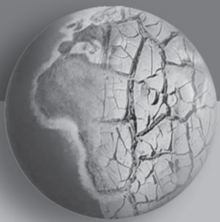

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The Case for Sustainable Agriculture: Meeting Productivity and Climate Challenges

Lim Li Ching

TWN
Third World Network

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Chapter One

INTRODUCTION

THE challenges facing agriculture today are immense. Of immediate concern is the global increase in food prices, starkly brought home by reports of food riots and food shortages in many countries around the world. During the first three months of 2008, international nominal prices of all major food commodities reached their highest levels in nearly 50 years while prices in real terms were the highest in nearly 30 years (FAO, 2008).

While the United Nations Food and Agriculture Organisation (FAO)'s food price index[1] rose, on average, 8% in 2006 compared with the previous year, it increased by 24% in 2007 compared to 2006. The increase in the average of the index for the first three months of 2008 compared to the same three months in 2007 was 53%. The continuing surge in prices is led by vegetable oils, which on average increased by more than 97% during the same period, followed by grains with 87%, dairy products with 58% and rice with 46%. The FAO estimates that the number of hungry people increased by about 50 million in 2007 as a result of soaring food prices.

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1 The FAO food price index is a trade-weighted Laspeyres index of international quotations expressed in US dollar prices for 55 food commodities.

In addition, the challenges of climate change are increasingly urgent. The Intergovernmental Panel on Climate Change makes it clear that warming of the climate system is ‘unequivocal’, as observations of increases in air and ocean temperatures, widespread melting of snow and ice, and sea-level rise have made evident (IPCC, 2007). Agriculture will therefore have to cope with increased climate variability and more extreme weather events.

Climate change, coincident with increasing demand for food, feed, fibre and fuel, has the potential to irreversibly damage the natural resource base on which agriculture depends, with significant consequences for food insecurity (IAASTD, 2008). The relationship between climate change and agriculture is two-way; agriculture contributes to climate change in several major ways and climate change in general adversely affects agriculture.

Agriculture is thus at a crossroads. It has to find ways to feed the world while being environmentally, socially and economically sustainable. Yet, it is increasingly clear that the path that agriculture has been on is not sustainable, nor can it feed the world without destroying the planet (IAASTD, 2008). With the spotlight once more on agriculture, and with many critical issues that need resolving, finding the answer to the question of the nature of agricultural development required has never been more pressing.

Chapter Two

'BUSINESS AS USUAL IS NO LONGER AN OPTION'

THE International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) is the most rigorous and comprehensive assessment of agriculture to date. Co-sponsored by the World Bank, FAO, UN Environment Programme (UNEP), UN Development Programme (UNDP), World Health Organisation (WHO), UN Educational, Scientific and Cultural Organisation (UNESCO) and Global Environment Facility (GEF), its report clearly concluded that a radical change is needed in agricultural policy and practice, in order to address hunger and poverty, social inequities and environmental sustainability (IAASTD, 2008).

The report's central message is that the business-as-usual scenario of industrial farming, input and energy intensiveness, collateral damage to the environment and marginalisation of small-scale farmers is no longer tenable. While past emphasis on production and yields had brought benefits, such as afforded under the Green Revolution, this was at tremendous cost to the environment and social equity.

The Green Revolution drove widespread shifts in the agricultural sector from subsistence and low-external-input agriculture to monocropping with high-yielding varieties (HYVs). This agricultural paradigm required the adoption of a 'package' of inputs, including irrigation, chemical pesticides and fertilisers, and hybrid seeds bred for disease resistance and high yield. Participating farmers often had access to credit and agro-processing facilities, transport and roads, machinery, marketing infrastructure and government price supports.

By the 1970s, Green Revolution-style farming had replaced the traditional farming practices of millions of developing-country farmers. By the 1990s, almost 75% of Asian rice areas were sown with these new varieties. Overall, it is estimated that 40% of all farmers in developing countries were using Green Revolution seeds by this time, with the greatest use found in Asia, followed by Latin America (Rosset et al., 2000; Shiva, 1991).

The rapid spread of Green Revolution agriculture throughout most countries of the South was accompanied by a rapid rise in pesticide use (Rosset et al., 2000). This was because the HYVs were more susceptible to pest outbreaks. Promising increases of yield were thus offset by rising costs associated with increased use of chemical inputs. In the Central Plains of Thailand, yields went up only 6.5%, while fertiliser use rose 24% and pesticide use jumped by 53%. In West Java, profits associated with a 23% yield increase were virtually cancelled out by 65% and 69% increases in fertilisers and pesticides respectively (Rosset et al., 2000).

Synthetic fertilisers, pesticides and herbicides are made from non-renewable raw materials such as mineral oil and natural gas or from minerals that are depleting such as phosphate and potassium. As the price of petroleum increases, so does the cost of external inputs and machinery, forcing small farmers who are dependent on these inputs into debt. The production of agrochemicals is also an important source of greenhouse gas (GHG) emissions. In particular, fertiliser production is energy-intensive, accounting for 0.6-1.2% of the world's total GHGs (Bellarby et al., 2008). Industrial, chemical-intensive agriculture has also degraded soils and destroyed resources that are critical to storing carbon, such as forests and other vegetation.

The rise in use of chemical inputs has also had adverse environmental and health impacts on farmworkers and consumers. A substantial portion of pesticide residues ends up in the environment, causing pollution and biodiversity decline (Znaor et al., 2005). The extensive use of pesticides has also resulted in pesticide resistance in pests and adverse effects on beneficial natural predators and parasites (Pimentel, 2005).

The Green Revolution also brought about a shift from diversity to monocultures. When farmers opted to plant Green Revolution crop varieties and raise new breeds of livestock, many traditional local varieties were abandoned and became extinct. And yet, maintaining agricultural biodiversity is vital to long-term food security as it is vital insurance against crop and livestock disease outbreaks and improves the long-term resilience of rural livelihoods to adverse trends or shocks (Pimbert, 1999).

Other costs of the Green Revolution, often underestimated, included the financial costs of building huge dams for irrigation, the financial costs of the energy required in the construction and operation of such projects, the health costs of a steadily affected population due to chemical contamination of food, the costs involved in soil losses from increasingly degraded soils, genetic erosion and the draining of groundwater aquifers (Alvares, 1996). Green Revolution farming systems also required substantial irrigation, putting further strain on the world's limited water resources.

Traditionally, local farming communities were close-knit as seeds and farming knowledge were shared freely. The Green Revolution seeds, however, were hybrids, for which seed saving is undesirable, as the seed from the first generation of hybrid plants does not reliably produce true copies. Therefore, new seed must be purchased for each planting and this meant that farmers were no longer preserving and storing seeds for the next planting season. This trend not only incurs extra costs for the farmers but has an impact on social cohesiveness too (Sangaralingam, 2006).

Productivity declines: Rice as a case study

In recent years, the biggest claims of success of the Green Revolution model, its productivity gains, have not been easy to sustain and, in some cases, have become exhausted. This is best illustrated by the yield trends from long-term trials conducted on experiment stations, such as the long-term continuous cropping experiment conducted by the International Rice Research Institute (IRRI). The objective is to monitor maximum yields obtained over time, holding input levels and crop management practices constant. The trends indicate that, even with the best available cultivars and scientific management, rice yields, holding input levels constant, decline over the long term (Pingali et al., 1997; FAO, 2001).

At the farm level, declining yield trends are usually not observed since input levels are not held constant over time. However, in areas where intensive rice monoculture has been practised over the past two to three decades, stagnant yields and/or declining trends in partial factor productivities, especially for fertilisers, and declining trends in total factor productivities have been observed. Moreover, the rate of deceleration in yields is higher for countries with higher cropping intensities (Pingali et al., 1997).

Farm-level evidence from the rice bowls of Asia thus indicates that intensive rice monoculture systems lead, over the long term, to declining productivities of inputs (Pingali et al., 1997). Over time, farmers have been found to use increasing amounts of inputs to sustain the yield gains made during the Green Revolution years.

Intensive rice monoculture on the lowlands results in the following changes: (i) rice paddies flooded for most of the year without an adequate drying period; (ii) increased reliance on inorganic fertilisers; (iii) asymmetry of planting schedules; and (iv) greater uniformity of cultivars. Over the long term, the above changes impose significant ecological costs due to negative biophysical impacts (Pingali et al., 1997). Adverse biophysical consequences that have reduced productivity have been: the buildup of salinity and waterlogging; declining soil nutrient status; increased incidence of soil toxicities; and pest buildup and reduced resilience of the ecosystem to pest attacks. Pingali et al. (1997) conclude that the practice of intensive rice monoculture itself thus contributes to the degradation of the paddy resource base and hence declining productivities.

Chapter Three

SUSTAINABLE AGRICULTURE AS AN OPTION

IT is thus clear that agriculture needs to undergo a radical overhaul to become more sustainable. This is not just because it is important to take care of the environment, but also because sustainability is absolutely necessary for the continuation of the productivity of the agroecosystem. Threats to the environmental sustainability of agriculture threaten agriculture itself.

The IAASTD report (2008) makes this clear by saying that greater emphasis is needed on safeguarding natural resources and agroecological practices, as well as on tapping the wide range of traditional knowledge held by local communities and farmers, which can work in partnership with formal science and technology. It stresses that sustainable agriculture that is biodiversity-based, including agroecology and organic farming, is resilient, productive and beneficial to poor farmers, and will allow adaptation to climate change.

Sustainable agricultural approaches can be in many forms, such as agroecology, organic agriculture, ecological agriculture, biological agriculture, etc. Sustainable agriculture should (Pretty and Hine, 2001):

- Make best use of nature's goods and services by integrating natural regenerative processes, e.g., nutrient cycling, nitrogen fixation, soil regeneration and natural enemies of pests.

- Minimise non-renewable inputs (pesticides and fertilisers) that damage the environment or harm human health.
- Rely on the knowledge and skills of farmers, improving their self-reliance.
- Promote and protect social capital – people's capacities to work together to solve problems.
- Depend on locally adapted practices to innovate in the face of uncertainty.
- Be multifunctional and contribute to public goods, such as clean water, wildlife, carbon sequestration in soils, flood protection and landscape quality.

Sustainable agricultural practices include:

- Crop rotations that mitigate weed, disease and insect problems; increase available soil nitrogen and reduce the need for synthetic fertilisers; and, in conjunction with conservation tillage practices, reduce soil erosion.
- Integrated pest management (IPM), which reduces the need for pesticides by crop rotations, scouting, timing of planting and biological pest controls.
- Management systems to improve plant health and crops' abilities to resist pests and disease.
- Soil-conserving tillage.
- Water conservation and water-harvesting practices.
- Planting of leguminous crops and use of organic fertiliser or compost to improve soil fertility.

Despite adequate global food production, many still go hungry because increased food supply does not automatically mean increased food security. What is important is who produces the food, who has access to the technology and knowledge to produce it, and who has the purchasing power to acquire it (Pretty and Hine, 2001). Sustainable agricultural approaches thus allow farmers to improve local food production with low-cost, readily available technologies and inputs, without causing environmental damage.

Sustainable agriculture is productive

One criticism of sustainable agriculture, especially organic agriculture, is that it cannot meet the world's food demands, primarily because of low yields and insufficient organic fertiliser. However, there is ample evidence to refute this argument. In general, organic yields can be broadly comparable to conventional yields in developed countries. In developing countries, organic practices can greatly increase productivity, particularly if the existing system is low-input.

A recent study has found that organic methods could produce enough food on a global per capita basis to sustain the current human population, and potentially an even larger population, without putting more farmland into production (Badgley et al., 2007). The researchers examined a global dataset of 293 examples, and found that on average, in developed countries, organic systems produce 92% of the yield produced by conventional agriculture. In developing countries, however, organic systems produce 80% *more* than conventional farms. Moreover, contrary to fears that there are insufficient quantities of organically acceptable fertilisers, the data suggest that leguminous cover crops could fix enough nitrogen to replace the amount of synthetic fertiliser currently in use.

In a review of 286 projects in 57 countries, farmers were found to have increased agricultural productivity by an average of 79% by adopting 'resource-conserving' or sustainable agriculture

(Pretty et al., 2006). A variety of resource-conserving technologies and practices were used, including integrated pest management, integrated nutrient management, conservation tillage, agroforestry, water harvesting in dryland areas, and livestock and aquaculture integration into farming systems. These practices not only increased yields, but also reduced adverse effects on the environment and contributed to important environmental goods and services (e.g., climate change mitigation), as evidenced by increased water use efficiency and carbon sequestration, and reduced pesticide use.

The work built on earlier research which assessed 208 sustainable agriculture projects. The earlier research found that for 89 projects for which there was reliable yield data, farmers had, by adopting sustainable agriculture practices, achieved substantial increases in per-hectare food production – the yield increases were 50-100% for rain-fed crops, though considerably greater in a number of cases, and 5-10% for irrigated crops (Pretty and Hine, 2001). Disaggregated data show:

- Average food production per household rose by 1.7 tonnes per year (up by 73%) for 4.42 million small farmers growing cereals and roots on 3.6 million hectares.
- Increase in food production was 17 tonnes per year (up 150%) for 146,000 farmers cultivating roots (potato, sweet potato, cassava) on 542,000 hectares.
- Total production rose by 150 tonnes per household (up by 46%) for the larger farms in Latin America (average size 90 hectares).

There are many other specific examples of increased yields following the application of sustainable agricultural practices, which are summarised here (Parrott and Marsden, 2002; Pretty and Hine, 2001):

- Soil and water conservation in the drylands of Burkina Faso and Niger have transformed formerly degraded lands. The average family has shifted from being in cereal deficit of 644 kg per year (equivalent to 6.5 months of food shortage) to producing an annual surplus of 153 kg.
- In Ethiopia, some 12,500 households have adopted sustainable agriculture, resulting in a 60% increase in crop yields.
- Participatory irrigation management in the Philippines has increased rice yields by about 20%.
- Forty-five thousand families in Honduras and Guatemala have increased crop yields from 400-600 kg/ha to 2,000-2,500 kg/ha using green manures, cover crops, contour grass strips, in-row tillage, rock bunds and animal manures.
- The states of Santa Caterina, Paraná and Rio Grande do Sul in southern Brazil have focused on soil and water conservation using contour grass barriers, contour ploughing and green manures. Maize yields have risen from 3 to 5 tonnes/ha and soybeans from 2.8 to 4.7 tonnes/ha.
- The high mountain regions of Peru, Bolivia and Ecuador are some of the most difficult areas in the world for growing crops. Despite this, farmers have increased potato yields threefold, particularly by using green manures to enrich the soil.
- In Brazil, use of green manures and cover crops increased maize yields by 20-250%.
- In Tigray, Ethiopia, yields of crops from composted plots were 3-5 times higher than those treated only with chemicals.
- Yield increases of 175% were reported from farms in Nepal adopting agroecological practices.
- In Peru, restoration of traditional Incan terracing led to increases of 150% for upland crops.

- Projects in Senegal promoted stall-fed livestock, composting systems, green manures, water-harvesting systems and rock phosphate. Yields of millet and peanuts increased dramatically by 75-195% and 75-165% respectively.
- In Honduras, soil conservation practices and organic fertilisers have tripled or quadrupled yields.

Sustainable agriculture can raise incomes

The productivity of sustainable agriculture often translates to increased incomes for farmers, who at the same time are also able to reduce or eliminate the costs of purchasing chemical inputs. Sustainable agriculture also often adds new productive elements to the system, and, by maintaining or improving on- and off-farm biodiversity, allows farmers to market non-cultivated crops and animals.

Moreover, if organic produce is sold, these carry a premium price on the market. For example, a comprehensive review of the many comparison studies of grain and soybean production conducted by six US Midwestern universities since 1978 found that the organic cropping systems were always more profitable than the most common conventional systems if organic price premiums were factored in (Welsh, 1999). When the higher premiums were not factored in, the organic systems were still more productive and profitable in half the studies. This was attributed to lower production costs and the ability of organic systems to out-perform the conventional in drier areas or during drier periods.

Fifteen-year results from the Rodale Institute in the US showed that after a transition period with lower yields, the organic systems were competitive financially with the conventional system (Petersen et al., 1999). While the costs of the transition are likely to affect a farm's overall financial picture for some years, projected profits ranged from slightly below to substantially above those of the conventional system, even though economic analyses did not assume any organic price premium. The higher profits for the organic farms came largely from higher yields (of corn, in this case), which nearly doubled after the transition period. When prices or yields were low, organic farms suffered less than the conventional and had fewer income fluctuations, as they had a diversity of crops to sell. Expenses on the organic farms were significantly lower than on the conventional – the latter spent 95% more on fertilisers and pesticides. Overall production costs on the organic farms were 26% lower.

In developing countries, evidence from hundreds of grassroots development projects shows that increasing agricultural productivity with agroecological practices not only increases food supplies, but also increases incomes, thus reducing poverty, increasing food access, reducing malnutrition and improving the livelihoods of the poor. Agroecological systems lead to more stable levels of total production per unit area than high-input systems; they give more economically favourable rates of return, and provide a return to labour and other inputs for an acceptable livelihood (Pretty, 1995).

Sustainable agriculture mitigates climate change and has climate adaptation potential

Sustainable agriculture, by its very definition, reduces harm to the environment, for example through the reduction or elimination of polluting substances such as pesticides and nitrogen fertilisers, water conservation practices, soil conservation practices, restoration of soil fertility, maintenance of agricultural biodiversity and biodiversity, etc. An FAO review summarises many of these environmental benefits in relation to organic agriculture (Scialabba and Hattam, 2002).

Importantly, sustainable agriculture practices can also mitigate climate change. Organic agriculture, for example, uses less fossil fuel-based inputs and has a better carbon footprint than standard agricultural practices. This is because conventional agriculture production utilises more overall energy than organic systems due to heavy reliance on energy-intensive fertilisers, chemicals and concentrated feed, which organic farmers forgo (Ziesemer, 2007). Organic agriculture performs better than conventional agriculture on a per-hectare scale with respect to both direct energy consumption (fuel and oil) and indirect consumption (synthetic fertilisers and pesticides), with high efficiency of energy use (Scialabba and Hattam, 2002).

Agriculture has the potential to change from being one of the largest GHG emitters to a net carbon sink, while offering options for mitigation. The solutions call for a shift to sustainable farming practices that build up carbon in the soil and use less fertiliser (Bellarby et al., 2008). There are a variety of sustainable farming practices that can reduce agriculture's contribution to climate change, which are easy to implement. These include crop rotations and improved farming design, improved cropland management (such as avoiding leaving land bare, using an appropriate amount of fertiliser, no burning of crop residues in the field, reducing tillage), nutrient and manure management, grazing-land and livestock management, maintaining fertile soils and restoration of degraded land, improved water and rice management, and set-asides, land-use change and agroforestry (Bellarby et al., 2008; Niggli et al., 2008).

A report by the International Trade Centre (ITC) and Research Institute of Organic Agriculture (FiBL) (2007) provides a detailed assessment of the benefits of organic farming regarding climate change. The benefits are summarised as follows (Khor, 2008):

- Organic agriculture has considerable potential for reducing emissions.
- In general it requires less fossil fuel per hectare and kg of produce due to the avoidance of synthetic fertilisers. Organic agriculture aims to improve soil fertility and nitrogen supply by using leguminous crops, crop residues and cover crops.
- The enhanced soil fertility leads to a stabilisation of soil organic matter and, in many cases, to a sequestration of carbon dioxide into the soils.
- This in turn increases the soil's water retention capacity, thus contributing to better adaptation of organic agriculture under unpredictable climatic conditions with higher temperatures and uncertain precipitation levels. Organic production methods emphasising soil carbon retention are most likely to withstand climatic challenges particularly in those countries most vulnerable to increased climate change. Soil erosion, an important source of carbon dioxide losses, is effectively reduced by organic agriculture.
- Organic agriculture can contribute substantially to agroforestry production systems.
- Organic systems are highly adaptive to climate change due to the application of traditional skills and farmers' knowledge, soil fertility-building techniques and a high degree of diversity.

The study concludes that: 'Within agriculture, organic agriculture holds an especially favourable position, since it realizes mitigation and sequestration of carbon dioxide in an efficient way... Organic production has great mitigation and adaptation potential, particularly with regard to topsoil organic matter fixation, soil fertility and water-holding capacity, increasing yields in areas with medium to low-input agriculture and in agro-forestry, and by enhancing farmers' adaptive capacity. Paying farmers for carbon sequestration may be considered a win-win-win situation as (a) carbon dioxide is removed from the atmosphere (mitigation); (b) higher organic matter levels in soil enhance their resilience (adaptation); and (c) improved soil organic matter levels lead to better crop yield (production).'

Crucially, for farmers who have to face increased climate variability and extreme weather events in the near future, sustainable agriculture, by increasing resilience within the agroecosystem, increases its ability to continue functioning when faced with unexpected events such as climate change. For example, organic agriculture builds adaptive capacity on farms as it promotes agroecological resilience, biodiversity, healthy landscape management and strong community knowledge processes (Borron, 2006). Improved soil quality and efficient water use also strengthen agroecosystems, while practices that enhance biodiversity allow farms to mimic natural ecological processes, which enables them to better respond to change. Sustainable farming practices that preserve soil fertility and maintain, or even increase, organic matter in soils can reduce the negative effects of drought while increasing crop productivity (Niggli et al., 2008).

Chapter Four

MAINSTREAMING SUSTAINABLE AGRICULTURE

THERE is a clear need for a systematic redirection of investment, funding, research and policy focus towards sustainable agriculture. This is the key recommendation of the IAASTD (2008) report.

While interest in agriculture has been increasing given the food crisis, there are still many complex issues to resolve. Over the past few decades Green Revolution methods have been the cornerstone of agriculture in many countries. Yet, many agricultural systems are presently in a state of ecological degradation. The productivity, stability and durability of these systems are being threatened, thus endangering the continued provision of food.

In reaction to these developments, practices that fit better with the economic, ecological, social and cultural/religious conditions of the farming and fishing community are needed. They should retain the productivity, stability and durability of the systems without causing harm to the environment or threatening public health. They should also promote the economic and social independence of the farming and fishing community and ensure the provision of food.

Most policy measures to support agriculture currently act as powerful disincentives against sustainability. In the short term, this means that farmers switching from modern high-input agriculture to resource-conserving technologies can rarely do so without incurring some transition costs. In the long term, it means that sustainable agriculture will not spread widely beyond the types of localised success.

The principal problem is that policies simply do not reflect the long-term social and environmental costs of resource use. The external costs of modern farming, such as soil erosion, health damage or polluted ecosystems, are not incorporated into decision-making. Policies framed to deliver increased food production will have to be changed if they are to help deliver environmental and social benefits too.

Agricultural policies that encourage Green Revolution-type farming by subsidising farm inputs such as pesticides, fertilisers, credit and irrigation have reduced the economic viability of sustainable agriculture technologies for pest management. In Indonesia, for example, it was only the removal of pesticide subsidies in 1986, coupled with the banning of 57 rice pesticides, that allowed farmer field schools to flourish and allowed farmers to successfully make the transition to pesticide-free or low-pesticide rice farming. The trend in some OECD countries now is to levy taxes on pesticides so as to reduce their use.

Some recommendations

Sustainable agriculture can contribute significantly to increased food production, as well as make a significant impact on rural people's welfare and livelihoods. However, without appropriate policy support at a range of levels, these improvements will remain at best localised in extent or, worse, will wither away. A thriving and sustainable agricultural sector requires both integrated action by farmers and communities, and integrated action by policy makers and planners. It is also vital for farmer-to-farmer learning and sharing of experiences to be encouraged and facilitated.

The following are some suggestions to move towards mainstreaming sustainable agriculture at a national level:

(1) Conduct an in-depth integrated assessment of general agriculture policies, programmes and plans to see where the gaps are, in terms of sustainable agriculture. Policies that provide disincentives against sustainable agriculture need to be changed.

(2) General and sustainable agriculture policies should support each other to the greatest extent possible to promote effective policy coherence.

(3) Agriculture has always been closely associated with the environment. Better integration of agricultural and environmental policies would provide mutual benefits. The goal is to move rapidly towards 'environmentally friendlier' sustainable agricultural practices.

(4) Develop a sustainable agricultural policy and action plan with clear objectives, targets and timeframes. This process should be participatory and involve relevant agencies, farmers and their organisations, the private sector and non-governmental organisations (NGOs). A lead agency/ department should be identified to carry the work forward.

(5) Promote and facilitate the adoption of sustainable and lower-input agriculture, and environmentally friendly technologies and practices. This may include the use of economic instruments and incentives for farmers to switch to sustainable agriculture, including organic agriculture.

(6) Promote and facilitate practices that encourage local biodiversity and endemic varieties. Encourage local seed banks so that traditional and diverse varieties of seeds are maintained.

(7) Plan with reference to water management, including growing traditional crops that do not have high water demands and integrating soil management using organic matter, which has higher water-holding capacity.

(8) Ensure sufficient resource allocation towards research and projects on sustainable agriculture. This should include (Khor, 2003):

- reassessing the concept and measurement of agricultural productivity, giving due recognition to the value of traditional and ecological farming and enabling a scientific comparison with conventional Green Revolution methods;
- studying sustainable agriculture systems, their operations and dynamic inter-relationships, their problems and solutions to these problems;
- sustainable agriculture experiments, test farms and demonstration farms;
- training programmes for farmers, policy and extension officials, and NGOs on sustainable agriculture;

- support for farmers' programmes and government programmes for implementation of sustainable agriculture, including eventually on a large scale;
- support to farmers, community groups and governments for establishing community-based seed banks to revive and promote the use of traditional varieties, support for subsequent exchange of seeds amongst farmers, and for improvement of seed varieties using appropriate traditional breeding methods.

(9) Farm advisory and extension services should promote sustainable agriculture. General awareness-raising about sustainable agriculture and its benefits should be carried out.

(10) Sustainable agriculture should be integrated into the education system, including at the tertiary level. Specialised institutions involved in training for sustainable agriculture should be supported.

(11) Further encourage farmers' markets, without middle agents, including for sustainable agriculture and organic products.

(12) Encourage decentralisation of processing industries as well as commercial centres, so as to address rising transportation and fuel costs.

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THE CASE FOR SUSTAINABLE AGRICULTURE: MEETING PRODUCTIVITY AND CLIMATE CHALLENGES

Chemical- and energy-intensive industrial agriculture has not only wrought environmental damage and perpetuated social inequity, but also increasingly faces the problem of stagnant yields and declining productivity. There is therefore an urgent need for ecologically, economically and socially sustainable forms of farming which will at the same time preserve the productivity of the agroecosystem.

Sustainable agriculture, which includes such practices as organic farming and agroecology, integrates natural regenerative processes, minimises non-renewable inputs and draws on traditional and local knowledge of farmers. As this paper shows, the application of sustainable agriculture methods can greatly enhance farm productivity, especially in the developing world, without harming the environment. Importantly, ecologically friendly, energy-efficient sustainable agriculture mitigates the pressing problem of climate change and also enables farmers to better respond and adapt to increased climate variability.

This paper calls for investment, research and policy support to be channelled towards sustainable agriculture in order to promote mainstream adoption of farming approaches which can more reliably feed the world now and into the future.

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