA to produce as much as conventional agriculture. Recent research has however shown that OA, particularly in developing countries and arid regions, can have considerably higher yields than conventional agriculture (Badgley et al. 2007; Pretty et al. 2006; UNEP-UNCTAD 2008), and it is acknowledged as being able to contribute to food security (FAO 2007). In particular, organic agriculture performs better than conventional agriculture under water scarcity (Badgley et al. 2007).

f) A further benefit of organic agriculture is its role for water protection. Absence of pesticides and chemical fertilizers reduces water pollution in general, and the eutrophication of water bodies. Reduced irrigation needs, due to the better water-holding capacity of soils, increase water availability.

g) OA also increases soil quality and fertility, not only due to higher organic matter content, but also to increased soil nutrients, improved soil structure and aeration, and water availability. The biological diversity of soil microbes, insects and earthworms is increased, all of which have important roles for soil quality. By not using synthetic fertilizers, OA avoids an increase in soil acidity caused by them.

h) Finally, more research is needed, in particular to increase knowledge on the sequestration potential for different crops, soil types, management practices and climate conditions, and on the adaptability of plants to environmental stress.

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Notes

I Energy use in OA is 20-30% (crop farms: based on corn and soy beans) to 50% (livestock: organic grass-fed beef vs. conventional grain-fed beef) lower than in conventional agriculture (Pimentel 2006, Pimentel et al. 2005).

II The following is based mainly on Niggli et al. 2007, 2009 and Muller 2009. Further specific references can be found in those papers. Details of the calculations are available on request from the authors (A. Muller, adrian.mueller@soi.uzh.ch).

III The conservative estimate for sequestration uses rates of 100 kg C/ha/yr on pastures and 200 kg C/ha/yr on arable land and permanent cropland. With 100 kg C/ha/yr on pastures, 500 kg C/ha/yr on arable land and 200 kg C/ha/yr on permanent cropland a higher value of 4 Gt CO_2eq is realized (Niggli et al. 2009). The estimate of 6.5 Gt CO_2eq is based on a sequestration rate of 1000 kg/ha/yr on arable land (based on cover cropping, Hepperly et al. 2007) and 11.7 Gt CO_2eq is based on a rate of 2000 kg C/ha/yr on arable land (employing composting, Hepperly et al. 2009). Recent research indicates that even much higher sequestration rates can be realized when crop and pasture systems are combined (Hepperly and LaSalle, 2009: Pasture, Range, and Cropland - Keys to Greenhouse Gas Management, Rodale Institute).

IV The estimates of N_2O reduction potential are based on N_2O contributing 38% of total agricultural non-CO_2 emissions (Smith et al. 2007), the fact that of all nitrogen applied to the soil 1-2% are emitted as N_2O, and the fact that OA uses 60 to 70% less nitrogen input than conventional agriculture (Niggli et al. 2009).

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