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Organic agriculture and the global food supply

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Abstract

The principal objections to the proposition that organic agriculture can contribute significantly to the global food supply are low yields and insufficient quantities of organically acceptable fertilizers. We evaluated the universality of both claims. For the first claim, we compared yields of organic versus conventional or low-intensive food production for a global dataset of 293 examples and estimated the average yield ratio (organic : non-organic) of different food categories for the developed and the developing world. For most food categories, the average yield ratio was slightly <1.0 for studies in the developed world and >1.0 for studies in the developing world. With the average yield ratios, we modeled the global food supply that could be grown organically on the current agricultural land base. Model estimates indicate 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 increasing the agricultural land base. We also evaluated the amount of nitrogen potentially available from fixation by leguminous cover crops used as fertilizer. Data from temperate and tropical agroecosystems suggest that leguminous cover crops could fix enough nitrogen to replace the amount of synthetic fertilizer currently in use. These results indicate that organic agriculture has the potential to contribute quite substantially to the global food supply, while reducing the detrimental environmental impacts of conventional agriculture. Evaluation and review of this paper have raised important issues about crop rotations under organic versus conventional agriculture and the reliability of grey-literature sources. An ongoing dialogue on these subjects can be found in the Forum editorial of this issue.

Key words: organic agriculture, conventional agriculture, organic yields, global food supply, cover crop

Introduction

Ever since Malthus, the sufficiency of the global food supply to feed the human population has been challenged. One side of the current debate claims that green-revolution methods—involving high-yielding plant and animal varieties, mechanized tillage, synthetic fertilizers and biocides, and now transgenic crops—are essential in order to produce adequate food for the growing human population[1–4]. Green-revolution agriculture has been a stunning technological achievement. Even with the doubling of the human population in the past 40 years, more than enough food has been produced to meet the caloric requirements for all of the world's people, if food were distributed more equitably[5]. Yet Malthusian doubts remain about the future. Indeed, given the projection of 9 to 10 billion people by 2050[6] and the global trends of increased meat consumption and decreasing grain harvests per capita[4], advocates argue that a more intensified version of green-revolution agriculture represents our only hope of feeding the world. Another side of the debate notes that these methods of food production have incurred substantial direct and indirect costs and may represent a Faustian bargain. The environmental price of green-revolution agriculture includes increased soil erosion, surface and groundwater contamination, release of greenhouse gases, increased pest resistance, and loss of biodiversity[7–14]. Advocates on this side argue that more sustainable methods of food production are essential over the long term[15–17].

If the latter view is correct, then we seem to be pursuing a short-term solution that jeopardizes long-term environmental sustainability. A central issue is the assertion that