

Organic Farming: As a Climate Change Adaptation and Mitigation Strategy

SARTAJ A. WANI¹, SUBHASH CHAND², G.R. NAJAR and M.A. TELI

Division of Soil Science, Sher-e-Kashmir University of Agricultural Sciences and Technology-Shalimar, Srinagar, Kashmir - 1900 031, India.

(Received: June 24, 2013; Accepted: July 16, 2013)

ABSTRACT

Organic farming, as an adaptation strategy to climate change and variability, is a concrete and sustainable option and has additional potential as a mitigation strategy. The careful management of nutrients and carbon sequestration in soils are significant contributors in adaptation and mitigation to climate change and variability in several climate zones and under a wide range of specific local conditions. Organic farming as a systematic approach for sustained biological diversity and climate change adaptation through production management, minimizing energy randomisation of non-renewable resources; and carbon sequestration is a viable alternative. The purpose of potential organic farming is therefore to attempt a gradual reversal of the effects of climate change for building resilience and overall sustainability by addressing the key issues. Research is needed on yields and institutional environment for organic farming, as a mitigation and sequestration potential.

Key words: Adaptation, Climate Change, Mitigation, Organic farming, Sustainable .

INTRODUCTION

Codex Alimentarius Commission (FAO/WHO) defines "Organic farming as holistic food production management system, which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological and mechanical methods, as opposed to using synthetic materials, to fulfil any specific function within the system". Organic farming is not only a specific agricultural production system, it is also a systemic and encompassing approach to sustainable livelihoods in general, where due account is given to relevant factors of influence for sustainable development and vulnerability, be this on physical, economic, or socio-cultural levels (Eyhorn, 2007). Organic farming has a long tradition as a farming system and it has been adapted for many climate zones and local conditions; as a result, much and

detailed situation-specific information on organic farming is available.

According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), greenhouse gas (GHG) emissions from the agricultural sector account for 10–12% or 5.1–6.1 Gt of the total anthropogenic annual emissions of CO₂-equivalent. However, this accounting includes only direct agricultural emissions; emissions due to the production of agricultural inputs such as nitrogen fertilizers, synthetic pesticides and fossil fuels used for agricultural machinery and irrigation are not calculated (IPCC 2007).

In general climate is one of the main determinants of agricultural production and climate alteration might cause variability in agricultural production. As climate pattern shifts, changes in the distribution of plant diseases and pests may also have adverse effects on agriculture. At the same time, agriculture proved to be one of the most adaptable human activities to varied climate

conditions (Mendelson *et al.*, 2001). It should be necessarily mentioned that refraining from the use of synthetic inputs does not qualify an operation as organic, as far as it is not accompanied by a proper farm design and management that preserves natural resources from degradation.

The Fourth Assessment Report of the IPCC (Inter-governmental Panel on Climate Change) states that "a wide array of adaptation options is available, but more extensive adaptation than is currently occurring is required to reduce vulnerability to future climate change. There are barriers, limits, and costs, but these are not fully understood" (IPCC 2007). The Bali Action Plan from the UN Climate Change conference in Bali in 2007

(UNFCCC 2007) clearly emphasizes the importance of enhanced action on adaptation. Organic farming has an inherent potential to both reduce GHG emissions and to enhance carbon sequestration in the soil. (Table 1). However, the adaptation aspects of organic agricultural practices must be the focus of public policies and research. One of the main effects of climate change is an increase of uncertainties, both for weather events and global food markets. Organic agriculture has a strong potential for building resilience in the face of climate variability. Organic farming addresses many of the key challenges identified for adaptation to climate change and variability and it fulfils many of the criteria, which are seen as important general UN Millennium Development Organic farming.

Table 1: Adaptation potential of organic agriculture

Objective	Means	Impact
Alternative to industrial production input (i.e., mineral fertilizers and agrochemicals) to decrease pollution	Improvement of natural resources processes and environmental services (e.g., soil formation, predation)	Reliance on local & independence from volatile prices of agricultural inputs
Landscaping	Creation of micro-habitats (e.g., hedges), permanent vegetative cover & wildlife corridors	Enhanced ecosystem balanced (e.g., pests, prevention), protection of wild biodiversity and better resistance to wind and heat waves
Soil fertility	Nutrient management (e.g., rotations, coralling, cover crops and manuring)	Increased yields, enhanced soil water retention/drainage (better response to droughts and floods), decreased irrigation needs and avoided land degradation

Benefits of organic farming

- | | |
|--|---|
| 1. Recycling wastes of plant and animal origin in order to return nutrients to the land, thus minimizing the use of non-renewable resources; | 5. Maintains long-term soil fertility and overcome micronutrient deficiency. |
| 2. Reduce global warming by lowering emission of greenhouse gases hence temperature rise; | 6. Reduce energy loss for both animal and machine, and risk of crop failure. |
| 3. Enhances biological diversity within the whole system and increase soil biological activity | 7. Promote the healthy use of soil, water, and air, as well as minimize all forms of gaseous pollution that may result from agricultural practices. |
| 4. Minimizes indiscriminate use of pesticides | 8. Highly adaptive to climatic change due to |
- affects on human and animal health, biodiversity of wildlife etc. & cause of environmental pollution.

application of traditional skills, farmers knowledge, soil fertility building techniques and a high degree of diversity.

Challenges addressed

The main organic strategies are diversification and an increase of soil organic matter, which both could enhance resilience against extreme weather events. Organic farming avoids nutrient exploitation and increases soil organic matter content, hence soils under organic farming capture and store more water than soils under conventional cultivation. Production in organic farming systems is thus less prone to extreme weather conditions, such as drought, flooding, and water logging. Organic farming accordingly addresses key consequences of climate change, namely increased occurrence of extreme weather events, increased water stress and drought, and

problems related to soil quality (IPCC 2007a).

- Organic farming comprises highly diverse farming systems and thus increases the diversity of income sources and the flexibility to cope with adverse effects of climate change and variability, such as changed rainfall patterns. This leads to higher economic and ecological stability through optimized ecological balance and risk-spreading.
- Organic farming is a low-risk farming strategy with reduced input costs, therefore, lower risks with partial or total crop failure due to extreme weather events or changed conditions in the wake of climate change and variability (Eyhorn 2007). As such, it is a viable alternative for poor farmers. In addition, higher prices can be realized for the products via organic certification. Higher

Table 2: Mitigation potential of organic agriculture

Source of GHG	Share of total anthropogenic	Impacts of optimized organic management	Remarks GHG emissions
Direct emissions from agriculture	10–12%		
N ₂ O from soils	4.2%	Reduction	Higher nitrogen use efficiency
CH ₄ from enteric fermentation	3.5%	Opposed effects performance and	Increased by lower energy concentration in the diet but reduced by lower replacement rate and multi-use breeds
Biomass burning	1.3%	Reduction	Burning avoided According to organic standards
Paddy rice	1.2%	Opposed effects	Increased by organic amendments but lowe red by drainage and aquatic weeds
Manure handling	0.8%	Equal	Reduced methane emissions but no effect on N ₂ O emissions
Direct emissions from forest clearing for agriculture	12%	Reduction	Clearing of primary ecosystems restricted
Indirect emissions			
Mineral fertilizers	1%	Totally avoided	Prohibited use of mineral fertilizers
Food chain	?	(Reduction)	Inherent energy saving but still inefficient distribution systems
Carbon sequestration			
Arable lands		Enhanced	Increased soil organic matter
Grasslands		Enhanced	Increased soil organic matter

farm incomes are thus possible due to lower input costs and higher sale prices. The coping capacity of the farms is increased and the risk of indebtedness is lowered. Risk management, risk-reduction strategies, and economic diversification to build resilience are also prominent aspects of adaptation, as mentioned in the Bali Action Plan (UNFCCC 2007).

- Crops and crop varieties used in organic farming are usually well adapted to the local environment. Local effects of climate variability cannot be foreseen in detail because, on the local level, climate change models are not very accurate or even available. Adaptation thus may utilize measures that build on self-adaptive capacity, such as local crop-breeding. The systemic character (on farm breeding, etc.) of organic farming is especially adequate to provide such.
- By its nature, organic farming is an adaptation strategy that can be targeted at improving the livelihoods of rural populations and those parts of societies that are especially vulnerable to the adverse effects of climate change and variability—for example, the rural population in sub-Saharan Africa; and improvements via reduced financial risk, reduced indebtedness, and increased diversity (Eyhorn 2007).
- By its systemic character, Organic farming is an integrative approach to adaptation, with potential also to work toward the United Nations Millennium Development goals, (“eradicate extreme poverty”) and (“ensure environmental sustainability”). The pivotal role organic farming plays in achievement of these and the challenges climate change poses to this task are widely acknowledged.

The IPCC estimates that the reduction in the options of agricultural GHG mitigation is cost-competitive with non-agricultural options for achieving long-term climate objectives. However, the total amount of mitigation is difficult to quantify, because it is highly dependent on local environmental conditions and management practices. A win-win approach could be achieved

by paying farmers for carbon sequestration (building organic matter), which sets up a scenario where CO₂ is removed from the atmosphere (mitigation) higher organic matter levels in soil increase the agro-ecosystem residence (adaptation) and improved soil fertility leads to better yields (production and income generation). The adaptive approach inherent to organic farming offers simultaneous climate mitigation benefits. Organic agriculture has a strong potential for building resilience in the face of climate variability (Table 2).

Organic farming as a mitigation strategy may address both emissions avoidance and carbon sequestration. The first is achieved through:

- Lower N₂O emissions (due to lower nitrogen input)—it is usually assumed that 1–2 percent of the nitrogen applied to farming systems is emitted as N₂O, irrespective of the form of the nitrogen input. The default value currently used by the IPCC is 1.25 percent, but newer research finds considerably lower values, such as for semi-arid areas (Barton *et al.* 2008).
- Less CO₂ emissions through erosion (due to better soil structure and more plant cover)—there usually is less erosion in organic farming systems than in conventional ones.
- Lower CO₂ emissions from farming system inputs (pesticides and fertilizers produced using fossil fuel).

The highest mitigation potential of organic farming lies in carbon sequestration in soils and in reduced clearing of primary ecosystems. Soil carbon sequestration is used to describe both natural and deliberate processes by which CO₂ is either removed from the atmosphere or diverted from emission sources and stored in the oceans, terrestrial environments (vegetation, soils and sediments). It is greatly enhanced through agricultural management practices (such as increased application of organic manures, conservation tillage, cover crops, nutrient management, irrigation, restoring degraded soils, pasture management, soil use of intercrops and green manures, higher shares of perennial grasslands and trees or hedges, etc.), which

promote greater soil organic matter content and improve soil structure (Niggli *et al.*, 2008). Increasing soil organic carbon in agricultural systems has also been pointed out as an important mitigation option by IPCC (2007b). The global carbon sequestration potential by improved pasture management practices was calculated to be 0.22 t C per ha per year. Assuming 0.2 t C per ha per year for organic farming practices, the total carbon sequestration potential of the world's grassland would be 1.4 Gt per year at the current state, which is equivalent to about 25% of the annual GHG emissions from agriculture (FAOSTAT, 2009).

However, sequestration of CO₂ in soils is not included in the clean development mechanism (CDM) agreed to in Kyoto protocol. The FAO should play a leading role in this process, including the establishment of this process, including the establishment of a global soil carbon sequestration initiative, entrusted with the promotion of agricultural technologies that restore carbon pools and soil quality (*e.g.* organic agriculture, conservation agriculture) and to create tools to measure, monitor and verify soil-carbon pools and fluxes of green house gas emissions (*viz.* nitrous oxide) from agricultural soils, including crop lands and pastures.

of the Division Soil science of SKUAST- Kashmir for providing the necessary facilities and moral support to carry out the work.

REFERENCES

1. Barton, L., R. Kiese, D. Gatter, K. Butterbach-Bahl, R. Buck, C. Hinz, and D. Murphy., "Nitrous Oxide Emissions from a Cropped Soil in a Semi-arid Climate," *Global Change Biology* **14**: 177–92 (2008).
2. Eyhorn, F. 2007. "Organic Farming for Sustainable Livelihoods in Developing Countries: The Case of Cotton in India." PhD diss. Department of Philosophy and Science, University of Bonn. http://www.zb.unibe.ch/download/eldiss/06eyhorn_f.pdf. HYPERLINK "http://www.zb.unibe.ch/download/eldiss/06eyhorn_f.pdf.%20Accessed%20February%2012" Accessed February 12, 2009.
3. Eyhorn, F., R. Ramakrishnan, and P. Mäder.,

CONCLUSION

Although remarkable, organic farming several critical issues remain to be resolved. To begin with, there is a need for more research. Recent research invalidates this prejudice, especially in the context of extensive farming systems, which characterize much of agricultural production in developing countries like India. Further research on this is, however, still needed. Currently the easy access to and increased development of local markets for the products, local processing possibilities, and export infrastructure are of particular importance for organic farming. For this, the role of international institutions and trade policies has to be discussed in context of organic farming. The institutional environment for organic farming as an adaptation and mitigation strategy also has to be identified, in particular, on a global level. To be successful, wider recognition of the potential of organic farming is needed among bodies that currently mainly promote pure conventional agriculture.

ACKNOWLEDGEMENTS

The authors feel privileged to thank the Vice Chancellor, DRI, Director Research and Head

"The Viability of Cotton-Based Organic Farming Systems in India," *International Journal of Agricultural Sustainability* **5**(1): 25–38 (2007).

4. FAO (Food and Agriculture Organization),. Online website and documents. "International Conference on Organic Agriculture and Food Security," Rome, May 3–5, 2007. http://www.fao.org/organicag/ofs/index_en.htm. Accessed February 12, 2009. See also, in general, <http://www.fao.org/organicag> (2007)
5. FAOSTAT., FAO Statistical Database Domain on Fertilizers: Resource STAT-Fertilizers. Food and Agriculture Organisation of the United Nations (FAO) Rome, Italy. Available at Web site <http://faostat.fao.org/site/575/default.aspx#anchor> (accessed 7 October 2009) (2009).

6. IFOAM (International Federation for Organic Agriculture Movements)., "Mitigation and Adaptation to Climate Change: The Role of Organic Agriculture." IFOAM side event to the 24th Session of the Subsidiary Bodies, Bonn, Germany, May 24, 2006 (2006).
7. IPCC (Intergovernmental Panel on Climate Change)., "Summary for Policy Makers." In *IPCC Fourth Assessment Report*, "Working Group II Report: Impacts, Adaptation, and Vulnerability." See specifically on adaptation, chapter 17; on inter-relationships between adaptation and mitigation, chapter 18; on vulnerability, chapter 19 (2007a).
8. IPCC. 2007. Synthesis report. In O.R.D. Metz, P.R. Bosch, R. Dave, and L.A. Meyer (eds). *Fourth Assessment Report: Climate Change* Cambridge University Press, Cambridge, UK (2007).
9. IPCC, *Climate Change 2007b: Synthesis Report*. United Nations Environment Programme, Ch5, 8, and 10 (2007).
10. Barton, L., R. Kiese, D. Gatter, K. Butterbach-Bahl, R. Buck, C. Hinz, and D. Murphy., "Nitrous Oxide Emissions from a Cropped Soil in a Semi-arid Climate," *Global Change Biology* **14**: 177-92 (2008)
11. Mendelson, Robert., Dinar, Ariel. And Sanghi, Apurva., The Effect of Development on the climate sensitivity Of Agriculture. *Environment and Development Economics*, **6**: 85-101 (2001).
12. Niggli, U., A. Fließbach, P. Hepperly, and N. Scialabba., "Low Greenhouse Gas Agriculture: Mitigation and Adaptation Potential of Sustainable Farming Systems." Rome: FAO (2008).
13. UNFCCC (United Nations Framework Convention on Climate Change)., Online document. "The Bali Action Plan, United Nations Framework Convention on Climate Change." http://unfccc.int/files/meetings/cop_13/application/pdf/cop_bali_action.pdf. Accessed February 12, 2009.