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Full Length Research Paper

Organic farming: As a climate change adaptation and mitigation strategy

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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 randomization 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 fulfill 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 CO_2-equivalent. However, this 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

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Table 1. Adaptation potential of organic agriculture.

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

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.

BENEFITS OF ORGANIC FARMING

The benefits of organic farming are as follows:

1. Recycling wastes of plant and animal origin in order to return nutrients to the land, thus, minimizing the use of non-renewable resources.
2. Reduce global warming by lowering emission of greenhouse gases hence temperature rise.
3. Enhances biological diversity within the whole system and increase soil biological activity.
4. Minimizes indiscriminate use of pesticides, affects human and animal health, biodiversity of wildlife and cause environmental pollution.
5. Maintains long-term soil fertility and overcome micronutrient deficiency.
6. Reduce energy loss for both animal and machine, and risk of crop failure.
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.
8. Highly adaptive to climatic change due to application of traditional skills, farmer’s 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):

1. 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

Table 2. Mitigation potential of organic agriculture.

Source of GHG	Share of total anthropogenic GHG emissions (%)	Impacts of optimized organic management	Remarks
Direct emissions from agriculture	10-12	-	-
N_2O from soils	4.2	Reduction	Higher nitrogen use efficiency
CH_4 from enteric fermentation	3.5	Opposed effects	Increased by lower performance and 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 lowered by drainage and aquatic weeds
Manure handling	0.8	Equal	Reduced methane emissions but no effect on N_2O 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

optimized ecological balance and risk-spreading.

2. 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 through organic certification. Higher 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 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):

1. 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.
2. 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 through reduced financial risk, reduced indebtedness, and increased diversity (Eyhorn, 2007).
3. 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 CO_2 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 N_2O emissions (due to lower nitrogen input), it is usually assumed that 1 to 2% of the nitrogen applied to farming systems is emitted as N_2O, irrespective of the form of the nitrogen input. The default value currently used by the IPCC is 1.25%, but newer research finds considerably lower values, such as for semi-arid areas (Barton et al., 2008).
- Less CO_2 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 CO_2 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 CO_2 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 CO_2 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 (for example, organic agriculture, conservation agriculture) and to create tools to measure, monitor and verify soil-carbon pools and fluxes of greenhouse gas emissions (namely, nitrous oxide) from agricultural soils, including crop lands and pastures.

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.

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