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ORGANIC AGRICULTURE AND FOOD AVAILABILITY

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ISSUES PAPER: ORGANIC AGRICULTURE AND FOOD AVAILABILITY

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I. INTRODUCTION

1. Food availability, access, stability and utilization are all part of the multi-dimensional nature of food security. The "availability" aspect, discussed here, refers to the availability of sufficient quantities of food of appropriate quality, supplied through domestic production or inputs.

2. Productivity is usually considered the ultimate benchmark when comparing the performance of agricultural systems. For example, those involved in agricultural research and development want to know how much yield would be reduced if conventional agriculture were converted to organic agriculture. While rigorous research has been done in developed countries to address this question, scientific evidence from developing countries is rare. This paper compiles the information available on productivity of organic systems and draws on current experiences to make assumptions.

3. However, measurement of productivity alone is not sufficient to evaluate the performance of an agricultural system. When natural resources are limited and production decisions are made on the basis of the economic resources available, resource efficiency is as important a criterion as productivity for evaluating a system's performance. Thus, this paper discusses adapted technologies considers the achievements of organic agriculture in terms of both productivity and resource efficiency.

4. Specific attention also is given to peri-urban agriculture. In terms of the high and rapidly increasing population density in urban areas, peri-urban agriculture has the potential to minimize transportation of food products and organic waste, yet supply food to a large part of the population.

5. Finally, the paper discusses how organic agriculture makes diverse food available at household, community, national and international levels. Furthermore, a summary of the organic food market is provided with most recent figures on market size and available organic food.

II. CONTRIBUTION OF ORGANIC AGRICULTURE TO FOOD AVAILABILITY

A. ORGANIC AGRICULTURE PRODUCTIVITY

6. Organic agriculture is considered an interesting option for sustainable agriculture in developing countries because it offers a unique combination of low external input technology, environmental conservation and input/output efficiency. It also provides access to premium price markets through labelling. NGOs and farmers' groups are increasingly adopting organic agriculture techniques as a method of improving productivity and food security.

7. At the same time, critical voices raise concern that organic agriculture is not capable of meeting the world's growing food needs due to low productivity per area (Borlaug, 2000; Trewavas, 2002; Anonymous, 2004). Extensive research with regard to the productivity of the organic

agriculture system has been carried out in developed countries in order to address this criticism. Although there are numerous project reports on the benefits of sustainable agriculture for farmers and the environment in developing countries, scientifically solid information on organic agriculture remains scarce.

8. Subsequently, four different agro-ecological zones have been considered in terms of their productivity when converting their agriculture from conventional to organic management. In all four, in the first two to three years, yield reductions were usually low (or sometimes nonexistent) if conversion was from a low-input system and, in fact, after the conversion period, organic yields could reach levels even higher than conventional yields. Yield reductions were generally higher if the system had been run on a high-input level. Yields recover after the conversion period, but usually not to the level of the previous conventional yields.

Temperate and irrigated areas

9. Agriculture in temperate and irrigated areas is generally characterized by favourable soils, high levels of mechanization and functioning markets for farm supplies. In these areas, high external inputs make it possible to obtain high production levels but productivity may be pushed beyond the actual ecosystem capacity. Soils receive high levels of synthetically produced fertilizers and crop genetic resources are often hybrids designed to perform well under ideal conditions (such as receiving regular and abundant water and nutrients) and with high levels of pesticides and herbicides. In converting to organic management from these conditions, it is common for yield to drop considerably during the first two to three years after conversion (Petersen, et al., 1999). It is estimated that yield reductions during the conversion period are 20 to 30 percent for cereals, 10 to 20 percent for maize, 30 to 40 percent for potatoes, 10 to 40 percent for vegetables and around 30 percent for fruits (Dierauer, et al., 2006). In the medium and long term, when soil fertility has recovered, yields will be slightly lower or comparable to the pre-conversion yields. Both short- and long-term field trials with maize, wheat, beans, soya, safflower, potatoes and tomatoes found no difference between organic and conventional crop yields (Warman, 1998; Clark, et al., 1999; Poudel, et al., 2002; Delate et al.; 2003, Denison et al.; 2004; Pimentel et al., 2005). However, other trials found organic crop yields to be 5 to 35 percent lower than conventional crop yields (Clark et al., 1999; Denison et al., 2004; Mäder et al., 2002). Lower yields are often a result of lower availability of nitrogen, generally due to inexperienced management such as introduction of green manuring.

Arid and semi-arid areas

10. In semi-arid and arid areas, rainfed agricultural systems, including livestock production, are often subsistence systems. Intensification of agriculture and livestock production often pushes beyond the capacity of the ecosystem, resulting in overgrazing and severe environmental degradation. In fact, UNEP estimates that 69.5 percent of drylands are degraded. However, livestock is also a vital and integral part of the organic production system. Well managed pastures and adequate stocking rates are necessary to adjust the feed production potential of the ecosystem. Agricultural inputs in these

ecosystems are often too expensive for small holder farmers and also difficult to purchase. Moreover lack of knowledge by small farmers can result in their using incorrect application methodologies. The main challenge in converting to organic agriculture is dealing with the scarcity and the disrupted dynamics of biomass decomposition during the long dry season(s) which results in a very slow build up of soil organic matter.

11. The following examples show that high organic yields can be achieved where biomass is available and where livestock is integrated in the system:

- In an 11-year hybrid cotton field trial in India, where organic manure application rates were high as 12 tonnes per ha per year, the average yield of the organic treatment was 10 percent higher than that of the conventional treatment (Blaise, 2006).
- Considerable yield increases in staple food crops (sorghum, millet, maize, rice) and fruits (mango and citrus) in the context of organic agriculture projects have been found in Pakistan, India, Senegal, Ethiopia, Kenya, Lesotho and Zimbabwe. Key to these achievements have been soil fertility management practices such as integrated stall-fed livestock, effective composting systems, introduction of green manure, cover crops and legumes in the rotation, use of bone meal and rock phosphate against P deficits, localized placement of ash and manure and soil conservation methods (Pretty, 2002).

Humid and per-humid areas

12. Agricultural systems in humid and per-humid areas are dominated by flooded cropping systems (i.e. rice) or tropical forest systems. These areas are often characterized by poor and acid soils due to abundant rainfall and fast decomposition/high mineralization rates of biomass and organic matter – the latter being the most important reservoir for nutrients. Pest and disease pressure is usually high because of year-round favourable temperatures and high relative humidity. Agricultural inputs are generally available, but not always affordable by small farmers living in these areas. Conversion to organic agriculture in humid and per-humid areas implies less intensive and more integrated production, using resistant and often local cultivars that are often lower yielding. On the other hand, increased crop rotations and diversifications, agroforestry and integration of livestock, aquaculture and beekeeping, open up opportunities to diversify the system and increases the security and stability of income and the total production of the farm if the different outputs are added together. Synthetic fertilizers are replaced by organic nutrient sources such as compost and green manure, which find excellent growing conditions but are labour intensive and may compete with food crops.

13. The following examples show that yields of organically grown annual crops are about the same as those of conventionally grown crops, but that yield reductions of 20 to 50 percent are common in perennial crops. Participatory technology development, appropriate training in organic crop management and biocontrol, and higher product prices could reduce these yield gaps considerably.

- In Bangladesh, a study comparing conventional and ecological farming with regard to ecological, economic and social sustainability found no difference in yields of paddy rice, wheat, jute, potato, pulses and mustard 12 years after the implementation of a nonconventional agriculture system by a non-governmental organization (Rasul and Thapa, 2004).

- In the Philippines, rice yields dropped during the first years after conversion from conventional to organic agriculture. However, after four years of organic rice production, farmers succeeded in producing yields of 4.5 to 5 tonnes per ha, which is about the same as produced on conventional rice farms (Lina, et al., 1999).
- In a pairwise farm comparison, Lyngbaek, et al. (2001) found mean yield drops of 22 percent on shaded organic coffee farms, compared to conventional shaded coffee farms. Pülschen and Lutzeyer (1993) found mean yield reductions of 28 percent on an organic shaded coffee farm compared to a neighbouring conventional shaded coffee farm in Mexico. Yield reductions were attributed to problems in replacing inorganic nitrogen (N) fertilizers by organic N sources (van der Vossen, 2005).
- In the Caribbean, organic banana production is assumed to have much lower yields at higher production costs than conventional production, mainly due to reduced nutrient input which has to be substituted by labour-intensive green manure (Polius, 2000; Lotter, 2003).
- In Costa Rica, organic cacao production has yield reductions estimated at more than 50 percent, mainly due to the diseases monilia, witches' broom and black pod (Slingerland and Gonzalez, 2006). However, an appropriate multi-storey and diverse forest system with extensive cacao production may reduce cacao yields but at the same time it will produce other food stuff and goods such as root crops, fruits, animals (protein), medicine, spices and timber/building materials (Daniels, et al., 1999; Rice and Greenberg, 2000).
- In many Asian countries, such as Korea and Vietnam, integrating fish in rice paddies provides benefits as the fish selectively feed on pests and animal droppings fertilize rice. Such systems multiply yields and offer a protein source important for local diets.

Hills and mountains

14. Hill and mountain areas, often characterized by extreme weather conditions, inaccessibility, poor and steep soils subject to erosion, low population density, poor infrastructure and training facilities, also have favourable conditions such as pristine environments with low incidence of pests and diseases. Access to agricultural inputs is difficult because of challenging topography and poor roads. Converting this type of agriculture to organic agriculture is a small step, because management is often organic by default, based mainly on inputs available on the farm. Only small reductions in the first years after conversion have been observed, provided that organic techniques such as composting and other basic recycling technologies, such as spreading of fertilizers, are in place (Avasthe, et al., 2005).

15. If there is market access, products of mountain areas often have the potential to get premium prices in both domestic and international markets for such products as medicinal and aromatic herbs and berries.

- Sikkim, India, is implementing a policy to switch all of its agriculture into organic production, calling for elimination of all forms of chemicals from agriculture in the next 10 years and employing options such as enriched rural compost, vermicompost, biofertilizers, green manure and organic amendments/fertilizers such as dolomite and rock phosphates (Avasthe, et al., 2005).

- According to reports from staple food projects in mountain agro-ecosystems, yield increases have been reported in Bolivia in organic potato yields and Nepal has had increases organic maize and rice yields (Pretty, 2002).

16. Yields of organic agriculture do not exceed conventional yields if the comparisons are made in a systematic and controlled way, as is the case in the field experiments of the temperate areas, or in the studies of Rasul and Thapa (2004) in Bangladesh, and Lyngbaek, et al., (2001) in Costa Rica. In contrast, when system productivity is estimated at farm level in the course of an agricultural project, yield increases of up to 300 percent are reported for the organic system (Parrott and Marsden, 2002; Pretty, 2002; Kilcher, 2007). The reason for this difference may be that these yield increases were not the outcome of organic agriculture techniques alone; they were at least as much the result of favourable cultural, social and economic dynamics such as the farmers' motivation, the sharing of experience in peer groups and successive learning, or the introduction of new crops which are often the beginning of a whole chain of innovations.

17. The difficulty of choosing an appropriate scale for comparing indicates the need to adopt a multi-disciplinary and integrated research approach that does not measure the yield of one individual crop but looks at a wide range of parameters (including for example multiple cropping over a rotation period) in a field, on a farm or even at regional or ecosystem level. Which level is relevant to stakeholders and fair for all systems under comparison is an ongoing debate. Small-scale and focused experiments are a prerequisite to making statistically sound statements, while large-scale and comprehensive studies are necessary to capture the synergies among different farm elements (e.g. crop production, livestock, agroforestry and aquaculture) or regional particularities. This is all the more true for tropical agricultural smallholder systems, where diversity is typically high.

B. DOES ORGANIC AGRICULTURE USE RESOURCES EFFICIENTLY?

18. An agricultural system's productivity is only one aspect of food availability and any comparison study is inadequate if resource efficiency is not considered. Since resources are always limited in one way or another, it is important to consider the capability to produce high output per unit of resources used rather than absolute productivity. Natural resource efficiency (expressed as energy efficiency) and economic efficiency (expressed as net return) are described below.

Energy efficiency

19. In developed countries, organic agriculture generally consumes less fossil energy than conventional agriculture because no synthetically produced fertilizers, pesticides and herbicides are applied. However, organic agriculture may consume more fuel with its farm machinery than conventional agriculture, as many management practices are handled mechanically instead of

chemically. For example, composting (high volume) replaces synthetic fertilizers (low volume), mechanical weed control replaces chemical weed control, and planting of a green manure crop substitutes for nitrogen fertilizer application. Work done by machinery in developed countries is to a large part replaced by manpower in developing countries.

20. In terms of energy inputs (fossil fuels for farm machinery, fertilizers, seeds and herbicides), Pimentel, et al. (2005) found in the Rodale trial, USA, that an organic maize production system consumed 33 percent less energy per ha per year than conventional farming. Energy consumption for soybean production was similar. In the Swiss DOK (bio-dynamic, organic and conventional) systems comparison field trial, based on a seven-year rotation including potatoes, winter wheat and beet roots, the organic and bio-dynamic systems consumed 20 to 56 percent less energy per produced unit of crop dry matter than the conventional systems (Mäder, et al., 2002). Reganold, et al. (2001) found the organic apple production system to be 7 percent more efficient in terms of energy use than the conventional system. To our knowledge, the study of Zarea, et al. (2000) is the only one reporting on energy efficiency as affected by the farming system in a developing country. Their field experiment, including three different wheat rotations in Iran, showed that the organic system was between 70 and 100 percent more efficient than a conventional high-input system.

Economic efficiency

21. Economic efficiency of an agricultural system is determined by yield, product prices and production costs. Organic agriculture often achieves similar to slightly lower yields, compared to conventional agriculture, as has been outlined above. Production costs vary greatly among farm types (e.g. heavily mechanized versus manpower-managed farms, labour intensive crops versus labour extensive crops). Typically, organic agriculture, both in developed and developing countries, requires more labour to produce compost, to plant cover crops and green manure and for weed control. This increases production costs, particularly in developed countries where labour is expensive. In return, organic farms can save on expensive synthetic fertilizers and pesticides. In industrialized countries, premium prices often paid for organic products make up for reductions in net returns. They are not considered in the presentation of the net returns in the studies listed below, since they are very much determined by societal and political processes that vary greatly over time and between countries. However, their importance should not be neglected, as it is the premium prices and government support payments that largely contribute to making organic agriculture profitable in Europe (Offermann and Nieberg, 2000).

22. Clark, et al. (1999) found in California, USA, the net financial returns (without premium prices) of organically grown tomatoes, beans and maize to be lower than conventionally grown crops, due to high costs in management of seedlings (tomatoes), weed control and cover crop management. In the Rodale trial, after two years of transition and learning, net returns (without premium prices) were similar in both systems, with the conventional system spending more on fertilizers and pesticides and the organic system having higher machinery costs due to mechanical weed control and additional cover crop/green manure planting. The net returns of the organic system were more stable over the years. However, when the transition period was included in the calculation and if family labour was

remunerated, organic returns dropped to 10 percent below the conventional returns (Pimentel, et al., 2005).

- In the USA, organic apples have 10-15 percent higher production costs than conventional apples, due to differences in weed control practices, fruit thinning and compost applications – all implying expensive labour costs (Reganold, et al.2001).
- In the cotton belt of central India, a case study found that organic net returns (without premium prices) on seed cotton were significantly higher than conventional net returns, because of 10-20 percent lower production costs (Eyhorn, 2006).

23. While costs for agricultural inputs such as fertilizers, pest management and seeds were 40 percent lower in the organic system, expenditures for hired labour were only slightly higher on organic farms compared to conventional farms. This study points out that premium prices are required to make up for income reductions during the conversion period (two to three years).

C. ADAPTED TECHNOLOGIES MAKE ORGANIC AGRICULTURE SUCCESSFUL

24. Organic agriculture's resource efficiency comes from using technologies well targeted to sites and scales and the recycling of natural resources. The most successful technologies are usually developed together with farmers (Williamson, 2002) or driven by the market (Delve, 2004).

Appropriate technologies

25. One of the most beneficial aspects of organic agriculture is the integration of different farm activities to create synergies with positive environmental effects, family supply and financial benefits. Experience shows that diversified farms are best in meeting the various demands of ecosystem, self-sufficiency and financial needs. Elements that can be integrated with high mutual benefit are: trees (fruit, timber,) animals (livestock, pigs, chicken, fish, ducks, bees), annual crops (cereals, legumes), seasonal crops (horticulture), including associations in space (agroforestry) and time (rotations) that maximize nutrient and energy use. Farm activities come together through interfaces such as allocating land to the various uses, planning of crop rotation, designing nutrient and organic carbon cycles, enhancing pest-predator balance, planning household food supply and the optimization of farm economics.

26. Considering the complexity and diversity of organic farms, participatory development of site-specific technologies is of immense importance for later adoption and positive impact on productivity. Many studies have shown that a technology can be successful in one site but not in another, even with only slightly different agro-ecological conditions. This effect sometimes occurs at a very small scale, such as between neighbouring villages or even within one field (Bationo, et al., 1999; Buerkert, et al., 2001 and 2002; Schlecht and Buerkert, 2004).

27. Technology development should also be specific to various socio-economic contexts farmers live and work in. For example, capital and labour availability play a large part in farmers' acceptance and adoption of a new technology (de Jager, et al., 1998; Warren, 2002; Quanash, 2004). The best way to ensure that solutions are both effective and acceptable to farmers is, again, to involve them as much as possible in all stages of the process – from the definition of the problem to on-farm fine-tuning.

Recycling of natural resources

28. One of the principles of organic agriculture is to rely on farm-own resources as much as possible. The techniques for recycling farm-own nutrients and organic carbon are among the most important assets of organic agriculture. For small-scale farmers in developing countries faced with lack of capital and low product prices, closing the nutrient cycle is a necessity rather than an optional commitment. Finding ways to improve on closing nutrient cycles is therefore a constant issue in organic technology development.

29. The key approach is to reduce nutrient loss through improving livestock systems with various forms of corralling and controlled grazing in favourable conditions that allow direct recycling of manure, efficient composting techniques for crop residues, non-palatable biomass and livestock manure (Edwards, 2000; Shepherd, et al., 2000), and mulching with crop residue and green manure to prevent erosion of fertile topsoil (Schlecht, et al., 2006).

30. In semi-arid, arid and mountain areas where growth conditions are limited by water, temperature and fertility factors, there is competition for use of residues. For example, they could be used as a feed for livestock, as mulch for increasing soil fertility and protecting against erosion, or for energy production. Moreover, food crops often compete with household fuel needs for farmyard manure. Generally, direct application of biomass to the field is more efficient in nitrogen cycling than if fed to livestock. On the other hand, farmyard manure can contain large amounts of easily available nutrients and thus trigger immediate crop growth (Rufino, et al., 2006). In terms of the best uses for biomass, the question of whether plant residues should be fed back to the soil, to animals or used to produce energy such as biofuel requires further investigation. Especially for arid and tropical environments, research is needed to increase understanding of the effect of green manure, mulch and other soil fertility practices, including compost.

31. Since nutrient recycling rarely reaches 100 percent, it is recommended to replace losses with nitrogen-fixing plants such as legume crops in the rotation, cover crops or, in the fallow period, with rock phosphate and agro-industrial waste. For instance, a well balanced mixture of compost raw materials, especially materials rich in phosphorus such as chicken manure and sugarcane by-products, is excellent for overcoming problems with the phosphorus balance and at the same time a good source of organic carbon (Kilcher, 2007). However, critical voices raise concern that organic agriculture could provide agricultural self-sufficiency without nutrient mining, but new ways to balance phosphorus exports must be explored and hygienically safe techniques to recycle organic waste must be realized (Buerkert, et al., 2000; Grenz and Sauerborn, 2007).

D. URBAN AND PERI-URBAN AGRICULTURE

32. Urban agriculture offers opportunities due to high population density, and the extraordinarily high turnover of food stuff, organic waste, energy and nutrients and as compared to rural agricultural systems. Despite this common feature, there are substantial differences in the roles of urban and peri-urban agriculture in developing as countries compared to those in industrialized countries.

Industrialized countries

33. In the temperate areas, peri-urban agriculture has often lost its purpose of production. In the densely populated areas of the Netherlands, rural and urban areas are strongly interrelated, and agriculture has a role in social life, labour and recreation (Blom-Zandstra, 2005). In Australia, urban organic community gardens contribute to health promotion and education in sustainability (Fulton, 2005) and the weekly direct supply of organic fruits and vegetables to consumers has restored direct farmer-consumer relationships (Segrave, 2005). The Flemish authorities request that peri-urban agriculture take on a multifunctional role and be oriented to environmental friendly production systems such as organic agriculture and to promotion of high-quality agriculture, to reduce negative externalities (Vandermeulen, et al., 2006). Wilkins, et al. (2005) postulate a closed urban-organic loop, in which peri-urban organic agriculture produces the food for the city and, in return, recycles organic waste and used water from the city, thus reducing food miles, waste dumps and CO2 emissions.

Developing countries

34. The importance of peri-urban agriculture in the tropics lies in the year-round supply of fruits and vegetables and, thus, of vitamins and micro-nutrients to urban residents (Drescher, 1998). It is estimated that 14 percent of the world's food is produced in urban and peri-urban areas with many urban areas producing up to 30 percent of their subsistence needs.

35. In Havana, the sudden shortage of imported goods in the economic crisis of the 1990s forced the country to reduce its dependency on fuel, imported food and agricultural inputs. Relocation of production from rural areas to the immediate vicinity of the consumer and locally available low-cost technology, including composting and biological control agents, were key elements in Cuba's agricultural re-structuring (Murphy, 1999; Warwick, 2001). Processing of organic waste and waste water are essential in closing peri-urban resource cycles and, thus, making efficient use of natural resources. The BioFarm Initiative of International Centre of Insect Physiology and Ecology (ICIPE) in Ethiopia processes livestock manure in a biogas digester for energy production and for control of potentially harmful bacteria and endoparasites. The slurry is used in horticulture. (Greiling, et al., 2000). In Argentina, organic home gardens have demonstrated the feasibility of improved food

availability through local non-traditional markets associated with urban agriculture (see enclosed case study).

E. DEVELOPING LOCAL MARKETS AND INTERNATIONAL TRADE

The Organic Food Market

Supply

36. Organic agriculture, now practiced in more than 120 countries, is developing rapidly. Its share of agricultural land and farms continues to grow in many countries. According to the latest organic agriculture survey, almost 31 million ha are currently managed organically by at least 633 000 farms. This constitutes 0.7 percent of the agricultural land of the countries covered by the survey (Willer and Yussefi, 2007). In total, Oceania holds 39 percent of the world's organic land, followed by Europe (23 percent) and Latin America (19 percent). In most countries, organic agriculture is on the rise. Wild collection adds another 62 million ha to the 31 million ha of organic agricultural land (Willer and Yussefi, 2007). While Alpine and Scandinavian countries have the largest areas devoted to organic farmland, the highest absolute number of organic farms is in developing countries such as Mexico, Indonesia, the Philippines and Uganda because of the prevalence of small farms. Furthermore, uncertified organic agriculture is practiced on even more land. Many organic farms in developing countries produce non-certified organic foods for self-sufficiency and local markets. In Africa particularly, organic production is rarely certified. Figures of non-certified organic production are not available.

Demand

37. Consumer demand for organic products is increasing worldwide. The Organic Monitor expected sales of nearly US$40 billion (€30.9 billion) in 2006, reaching US$70 billion by 2012 (Sahota, 2006). Although organic agriculture is now present in most parts of the globe, demand remains concentrated in Europe and North America. The two regions generate most global turnaround in organic business and are at the same time the largest importers of organic products. In many developing countries, the demand and therefore the availability for certified organic food is weak because consumers are not aware of organic production methods. There is a lack of access to market information and market contacts. Another factor is poor differentiation of organic and non-organic products in the marketplace. Competing products such as low-pesticide foods also confuse consumers who sometimes do not trust organic foods and certification. However, the high price premium is the most limiting factor in consumer demand. In many parts of the world, consumers have low disposable incomes and do not have the means to pay extra for organic foods.

38. Certified organic products provide access to lucrative local and international markets, the producers generate higher incomes and consumers have access to high-quality food. There have been a large number of successful organic market initiatives to improve food availability at different levels.

Household and community level

39. At household and community level, organic rural and rural-urban markets and networks contribute to improving food quantity, quality and diversified food availability. Food quality is not only an issue for wealthy consumers. Rural and urban consumers with relatively low purchasing power all over the world give high importance to quality issues. Examples include:

- The south Brazilian network EcoVida promotes organic food to the local community and, at the same time, offers new sources of income and livelihoods for the growers. They sell directly to the consumers via fairs and consumer cooperative shops. Organic food products produced according to the network standards are given a special seal, certified by a participatory guarantee system (EcoVida 2007). EcoVida is a fine example of how producers have developed local markets by building strong relationships with consumers (Organic Monitor, 2006).
- The farmers of an organic coconut cooperative in Baracoa, Cuba, produce their coconut within an agroforestry system that also provides cash crops such as grapefruits, cocoa, honey; self-sufficiency crops such as rice, beans, maize, lettuce, yams, sweet potatoes, avocado, plantains and other vegetables; livestock production such as creole pigs, chicken and sheep (free-roaming); and wood for construction and cooking from shade trees such as Inga, Erythrin and, Leucaena (Kilcher 2006).
- Consumers in Islamic countries are particularly quality conscious and sensitive to regional provenance. Wadi El Tayim, a Lebanese organic market initiative, is a women's cooperative that produces Lebanese specialities with artisan processing techniques. Their main markets are Arab communities that are familiar with the much valued Lebanese cuisine (Kilcher 2007). The Association for Lebanese Organic Agriculture provides market intelligence to the operators in the organic market and promotes local organic produce.

40. Many other examples indicate that developing regional and local trade with organic products has a direct impact on food availability. Although the main challenges at this level is high consumer prices. In the EU, organic vegetables and fruits average cost is 55 to 160 percent more than conventional, while organic milk products are 35 to 55 percent more expensive (Hamm and Gronefeld, 2004). There is no comparable data available for developing countries. However, it is evident that most consumers in developing countries cannot afford to pay premium prices for organic products.

National level

41. At national level, organic markets have the potential to improve food security and to improve national food supply. This is true because organic farms produce more efficiently, with more sustainable and stable yields (see OFS/2007/4). In some cases, organic farms even enable an increase in production. Additionally, organic farms harvest a higher diversity of products from the same area, providing more food for the farmers' families and reducing dependency on a few products in the market. Diversity in agricultural production and value added products increases income-generating opportunities and spreads the risks of failure over a wider range of crops and products. Diverse

agricultural production, rather than focusing on a few cash crops, facilitates the creation of farmer-to-farmer enterprises and farmer-owned trading companies as well as non-farm enterprises, such as agro-ecotourism. Examples include:

- The Indian Organic Farmers' Producer Company, Jaiva, is owned by organic farmers and aims to market the complete diversity of organic products from India on the domestic and international market. Jaiva, founded in Kerala in 2004, trades a broad range of organic spices, tropical fruit, coffee, cocoa, rice and other products.

42. At the national level, such initiatives contribute to improving the viability of rural economies, improving self-reliance of local food systems, increasing food self-sufficiency and improving the import/export balance. Increased quantity and quality of national products and more diversity in food supply reduces the need for imported food. However, most markets in transition and emerging markets are mainly producers of organic products rather than consumers. The big challenge for organic food producers in Asia, Africa and Latin America is to become less reliant on exports and to develop domestic markets for their products in order to spread the business risk of organic food production. Domestic market development is a pre-condition for a healthy organic sector, especially to find economic use for lower value crops used during the rotation period, in an intercropping or agroforestry system.

43. By building on local knowledge and using local services such as organic extension and certification programmes and by enhancing short food supply chains, the approaches applied in organic agriculture revitalize traditional customs. Employment opportunities and higher incomes encourage farmers to remain in agriculture and to invest in rural communities. With organic agriculture, producers regain control of the production cycle and increase their self-confidence (see OFS/2007/2). Developing organic farmers' organizations, standards, certification systems, extension services, education, research and food supply value chains brings producers together in a new manner. Such communities are in a stronger position to demand and assert their rights and to maintain or improve their economic position (Kilcher, 2007).

International level

44. At international level, it is difficult to measure the contribution of organic agriculture to international food security. No figures are available and it might be rather speculative to make a statement, considering that the organic sector barely caters to 2 percent of world markets. However, the high potential of organic agriculture in production and market development certainly is a positive driving force towards improved international food security. At the macro level, a more locally oriented agricultural system can improve national food self-sufficiency and empower the trade position of its producers in the international market. A serious challenge is to bring the producers together, to create participatory networks, to develop value chains based on fair trade and to improve access to the organic market for producers and consumers at a global level.

45. There are several ongoing debates concerning international organic market development. The following are the most prominent.

- Energy production: Organic agriculture has the potential to improve energy self-sufficiency at the national and international levels. Most so-called “biofuel” projects are still based on conventional production of energy-plants (sugarcane, maize, wheat, etc.) that call for high input of synthetic fertilizers and pesticides and thus high energy input. The energy balance of such projects is not well known, especially if “biofuel” is used far away from the production site. However, real “biofuel” production – meaning organic biofuel production with local and low-input technologies, destined for local markets – has the potential to produce a positive energy balance and thus contribute to local energy self-sufficiency. Still, there is a lack of data on the contribution of organic agriculture to energy production. The common global understanding of what is appropriate in organic food labeling includes aspects such as the energy balance of organic products, including food miles. Many consumers expect organic food production to minimize food miles. Presently, organic regulations and certification rarely take into account the proximity of production and consumption. Only a few labels, such as Bio Suisse, do not accept transport by plane.
- Diversification and locally adapted systems versus liberalized world market: Diversification – a core concept of organic agriculture – is in direct opposition to the “concept of comparative advantages”. The concept of comparative advantages indicates that a commodity should be concentrated on the few sites that offer the best advantages worldwide. It is evident that diversification guarantees a safer food supply worldwide compared to a system where each crop is produced in very few production spots. Worldwide integration of all markets into one worldwide market place for products where all suppliers compete on an equal basis so that the cheapest supplier prevails overcasts environmental and social values (Vogl, et al., 2005). Some experts (Willer and Yussefi, 2003) believe that the implementation of worldwide harmonized standards for organic agriculture is important for further growth of the organic market. However, other experts believe that globalization will undermine organic agriculture by forcing farmers, processors and certifiers to submit to the forces of the so-called free markets (Singh, 2001). Singh worries that homogenization and the dictates of the market will erode both biodiversity and the diversity of cultivation.

46. The debate on globalization and its effects on one hand, and diversification, food miles, fairness and food safety by production adapted to local site conditions on the other hand, will certainly gain importance in the future.

III. CONCLUSIONS AND RECOMMENDATIONS

A. CONTRIBUTION OF ORGANIC AGRICULTURE TO FOOD AVAILABILITY: KEY FINDINGS

47. Organic agriculture substantially contributes to food availability in a large number of countries and projects. However, it must be kept in mind that sustainable production is a core of organic agriculture and, accordingly, yield increases are not the only focus. The real beneficiaries of organic agriculture are the farmers and the ecosystem. Through intelligent management of natural resources, fewer inputs such as fossil fuel and pesticides are needed to produce the same output as conventional

farms. Most farmers considering conversion to organic agriculture want to know what yield levels they can expect. If conventional farm management is on a low-input level prior to conversion, organic farmers can expect to maintain similar yields. If the farm was managed at a high-input level, yields will drop initially, recover as soil fertility recovers and then stabilize on a level corresponding to the ecosystems' carrying capacity.

48. However, conversion to organic agriculture is not always beneficial in terms of production costs. In countries of temperate areas where labour is expensive, labour-intensive organic farms may have higher production costs compared to conventional farms. In developing countries, where labour costs are low, we can expect a two-fold benefit from organic agriculture: organic agriculture has the potential to offer employment to landless people in rural areas and; production costs of organic farms may be slightly lower than those of non-organic farms because they substitute expensive synthetic fertilizers and pesticides with farm own or local resources and cheaper labour. In both developed and developing countries, market opportunities such as premium prices, long-term contracts, access to high-quality markets and capacity building are required for organic farmers to benefit financially and socially from their conversion.

49. Organic agriculture makes diverse food available on local, national and international markets.

- At the household and local community level, organic agriculture provides access to attractive local and international markets and promotes alternative food chains as well as community-based rural-urban networks. Organic agriculture, therefore, makes diversified food available to the poor and offers new income sources and livelihoods. Integral supply chains and organic market initiatives contribute directly to the self-reliance of local food systems and to food availability.
- At the national level, organic markets have the potential to increase food security and national food supply. Stable, diverse farms contribute to the availability of food products on the national market. Organic agriculture, therefore, improves the viability of rural economies and increases food self-sufficiency.
- At the international level, the high potential of organic agriculture in production and market development are positive driving forces for improving international food security. A strong food identity and self-confident farmers can strengthen the position of a country in the international market. Organic agriculture also has the potential to make energy available with real "biofuel" and to reduce food miles.

B. CHALLENGES AND RECOMMENDATIONS

50. Organic agriculture is now present in most parts of the globe. However, only a relatively small percentage of producers and consumers benefit from organic agriculture. Therefore, the impact of organic agriculture on food availability is still limited.

51. On the production level, this is due to the difficulty of building up a comprehensive soil fertility management system that is able to provide the crops with sufficient nutrients and water. In the

temperate areas, there is plenty of experience in soil fertility management techniques (e.g. compost preparation, planting green manure and cover crops), but the implementation of these practices is costly, in terms of high labour and machinery costs. In the semi-arid and arid tropical areas where biomass production is limited (be it fodder for livestock, green manure in the field or organic material that can be composted), the build-up of organic matter in the soil as a nutrient reservoir is a serious challenge. Pest and disease problems deter organic production only in very specific areas and in particularly sensitive crops. Given that a diverse cropping pattern exists in the area, pests and diseases can usually be kept under sufficient control by indirect, preventive measures.

52. Organic agriculture is knowledge intensive. Farmers need to be aware of underlying biological principles and ecological dynamics in order to make them work for their own purposes. While organic farmers in developed countries are well informed about integrated farm management and organic agriculture practices, organic farmers in developing countries face severe difficulties in finding relevant information, be it in the form of publications, training or extension. This can lead to their simply substituting organic inputs for chemical inputs, which does not adequately reflect the idea of comprehensive organic management or, in the last consequence, to detrimental mismanagement of crops, which becomes particularly obvious in perennial systems.

53. On the market level, this is indicated particularly by the fact that most developing countries export the largest share of certified organic products to Europe and North America. Domestic markets for organic food develop slowly in developing countries because of:

- lack of awareness at consumer and producer levels and, therefore, lack of trust in organic production and certification;
- inability of most developing country consumers to pay premium prices for organic products; and
- lack of market access and market information.

54. In order to address ways for organic agriculture to multiply its impact on food availability. public and private sector capacities need to be strengthened at both production and market levels as follows:

At production level

- Training and extension – provide farmers with basic knowledge of biological principles and ecosystems processes, and support them in the implementation and adaptation of sustainable farming practices.
- Participatory research – develop locally adapted technologies, particularly in soil fertility management. The issue of increasing soil organic matter and soil microbial activity and managing timely mineralization and nutrient availability is complex and particularly demanding in areas where biomass production is limited due to climatic constraints.
- Organic input production – increase access to compost, seeds and planting material. Increasing access to compost requires availability of biomass, knowledge of composting techniques and, for larger scale farms, considerable investments in mechanization. Community-based compost projects can be designed for the farmers of a village to produce

compost together on one site and learn together to produce a high-quality compost. Seeds for cover crops, disease-resistant seeds and planting materials could also be produced locally by farmer groups, with the support of regional researchers. Production and access to means of biological control can be improved through the development of affordable and locally adapted technologies.

- Farming system comparison trials – establish physical references for organic agriculture in as many places as possible to give farmers a basis for decision making in view of a possible conversion to organic agriculture; to back up local extensionists and development projects with evidence from the field; to support national authorities, cooperation agencies and international donors in their strategic orientation and action plan development; to aggregate scientifically robust data on productivity, efficiency and ecosystems services from as many different contexts as possible; and to identify challenges for organic agriculture in order to address them in a targeted way.

At market level

- Create awareness: introduce producers and consumers to organic agriculture, particularly in countries where organic agriculture is being introduced. It is possible to improve the level and quality of information through materials ranging from simple leaflets up to Web sites and comprehensive information campaigns.
- Increase information and transparency: provide farmers and other stakeholders with information through market studies, market intelligence and business directories, published for free access on paper and on the Internet.
- Link production with supply: bring market actors together via networking, trade fairs, food festivals and other events. Vertical and horizontal cooperation of players in the supply chain such as producers, traders, processors and retailers is essential and needs support.
- Support creative initiatives: create and develop organic market initiatives, value chains and farmer enterprises for organizing processing and marketing of their products, based on successful market initiatives initiated by producer groups, NGOs or companies. Such initiatives should also include diversified activities such as tourism, capacity building and environmental protection. There is a need for projects and programmes to support organic market initiatives through coaching, capacity building, financial support for first marketing steps and fair credits.
- Develop domestic markets: focus organic market initiatives specially to develop the domestic market for organic food products. There is a need for accompanying measures such as regional and national promotion activities, development of regional labels and capacity building.
- Reduce certification costs: overcome the expense of organic certification, an insurmountable barrier for many producers. There is a need for local certification bodies and participatory guarantee systems.
- Create locally adapted standards: support trade rules and favourable business conditions up to comprehensive national action plans in order to support the development of the organic market. Trade should support diversity, fair trade, local solutions for organic production and certification, and local food supply chains.

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CASE STUDIES

The Impact of Compost Use on Crop Yields in Tigray, Ethiopia

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Introduction

The results reported in this paper come from farmers' fields in Tigray Region, northern Ethiopia. In 2003, the population of Tigray was over 4 million, occupying an area of 50,078.64 km^2. Most households in the region are rural and practice mixed crop/livestock agriculture with an average of less than 1 ha cultivated land per household. Average annual rainfall is 500–700 mm in the cultivated highlands. Precipitation occurs mostly during the short summer rainy season (end of June to mid-September), often falling as intense storms.

In 1996, the Institute for Sustainable Development (ISD) began an initiative called the Sustainable Agriculture Project, which included training for farmers and local agricultural experts in making and using compost in addition to more traditional ecologically based practices. Farmers continued to use their own crop varieties and agronomic practices. The objective of the project was to determine if an ecological approach could help to restore soil fertility and raise crop yields. Beginning in 2001, yields were recorded from samples of farmers' fields each year until 2006.

The methodology was based on the crop sampling system of FAO. Three one-metre square plots were harvested from each field to reflect a range of crop conditions. The harvested crops were then threshed and the grain and straw weighed separately. Data were recorded along with the name of the farmer, the crop, the treatment, the location and the date; farmers kept the straw and grain. Straw is important as the main source of animal feed during the dry season and animal manure is an important raw material for compost-making.

Results

Between 2001 and 2006, yield data of 14 crops were collected from 779 fields. The data were analysed using the statistical program STATA. The average grain and straw yields converted to kg/ha for the seven most widely grown crops are shown in Table 1 with the overall average of grain and straw yields for all crops shown in Figure 1.

Grain and straw yields were separately subjected to linear regression analysis based on the values obtained from separate fields in which compost, chemical fertilizer (diammonium phosphate and urea) and no input were applied (control). The null hypothesis was that the treatments would have no impact on the yields, but this was not the case. The increase in grain yields in fields where chemical fertilizer was applied was significantly higher ($p>99\%$) than in the fields where no input was applied, and grain yields in fields where compost was applied were significantly higher ($p>99\%$) than those in fields where chemical fertilizer was applied. The significance of the differences in straw yields was similar. The differences in yields of each of the individual crops were also significant.

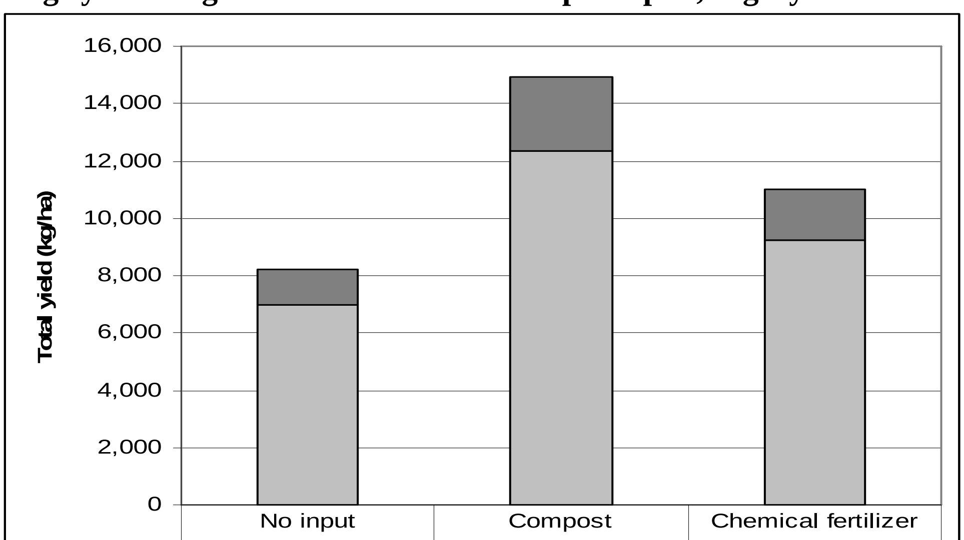
Overall, compost doubled the grain yield of all crops. It also increased straw yield, but not to the same extent as grain. When grain yield was compared to total biomass, it was found that grain cultivated with no input equalled 14.7%, grain from compost was 17.1% and grain from chemical fertilizer was 16.1% of the total biomass yield for each respective treatment. One reason why compost significantly increased yields could be that the farmers were still using their own varieties, which had been selected by them in an essentially organic environment in which overall soil fertility is more important than simply the amounts of major nutrients N, P and K. The fact that other nutrients are important is reflected in the response of the legume crop broad bean.

Another reason why farmers have been ready to adopt compost as an input is that it avoids the financial risk of procuring chemical fertilizer on credit; compost is available when it is needed while chemical fertilizer is sometimes delivered late.

Table 1: Average yields for seven crops in Tigray, 2001–2006

	Average Yield (kg/ha)					
Crop type	No input (control)		Compost		Fertilizer	
	Grain	Straw	Grain	Straw	Grain	Straw
broad bean (n=38)	1,544	7,119	3,535	13,998	2,696	11,350
barley (n=112)	1,161	6,927	2,374	13,670	1,832	8,269
wheat (durum) (n=141)	1,313	6,464	2,791	10,740	1,760	8,453
teff (n=223)	1,179	7,384	2,401	12,193	1,774	11,096
maize (n=83)	1,843	13,545	3,895	17,840	3,031	14,363
'hanfets' (n=109)	858	6,706	1,341	10,187	1,199	6,712
finger millet (n=30)	898	4,177	2,496	12,148	1,297	6,655
'hanfets' is a mixture of barley and durum wheat						

Figure 1: Average yields of grain and straw for all crop samples, Tigray 2001–2006



	No input	Compost	Chemical fertilizer
Grain	1,208	2,550	1,783
Straw	6,987	12,375	9,231

Treatment

Conclusion

Since 1998, the Bureau of Agriculture and Rural Development of Tigray Region has adopted the production of compost as part of its extension package. A reflection of the success of this approach is that between 1998 and 2005, chemical fertilizer use decreased from 13 700 to 8 200 tons, while total grain yield for the region almost doubled from 714 000 to 1.3 million tons. Production and use of compost is also being promoted in other regions of Ethiopia, particularly through the Community-based Participatory Watershed Development project of the Ministry of Agriculture. Further intensification of the organic approach would require a breeding strategy tailored for the purpose.

Pro-Huerta: A National Experience in Organic Production

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Introduction

The purpose of this paper is to relate16 years of national promotion of organic gardens and farms, to assess results and to reflect on the next steps. Pro-Huerta was established in 1990 as a targeted social policy strategy to compensate for structural adjustment policies. Its main objective is to improve the food security of socially vulnerable (urban and rural) populations, by enhancing food availability, accessibility and variety through organic home production determined by local characteristics and traditions.

Pro-Huerta is jointly implemented by the National Institute of Agricultural Technology (INTA) and the Ministry of Social Development (MDS). This dual ownership permits linkage with the other INTA extension programmes and the MDS package of programmes. Pro-Huerta has a National Coordinating Body and 24 Provincial Coordinating Bodies. Each province has a technical team of agricultural engineers, agricultural technicians and social scientists covering the different areas. It currently has 500 technicians at national level. Another key player is the voluntary or institutional promoter (teacher, health agent, etc.). There are 17 000 promoters operating at local level in seed distribution, skills organization and follow-up collaboration.

Results

Basic operational strategies include promotion, training, provision of strategic inputs and technical assistance. These are implemented through the network of technicians and promoters. Central vehicles for strategic implementation are inter-institutional linkage and network building. The programme supplies seeds, a main strategic input, through a smallholder producer cooperative in San Juan province. Access is conditional upon participation in training courses run by programme experts, who also provide training materials.

For protein supply, the programme provides dual purpose chicks from a Pro-Huerta institutional network of breeding centres. Access to the birds requires proven responsibility and creditworthiness in the management of gardens. Pro-Huerta experienced sustained growth in the 1990s, peaking at 460 000 gardens in 1999. There was then a brief decline because of financing difficulties followed, since 2003, by stable recovery at about 550 000 gardens (family, school, community and institutional).

The model household garden advocated can supply 70 percent of a family's fresh vegetable needs. Such gardens serve as a springboard for community promotion activities. Pro-Huerta has proven its validity as a tool for enhancing food security and promoting social networks.

Pro-Huerta's key strengths include:

- Significant territorial presence thanks to the institutional structure of INTA, reaching 88 percent of the country's municipalities.
- High social appreciation among beneficiaries, technicians and promoters.

- National reference for training in organic agriculture topics for home production of food.
- Programme implementation has developed a wide range of appropriate technologies.
- Programme sustainability has fostered credibility of results.
- High level of coordination with grassroots organizations, religious, municipal and school bodies and other actors of civil society.
- High level of commitment of its technical corps and the promoters.

Pro-Huerta's key weaknesses include:

- Inadequacies of the programme's monitoring and evaluation system.
- Insufficient processing and retrieval of production and organization experiences developed under the programme.
- Excessive dependence on external inputs (seeds, birds, etc.). This has also restricted recourse to local species.
- Precariousness of use of production spaces.
- Limited support to operations extending beyond home production.

New challenges:

On the basis of these strengths and in an attempt to overcome the noted weaknesses, an integrated project is being introduced with the following objectives:

- to strengthen and develop skills that will help optimize organic production and consolidate the organizational and social capital development of vulnerable households involved in the home production of food;
- to retrieve, develop and implement better performing organic production models;
- to retrieve and develop local plant and animal species and food, aromatic and medicinal species of local interest;
- to retrieve, develop and disseminate machinery and equipment for organic production and commodity processing;
- to develop procedures and tools for household access to spaces available for production. This includes issues of environmental rehabilitation and land-use planning in urban and periurban areas;
- to develop a system of human resource training in food security and education, social economics and agroecology;
- to strengthen socio-organizational processes for food sovereignty, inclusion and social equity;
- to promote the development of financial systems for social economics and alternative forms of marketing; and,
- to develop a system of information, monitoring and evaluation for programme activities.

Conclusions

The Pro-Huerta experience has demonstrated that organic production is clearly appropriate for work targeting the poor. We believe that Pro-Huerta's operations can be extended much further, refining its role in achieving food security and social inclusion, raising its present levels of production and stimulating the development of a social economy that includes the strengthening of local non-traditional markets associated with urban agriculture.