

Is ecological agriculture productive?

by Lim Li Ching

Introduction

A key question that is often asked about ecological agriculture, including organic agriculture, is whether it can be productive enough to meet the world's food needs. While many agree that ecological agriculture is desirable from an environmental and social point of view, there remain fears that ecological and organic agriculture produce low yields.

This short paper will summarise some of the available evidence to demystify the productivity debate and demonstrate that ecological agriculture is indeed productive.

In general, yields from ecological agriculture can be broadly comparable to conventional yields in developed countries. In developing countries, ecological agriculture practices can greatly increase productivity, particularly if the existing system is low-input, which is largely the case for many developing countries. This paper will focus mainly on evidence from developing countries.

Evidence from global modelling

A recent study examined a global dataset of 293 examples and estimated the average yield ratio

(organic : non-organic) of different food categories for the developed and developing world (Badgley *et al.*, 2007). For most of the food categories examined, it was found that the average yield ratio was slightly less than 1.0 for studies in the developed world, but more than 1.0 for studies in developing countries.

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.

With the average yield ratios, the researchers then modelled the global food supply that could be grown organically on the current agricultural land base. They found that organic methods could hypothetically 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.

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.

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This model suggests that organic agriculture could potentially provide enough food globally, but without the negative environmental impacts of conventional agriculture.

Evidence from reviews of ecological agriculture projects

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 ecological 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 were 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 on 542,000 hectares cultivating root crops (potato, sweet potato, cassava).
- Total production rose by 150 tonnes per household (up by 46%) for the larger farms in Latin America (average size 90 hectares).

The database on agricultural sustainability (comprising the 286 projects) was reanalysed to produce a summary of the impacts of organic

and near-organic projects on agricultural productivity in Africa (Hine and Pretty, 2008). The average crop yield increase was even higher for these projects than the global average (79%): 116% increase for all African projects and 128% increase for the projects in East Africa.

For Kenyan projects, the increase in yield was 179%, for Tanzanian projects 67% and for Ugandan projects 54%. Moreover, all case studies that focused on food production in this research where data have been reported, showed increases in per-hectare productivity of food crops, which challenges the popular myth that organic agriculture cannot increase agricultural productivity.

Evidence from specific ecological agriculture interventions

Data from the Tigray Project in the Tigray Region in Ethiopia, where a project on ecological agriculture has been carried out since 1996, concretely demonstrate the benefits of compost on productivity. Preliminary data collected in 1998 had already shown that using compost gave similar yield increases as chemical fertilisers. Data collected in 2002, 2003 and 2004 showed that, on average, composted fields gave higher yields, sometimes double, than those treated with chemical fertilisers (Araya and Edwards, 2006).

In a new paper written for the UN Food and Agriculture Organisation (FAO), statistical analysis on a larger data set over the years 2000 to 2006 inclusive confirms that compost use in Tigray has increased yields in all the crops analysed (Edwards *et al.*, 2008). In total, data were collected from 974 fields from 19 communities. Grain and straw yield data were obtained for barley, durum wheat, finger millet, hanfets (a mixture of barley and durum wheat), maize, sorghum, teff, faba bean and field pea.

Except for field pea, the compost generally doubled the grain yield when compared to each respective check (crops grown without any inputs). (For field pea, the increase in yield was approximately 28%.) The difference was significant (95% confidence limit). The application of compost also increased straw yield compared to the check, but not to the same extent as it increased grain yield.

The use of compost also gave higher yields than the use of chemical fertiliser, though differences

in the yields from compost and from chemical fertiliser were not as great as the differences between the use of compost and the check. For sorghum and faba bean, the yields from the use of compost and chemical fertiliser were similar. But the yield difference for all the other crops was greater, with that from the compost treatment being always higher than that from the use of chemical fertiliser. The results also showed that compost not only increases the overall biomass yield, but also increases the proportion of the grain to straw in the yield.

Since 1998, the Bureau of Agriculture and Rural Development of the Tigray Region has adopted the making of compost as part of its extension package and by 2007 at least 25% of the farmers were making and using compost. A reflection of the success of this approach is that between 2003 and 2006, grain yield for the Region almost doubled from 714 to 1,354 thousand tonnes. Since 1998, there has also been a steady decrease in the use of chemical fertiliser from 13.7 to 8.2 thousand tonnes.

There are many other specific examples of increased yields following the application of ecological agriculture practices, some of which are summarised below (Hine and Pretty, 2008; Parrott and Marsden, 2002; Pretty and Hine, 2001; Scialabba and Hattam, 2002).

In Africa:

- 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.
- In Tigray, Ethiopia, yields of crops from composted plots were 3-5 times higher than those treated only with chemicals.
- 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 Kenya, 500 farmers on some 1,000 hectares have seen maize yields improve from about 2 to 4 t/ha following the application

of soil conservation, soil fertility and organic agriculture methods.

- A range of biological pest management methods together with legumes, cover crops and green manures for soil fertility improvement resulted in a doubling of beans and groundnut yields from 300 to 600 kg/ha in western Kenya.
- In eastern and central Kenya, smallholder farmers have been trained in natural soil fertility management; integrated environmentally friendly weed, pest and disease protection; on-farm soil and water conservation techniques; and farm level seed conservation, with a resulting 50% increase in productivity and 40% increase in income.
- More than 1,000 farmers in low-soil-fertility areas in the North Rift and western regions of Kenya increased maize yields to 3,414 kg/ha (71% increase in productivity) and bean yields to 258 kg/ha (158% increase in productivity) as compared to traditional agriculture, by incorporating soil fertility management, crop diversification and improved crop management.
- Integration of pond fish culture into low-input farm systems with some 2,000 farmers in Malawi increased vegetable yields from 2,700 to 4,000 kg/ha, with the fish ponds producing the equivalent of 1,500 kg/ha of fish, a new source of food for households.

In Latin America:

- 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 by threefold, particularly by using green manures to enrich the soil. Using these methods, some 2,000 farmers

in Bolivia have improved potato production from about 4,000 kg/ha to 10-15,000 kg/ha.

- In Brazil, use of green manures and cover crops increased maize yields by between 20-250%.
- In Peru, restoration of traditional Incan terracing led to increases of 150% for upland crops.
- In Honduras, soil conservation practices and organic fertilisers have tripled or quadrupled yields.
- In Cuba, there are more than 7,000 organic urban gardens and productivity has grown from 1.5 kg/m² to nearly 20 kg/m².

In Asia:

- Participatory irrigation management in the Philippines has increased rice yields by about 20%.
- Yield increases of 175% were reported from farms in Nepal adopting agroecological practices.
- In Pakistan, yields of mango and citrus fruits increased by 150-200% after organic agriculture techniques were adopted such as mulching, no till production, composting and planting the fruit trees in double dug beds.

Conclusion

It is clear that ecological agriculture is productive and has the potential to meet food security needs, particularly in developing countries. The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) concurs that an increase and strengthening of agricultural knowledge, science and technology toward agroecological sciences will contribute to addressing environmental issues while maintaining and increasing productivity (IAASTD, 2008). Moreover, ecological agricultural approaches allow farmers to improve local food production with low-cost, readily available technologies and inputs, without causing environmental damage.

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