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Global organic market access

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Abstract

Organic trade is growing at the rate of 10%-20% per year worldwide with over 100 countries exporting certified organic products and over 400 public and private certification bodies in the global organic marketplace. The presence of many governmental and private standards and technical regulations governing organic production and certification, well as the limited scope of mutual recognition and equivalency among these systems, places a burden on producers and traders because they need multiple certifications to access different markets. The multitude of standards and certification requirements are a major obstacle to the growth of the organic sector, especially in developing countries. In 2001, IFOAM, FAO and UNCTAD joined forces to search for solutions to the problems in the global organic marketplace. They created the International Task Force on Harmonization and Equivalency in Organic Agriculture (ITF). In 2008, ITF ended its work and launched 2 international Tools for harmonization and equivalence. The International Requirements for Organic Certification Bodies (IROCB) is a set of performance requirements for organic certification. This is a normative document including ISO 65 requirements and additional organic-sector requirements. This document is an international "common denominator" that reconciles differences among various organic certification performance requirements (both private and government). The other significant document is called EquiTool. It is a tool for determining equivalence between standards for organic production and processing, a set of procedures and criteria for assessing equivalence, and a flexible blueprint for an equivalence assessment process. IFOAM, FAO and UNCTAD have started a follow up project called Global Organic Market Access (GOMA). GOMA will communicate results and promote adoption of ITF Tools, assist developing countries to use ITF results and foster regional cooperation among stakeholders.

Keywords: Organic trade, certification, standards, regional cooperation

Introduction

Organic trade is growing at the rate of 10%-20% per year worldwide with over 100 countries exporting certified organic products and over 400 public and private certification bodies in the global organic marketplace

The presence of many governmental and private standards and technical regulations governing organic production and certification and the limited scope of mutual recognition and equivalency among these systems places a burden on producers and traders because they need multiple certifications to access different markets.

The multitude of standards and certification requirements are a major obstacle to the growth of the organic sector, especially in developing countries.

Background

In 2001, IFOAM, FAO and UNCTAD joined forces to search for solutions to the problems in the global organic marketplace and created The International Task Force on Harmonization and Equivalency in Organic Agriculture (ITF).

In 2008, ITF ended its work and launched 2 international Tools for harmonization and equivalence.

The International Requirements for Organic Certification Bodies (IROCB) is a set of performance requirements for organic certification. This is a normative document including ISO 65 requirements and additional organic-sector requirements. This document is an international "common denominator" that reconciles differences among various organic certification performance requirements (both private and government).

The other significant document is called EquiTool. It is a tool for determining equivalence between standards for organic production and processing, a set of procedures and criteria for assessing equivalence and a flexible blueprint for an equivalence assessment process.

Global Organic Market Access Project

IFOAM, FAO and UNCTAD have started a follow up project called Global Organic Market Access (GOMA). GOMA will communicate results and promote adoption of ITF Tools, assist developing countries to use ITF results and foster regional cooperation among stakeholders.

The 3 year project has four main objectives

Objective l

- Targeted presentations and interventions at international, regional and national events of importance. The project will use, adapt and update the existing ITF presentation materials, deliver clear key messages and train a limited number of "ITF Ambassadors" that will bring the ITF recommendations to relevant events:
- Promotion of the IROCB and EquiTool in key events;
- Advocating for the revision of ISO Guide 65 (certification requirements) to become more suitable for the organic sector and IROCB in particular;
- Planning and activities to support the adoption of the IROCB or main components thereof, as an ISO or Codex Alimentarius Commission standard or guideline;
- Updating and maintenance of the ITF web site to turn it into an effective information dissemination, communication, training and advocacy tool;

- Translation of key ITF materials to allow their wide dissemination (in addition to what was translated during the ITF project).

Objective 2

- Technical assistance to selected countries and policy support to East Africa and Pacific standards;
- Development of practical guidance and policy advice to stakeholders on harmonization and equivalency options;
- Putting the EquiTool and IROCB into practical use, based on a pro-active policy framework and stakeholders initiatives.

Objective 3

- Analyses of and promotional communications for the various regional initiatives; including liaison with authorities regulating organic export markets;
- Facilitation of international third party assessment of regional guarantee systems;
- Participation of key stakeholders in relevant regional events;
- Workshops for participants in regional initiatives to share experience;
- Study on how organic equivalence can be part of regional trade agreements, and if the study is positive, possible support to such a process.

Objective 4

- Technical reports on emerging issues and studies with updated information and analysis
- Workshops on the reports and studies;
- Participation by project experts in consultative meetings or visits by experts to the relevant parties;
- Information dissemination – website, web seminars, web training etc.;
- An international conference, with funded developing countries' attendance, to be held in 2011, to review the IFT recommendations; the project progress and update the analysis.
- If needed, revision of the IROCB and the EquiTool.

Two of the objectives involve regionally or in-country focused work with stakeholders in developing countries and regions to assist them to implement the Tools and recommendations and to facilitate regional cooperation such as equivalence agreements and new regional standards development.

At this point the Steering Committee anticipates assistance to Central America for regional standards development, assistance to East Africa and the Pacific Islands to get international recognition for their recently developed regional standards, and a scoping study followed by assistance in Asia toward harmonization and equivalence. Implementation in these regions will be handled through contracted experts, to the extent allowed by the budget, in collaboration with the GOMA Project Manager.

The project also provides for general monitoring of the organic trade barrier situation, feedback on the Tools leading to possible revisions of these instruments, and a major Harmonization & Equivalence Conference in 2012.

Conclusion

GOMA is an ambitious project that will assist the process improving organic trade between countries by providing consistent criteria for both establishing equivalence in standards and certification systems.

Regulation & certification: How to break the barriers among the APEC member economies

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Abstract

The maturing of the organic marketplace over the past decades has seen a mixture of non government organisation (NGO) as well as government agency involvement in standards setting, certification and accreditation. The markets of the US, EU and Japan all now have well established government systems of standards setting and accreditation. Such approaches have created certainty as well as confusion and challenge for those wishing to either trade in or import into those markets. Australia has since the 1990s had well established (government supported, but industry driven) national standards setting and accreditation criteria, oriented to the export market, in particular the EU. A balance of government involvement and industry self-regulation has also worked exceedingly well within what is now a thriving domestic organic market. This has not been achieved without huge industry investment however, including financial, technical and human resources. Such multi-layers of market access requirements, additional government criteria, not to mention market driven supplier requirements, clearly add to costs, but more importantly to confusion and degrees of difficulty which have choked and in some cases turned off product supply into some markets, and therefore lost opportunity for the producing economy. Equivalence (of standards, of certification and of accreditation criteria), set up as an ideal by IFOAM in its formative years of standards setting, must remain an ideal to strive for. Like "world peace" however it may prove constantly elusive, and in this context we must ensure we achieve the next best model for efficient market and regulatory function, which is partnerships of NGOs (such as IFOAM/IOAS and certification agencies) with industry invited government involvement and multi-government support and recognition where feasible and achievable. The Australian story of this path is indicative of an ongoing quest to deliver efficiency and simplicity, as well as ongoing organic integrity for the domestic and global organic marketplace. There remain many challenges ahead for APEC members to achieve this collectively, with rewards far exceeding costs for all.

Keywords: Organic Standards, certification, accreditation, equivalence, compliance

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30 years of standards setting and regulatory arrangements: 1970s to 2000s

The maturing of the organic marketplace over the past decades has seen a mixture of non government organisation (NGO) as well as government agency involvement in standards setting, certification and accreditation. The markets of the US, EU and Japan all now have well established government systems of standards setting and accreditation. Such approaches have created certainty as well as confusion and challenge for those wishing to either trade in or import into those markets.

While on the surface, the increased interest in governments, now most recently Canada, in formalizing regulatory arrangements pertaining to the production and marketing of organic products is to be welcomed, with this has evidently come increased layers of bureaucracy, and hence cost, as well as time and distraction in then entangling, or disentangling, other standards and regulatory arrangements from markets seeking access into these newly regulated ones.

Clearly where this has occurred for "gorilla markets" such as the US, EU and Japan, where there are large, well educated and relatively affluent consumer bases to drive demand, these have been reticently enlisted by the organic community as an accepted if not necessary evil.

The risk for APEC however is that members may be tempted to establish models now evolving in markets such as Korea which are not only moving away from equivalence arrangements with other like regulated markets but are adding to costs and red tape for those wishing access to those markets. In this instance we are seeing a national requirement for not only unique and exacting requirements for certification agencies, but with direct and costly accreditation requirements with the relevant government regulatory agency. This has driven importing businesses to achieve certification with foreign certification agencies adding significantly to the cost of doing business. Ultimately this works against most interests, including many of the businesses within the very economy pursuing this type of regulatory approach. It also adds costs and red tape burdens that are negative for the marketplace in general.

Multi-layers of market access requirements, additional government criteria, not to mention market driven supplier requirements, clearly add to costs, but more importantly to confusion and degrees of difficulty which have choked and in some cases turned off product supply into some potential export markets, and therefore lost opportunity for the producing economy.

The opportunity for APEC members is to move to a simpler and more open market model of equivalence of standards (a decades long ideal) and related regulatory arrangements that maintains the essential kernel of organic integrity in the products traded, while simplifying such trade to keep market options open for the very people that these regulations were first set up for: the organic producer and in turn their end consumer.

And both the catalyst and vehicle to deliver this in large measure will be dependent on the vibrancy and capacity of organic industry organisations in each of the APEC member countries. It will also be driven by government interest in investing in the industry sufficiently to understand and appreciate the market and regulatory issues at hand, and to enable effective engagement with government and industry to establish workable and effective policies and models. In the absence of these, APEC risks seeing more complex regulations and over-regulation suiting a dwindling number of stakeholders in the longer term.

Australia: dealing with both exporting and importing and domestic market realities

Australia has since the 1990s had well established (government supported, but industry driven) national standards setting and accreditation criteria, oriented to the export market, in particular the

EU, while operating as a default on the domestic market (National standard for organic and biodynamic produce, 2009). A balance of government involvement, market (retailer) support and industry self-regulation has worked exceedingly well within what is now a thriving domestic organic market.

This has not been achieved without huge industry investment however, including financial, technical and human resources.

Looking at the history and nature of the industry member owned Biological Farmers of Australia Co-op Ltd (BFA) highlights the opportunities as well as challenges for other organisations and countries in the quest to maintain best fit regulatory arrangements and standards setting arrangements appropriate to, and of best use for, the industry.

BFA along with other industry organisations such as National Association for Sustainable Agriculture, Australia (NASAA), arose in the late 1980s in Australia in response to farmer interests in setting organic standards and related regulation arrangements in place that could have meaning both in the field and in the marketplace. Such associations were also designed to lobby governments in relation to industry interests and to promote organic products in the marketplace.

BFA is now an industry services organisation, a turnover of some A$3M with significant funds now being turned both to promotion and permanent professional staff working on organic issues within Australia, and also research into the organic industry. The resourcing of standards setting activities is also a core function of BFA, with 12 sectoral advisory groups feeding into the ongoing process of standards review.

This independence gained from non-reliance on government funding, and more importantly broad industry support with a strong and growing membership base, is a defining feature of the success and vibrancy of the organic community within Australia, which in turn has significant influence on how regulation of the organic marketplace operates.

BFA has two independent subsidiary certification programs: Australian Certified Organic (ACO) and Organic Growers of Australia (OGA) which together make up a majority of certified operators in Australia. The tales of, and market presence of these two programs is indicative of the balance that has been struck in Australia between multi-export-destinations and the domestic market. OGA is now International Organic Accreditation Service (IOAS) accredited to ISO 65 and certifies operators to the BFA maintained Australian Organic Standard (AOS) (Australian organic standard, 2006). This program is designed for the smaller Australian farmer with limited turnover. It was once accredited for export via the Australian Quarantine Inspection Service (AQIS) program.

Ironically, while Australia is traditionally an export oriented economy, the majority of its organic operators are domestic market focused, and the rise in domestic demand within Australia in the past 5 years has further exacerbated this (Australian organic market report, 2008). This trend is expected to continue for the coming years, even with the significant industry investment in compliance to other market regulations requirements (from US, Japan to Canada).

ACO, which is better known internationally and is connected with the use of the Organic Bud logo on products, maintains both specific market access certifications for operators (e.g. USDA NOP; Japan

JAS; etc); is accredited by the Australian Government agency AQIS as well as IOAS accreditation (IFOAM, ISO 65, COS). This is similar to NASAA, while there are 5 other certifiers in Australia with some mix of the above accreditations and market access options for clients.

The Australian organic industry has utilized the services of AQIS, via an industry consultative body called Organic Industry Export Consultative Committee (OIECC), which in prior days was called Organic Produce Advisory Committee (OPAC). This has advised AQIS on the setting of the National Standard for Organic and Biodynamic Produce since the early 1990s. The industry is on the cusp of most likely establishing a new advisory Council that will preside over both export and domestic standard and regulatory arrangements (to be known as the Organic Industry Council OIC).

In parallel with this the industry has moved to set up a new standard via Standards Australia, being a conventional peak standards setting organisation within Australia. This standard, to be finalized in 2009, will remain a voluntary standard potentially to be used by the Courts in the coming years, along with use of other standards and certification program logos. There is strong industry desire to see in the coming year ahead one single base standard signed off by industry with associated accreditation arrangements, similar to, and entwined with the existing AQIS program for export and the existing National Standard. How this will be finalised is yet to be determined, but will occur via the OIC structure through 2010.

A defining feature and benefit of the Standards Australia document is its emulation of the BFA owned Australian Organic Standard in relation to equivalence recognition of key international standards and certifiers. This is a key point, as it draws in and lists the "family of standards" in operation in the world, enabling recognition of these for the domestic Australian marketplace.

The market driven and voluntary nature of the Australian marketplace might be a surprise to some more used to legislative approaches. The key ingredient here has been the support by the main retailers to certified organic product, and the industry efforts through the past decade to "look for the logo" and only buy certified organic product. This has come about from years and in fact now decades of industry organisation support and working with these markets.

Hence it could be argued that Australia is achieving a "best of all worlds" approach here, with minimal government intervention (hence low costs and limited bureaucracy and red tape) combined with active and significant industry investment in both standards and regulatory arrangements and the vital element of promotion of what is organic (certified only, and to a recognised standard).

This option has much to offer the broader APEC community where organic regulations still do not exist. Anything more or less with either lead to excess of cost and red tape or in the latter to the risk of market failures and the loss of confidence by the organic consumer in the domestic marketplace.

Government: Invited or uninvited guests?

It would appear that I am therefore advocating keeping governments out of organic regulations. In fact given existence of the US, Japanese, and now Canadian systems in place, the presence of governments in achieving where feasible equivalence arrangements for these markets is an important step in maintaining efficient arrangements for industry (for example there are now 4 certifiers in Australia directly accredited to the USDA NOP, rather than one government to government agreement that would eliminate this additional cost impost on industry).

Where government investment is needed is in the resourcing and capacity building of its own departments to both understand and engage with the organic industry to ensure effective and appropriate policies, and where relevant, programs.

The important point is that for the majority of APEC members, I am arguing that government intervention in setting specific regulations for organic is not called for, as long as there is active and ongoing industry investment in self-regulation and in standards setting and ownership processes.

The particular example of the Korean regulations are the most extreme case of a “what not to do” scenario. Such an approach is arguably laying undesirable layers of government red tape over the industry, both within the economy and for importers, and in addition has set unrealistic costs onto the broader international community. This example needs to be highlighted as a text book case of what not to do in fostering both open markets within APEC and just as importantly organic integrity and regulatory efficiency in the broader marketplace.

What should be encouraged is government interest in working with the indigenous industry in each member economy on standards matters and where possible assisting in achieving equivalence arrangements with existing regulated markets. Governments can otherwise best help by being aware of and sensitive to the existing governance and regulatory arrangements that the international organic industry has in place in each economy and working with these organisations and programs to continue to self-regulate in those markets.

On the surface the US and Canadian announcement of equivalence recognition of standards in June this year looks promising. The concerns are that not only is this bilateral, rather than multilateral, the industry and government investment in time and resources to achieve this outcome does not bode well as a model of efficiency and effectiveness for the APEC, let alone global, community. Consider for instance the length of time that has transpired in the liaison between US and EU governments in relation to equivalence determination of those standards and regulatory arrangements.

APEC members that are net exporters of organic products should take note that just perhaps the current market regulation situation is as good as it gets. Equally, for those countries with emerging indigenous market demand for organic products, the challenge is to have the willingness and courage to open up both competition and equivalence recognition to fellow organic standards and regulatory programs from other countries.

The specific APEC challenge: How to break the barriers

Hence the solution is that there are a number of solutions required, at both micro and macro levels. I would argue that APEC will clearly not benefit as a whole by seeing further legislative arrangements put in place by individual APEC members, unless those legislations are more aligned with the EU model of equivalence, and certainly not if they are aligned with that of the Korean model. Even in the case of the EU system there will remain the concern of the level of efficiency and effectiveness of such an approach given the significant government investment required in overseeing such regulations, which perhaps now in hindsight the Koreans are also realizing.

There are better options and models, and the Australian situation stands testament to this.

The open economy of Australia in relation to the flow of organic products has fostered and encouraged a vibrant and most importantly self resourced organic industry structure in relation both to standards setting and regulation via certification. It remains enjoying a strong presence of International Federation of Organic Agriculture Movements (IFOAM) via the IOAS, has competitive options for operators needing certification access to the markets of the US, Japan, Canada, etc, and has a vibrant and active domestic market presence which is now gaining ground after decades of being marginal and less than professional.

Australia now arguably has close to a "best of all worlds" situation, where it has internationally respected and accredited certification agencies, competition for service provision for market access, and an open market sufficient to enable relative ease of flow of organic products and ingredients.

This market does not remain without the challenges of exporting into regions that have conformance oriented regulations such as the US or Japan, let alone Korea, however these are not likely to go away in a hurry and the market does now accept most of them as an inevitable hurdle to overcome in doing business. Given the size of these former markets, it is unlikely there would be any change to such circumstances any time soon.

Ultimately the most important and vital essence of the organic industry and its associated movement is the ongoing maintenance of the integrity and meaning of organic standards. There will be constant pressure to "dumb down" standards, particularly where equivalence between regions is sought, and also the pressure to conform to an industrialized food production and distribution system rather than to originating organic ideals.

Not to be forgotten either, just like democratic processes in other fields, is the ongoing balance to ensure that organic sector minorities are heard, engaged with and catered for where justified, but that no single authority or group sector rule in imposing their interests of the broader organic community. Equally the challenge is to have consumers continue to understand and appreciate the challenges for the organic farmer, be they growing vanilla in Sumatra or beef cattle in Australia.

These challenges all require resourcing and capacity building and that best comes from within the industry itself. Hence the ultimate challenge is for the organic movement to remain just that, a movement, via well resourced, and independent (of government and commercial interests) organisations both regulating and promoting the organic message.

Conclusions

Equivalence (of standards, certification and accreditation criteria), set up as an ideal by IFOAM in its formative years of standards setting, must remain an ideal to strive for. Like "world peace" however it may prove constantly elusive, and in this context we must ensure we achieve the next best model for efficient market and regulatory function, which is partnerships of NGOs (such as the likes of IFOAM/IOAS, BFA and certification agencies) with industry invited government involvement and multi-government support and recognition where feasible and achievable. The Australian story of this path is indicative of an ongoing quest to deliver efficiency and simplicity, as well as ongoing organic integrity for the domestic and global organic marketplace. There remain many challenges ahead for APEC members to achieve this collectively, with rewards far exceeding costs for all.

APEC member countries need to continue to work on conceptual frameworks for multilateral arrangements of equivalence. The Australian model, operated for some years now by Australian Certified Organic, which at the domestic level is open to equivalence recognition of the family of international organic standards, delivers a best of all worlds approach to organic market regulation, in the absence of government legislation.

However to this end when looking across the broader APEC member group, the 1994 Bogor Goals for free and open trade have perhaps been forgotten in relation to the free and easy movement of organic products. To this end there remains much to do.

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Organic agriculture mitigates climate change

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Abstract

Climate change, food security, and agricultural productivity are related because climate directly affects the ability of a economy to feed its people. Agriculture is both a cause and a victim of climate change. The solution of climate change caused by agriculture lies in selecting the best form of agriculture and farming practices to provide cost-effective agricultural production with minimum adverse effects on the environment and climate.

Organic agriculture has considerable potential for mitigating climate change, largely due to its greater ability to reduce emissions of greenhouse gases (GHGs), nitrous oxide (N_2O) and methane (CH_4), and also increase carbon sequestration in soils compared with that of conventional agriculture. In addition, many farming practices in organic agriculture favour the reduction of GHGs and the enhancement of soil carbon sequestration. The certification of farming practices as required in organic agriculture provides a transparent guarantee of organic principles and standards. This also allows the enforced adoption of new and effective practices aim at improving the mitigation of climate change. Furthermore, organic agriculture is highly adaptable to climate change compared to conventional agriculture. However, greater recognition of the potential of organic agriculture for mitigating climate change is needed. At present, this recognition depends on the ability of organic yields to out-perform conventional yields, which has been shown to occur in developing countries. More research is needed for improving organic yields in developed countries and in improving the potential of mitigating climate change by organic agriculture.

Future strategies for improving the effectiveness of organic agriculture in mitigating climate change are presented and discussed.

Keywords: Climate change, organic agriculture, greenhouse gases, carbon sequestration

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Introduction

Global warming causing climate change is due to the increase in the average temperature of the Earth's surface air and oceans since the mid-twentieth century and is predicted to continue. The Intergovernmental Panel on Climate Change (IPCC, 2007) concludes that global warming is due to anthropogenic GHGs, which include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. Agriculture is the main contributor to CH_4 and N_2O emissions, and also, to a lesser extent to CO_2 emissions.

Carbon dioxide accounts for about 50 per cent of the warming effect of all climate-impact-gases (IPCC, 2001). Concentrations of GHGs in the atmosphere have increased by about 30 per cent over the last two centuries. Emissions of GHGs increased on average by 3.1 per cent per annum between 2000 and 2006, compared to 1.1 per cent per annum in the previous decade and is predicted to continue to increase rapidly due to economic growth and lack of effective mitigation strategies (Garnaut Climate Change Review, 2008). The average global temperature has risen 0.8 ºC in the past century and 0.6 ºC in the past three decades (Hansen *et al*., 2006), largely due to human-induced activities. If no action is taken to reduce GHG emissions, an increase in global warming of 1.4 to 5.8 ºC over the 1990 level is projected to occur by 2100 and sea level rises by 90 to 880 mm (IPCC, 2001). Glaciers will continue to retreat, permafrost and sea ice are expected, especially in the Arctic and Antarctic regions. The amount and patterns of precipitation will change, causing extreme weather events (e.g. droughts, floods) and changes in agricultural yields, loss of biodiversity and species extinctions.

Climate change, food security, and agricultural productivity are related because climate directly affects the ability of a economy to feed its people. On a global scale, in order to increase food production to meet the need of the ever increasing world population, climate change is the most serious long-term challenge facing the world today.

Relationships between agriculture and climate

Agriculture and climate are inextricably linked. Agriculture is both a victim and a cause of climate change. Agricultural production relies fundamentally on the weather. Increasing severe weather patterns such as droughts, floods, desertification and disruption of the growing seasons in many parts of the world have resulted in negative impact on agricultural production. This negative impact is region-specific and is more severe in developing countries such as Africa, Latin America and India which are already facing food security problems than in developed countries (William, 2007). According to the Food and Agriculture Organisation (FAO, 2008), an increase of two to four degrees Celsius in the average global temperature above the pre-industrial levels could reduce crop yields by 15 to 35 per cent in Africa and western Asia, and by 25 to 35 per cent in the Middle East. The impact has also adversely affected the ecosystems and biodiversity (WWF, 2006).

Agriculture practices exacerbate climate change. Agriculture is a major contributor to the emissions of CH_4, CO_2 and N_2O. A considerable amount of CO_2 has been released to the atmosphere from the combustion of fossil fuels, agricultural and forestry activities, deforestation, and other land use changes (Lal *et al*., 1997, Goh, 2004). Rice production in flooded paddy fields, lagoon storage of farmyard manure, and ruminant digestion of pasture herbage result in the production of CH_4 while N_2O originates from the microbial transformation of nitrogen (N) from fertilisers, manure and soil organic matter. Per unit mass of gas, CH_4 and N_2O cause considerably greater global warming potential (GWP) (21 and 310 times, respectively) than CO_2.

According to IPCC (IPCC, 2004) agriculture contributes 13.5 % of GHG emissions. When direct and indirect (land use, transportation, packaging and processing) are included, the contribution could be as high as 32 % (Greenpeace, 2008).

The largest sources of total non-CO_2 emissions in 2005 were from soil N_2O (32 %) and CH_4 (27 %) from enteric fermentation of cattle (Table 1, Greenpeace, 2008). Emissions of N_2O arose from N fertilisers and manure applied to soils and during manure storage. The livestock sector in agriculture has been identified as a major contributor to global GHG emissions.

Table 1. Direct and indirect sources of agriculture greenhouse gases[a].

Sources of agriculture	Giga tonnes (Gt) CO_2-eq.
Nitrous oxide from soils	2.128
Methane from cattle enteric fermentation	1.792
Biomass burning	0.672
Rice production	0.616
Manure	0.413
Fertiliser production	0.410
Irrigation	0.369
Farm machinery operations	0.158
Pesticide production	0.072
Land conversion to agriculture	5.900

[a] Data from Greenpeace (2008).

The FAO (FAO, 2006) report on the 'livestock's long shadow' indicated that 18 % of global GHG emissions were from livestock (including one third of this from deforestation). This exceeded that from global transport.

The total annual amount of GHGs emitted by the agricultural sector in 2005 was estimated to be between 5.1 and 6.1 Gt. CO_2 equivalents (CO2-eq) (Barker *et al.*, 2007). The estimate showed that CH_4, N_2O and CO_2 accounted for 3.3, 2.8 and 0.04 Gt CO_2-eq, respectively. According to current projections, total GHG emissions are expected to reach 8.3 Gt CO_2-eq per year in 2030 (Smith *et al.*, 2007).

The potential of organic agriculture in mitigating climate change

The solution to present-day climate change problems caused by agriculture systems lies in changing the farming practices of agriculture. According Greenpeace (2008), agriculture has a significant mitigation potential for climate change and could be improved from being the second largest global GHG emitter to a much less important emitter or even a net sink for GHGs.

There is considerable world-wide support at present in advocating organic agriculture for mitigating climate change (e.g. Kotschi and Müller-Sämann, 2004; ITC, 2007; IFOAM, 2008; Ellis, 2008; Smith, 2009). The potential of organic agriculture in mitigating climate change depends on its ability to:

- reduce emissions of GHGs, nitrous oxide, and methane,
- increase soil carbon sequestration,
- enhance effects of organic farming practices which favour the above two processes.

Reduction of greenhouse gas emissions

Recent experimental results suggest that organic agriculture can significantly reduced GHG emissions. For example, two long-term experiments in Switzerland showed that the GWP of all organic crops was reduced by 18 % (Mäder *et al*., 2002; Nemecek *et al*., 2005). This was also reported in some Dutch dairy farms and some vegetable crops (ITC, 2007). In general, the GWP of organic farms is considerably smaller that that of conventional or integrated systems based on per land area. The difference declines when calculated on a per product basis due to higher conventional yields (Badgley *et al*., 2007). This also occurs when the net carbon stock changes (i.e. gains and losses of carbon) are considered (Robertson *et al*., 2000; Küstermann *et al*., 2007).

As both N_2O and CH_4 are more potent than CO_2, their emissions will have considerable impact on global warming than CO_2. Thus, these gases should be included in assessing the effects of any farming practice on global warming by using carbon footprint measurements.

Recently, Hillier *et al*. (2009) reported that organic farms showed a significantly lower carbon footprint compared to conventional and integrated farms, due to N fertiliser use.

Reduction of nitrous oxide emissions

Nitrous oxide emissions are directly linked to the concentration of available mineral N (ammonium and nitrate) in soils arising from the nitrification and denitrification of available soil and added fertiliser N (Alexander, 1977; Firestone and Davidson, 1989; Wrage and Velthop, 2001). High emissions rates are detected directly after mineral fertiliser additions and are very variable (Bouwman *et al*., 1995).The banning of mineral N fertiliser use and the reduced livestock units per hectare in organic farms are expected to reduce the concentration of easily available mineral N in soils resulting in decreased N_2O emissions.

In addition, organically managed soils are better aerated due to the improved soil organic matter levels resulting in better soil structure and physical conditions than that of conventionally managed soils. This leads to less denitrification occurring in organically managed soils causing the release of N_2O.

Zeddies (2002) found that farms in southern Germany gave 50 % lower N_2O emissions without mineral N fertiliser inputs and also with minimum inputs of animal feed from outside the farm. Petersen *et al*. (2005) reported lower N_2O emissions from organic than conventional farms in five European countries while Flessa *et al*. (2002) reported decreased N_2O emission rates in organic farms only when yield-related emissions were not considered. Earlier studies found either no difference or slightly higher N_2O emissions in the organic variant (Stolze *et al*., 2000; Kotschi and Müller-Sämann, 2004).

According to Olesen *et al*. (2006), GHG emissions at the farm level may be related to the farm's N surplus or its N efficiency. Since organic cropping systems are limited by N availability with the aim of balancing N inputs and outputs and N efficiency, GHG emissions in organic farms are lower than those of the conventional farms.

Reduction of methane emissions

The reduction or avoidance of CH_4 emissions is of special importance in global warming from the agricultural sector because two thirds of global CH_4 emissions are of anthropogenic origin, mainly from enteric ruminant fermentation in animals (FAO, 2006) and in paddy rice production (Smith and Conan, 2004). In general, the CH_4 emissions from ruminants and organic rice production are not significantly different between organic and conventional agriculture. Differences are due largely to the extent and intensity of various farming practices and their improvement used within different forms of agriculture.

For example, the amount of CH_4 emitted by animals is directly related to the number of animals (IPCC, 2007), the type of animals, manure management, and diet fed to animals. Intensive conventional farms with higher animal number than less intensive organic farms will have higher emissions although the emissions per unit of product (e.g. meat, milk) might be lower (IPCC, 2007). Chicken and pigs produce much less GHG emissions than dairy cattle and sheep (US-EPA, 1998). Pig produces the largest amount of manure followed by dairy (Steinfeld *et al*., 2006). However, if pig manure is used for biogas production to replace fossil fuels, the net effect on GHG emissions could be significantly less.

Methane is released when manure is stored in liquid forms (lagoon or holding tank) or stored wet as a collection method to handle large quantity of manure produced in intensive livestock systems (Reid *et al*., 2004). However, the CH_4 released from the stored manure can be reduced by cooling, use of solid covers, mechanically separating solids from slurry or capturing the CH_4 released (Clemens and Ahlgrimm, 2001; Paustian *et al*., 2004; Amon *et al*., 2006; Monteny *et al*., 2006). Storing manure in solid form such as composting can suppress CH_4 emissions but may result in more N_2O emissions (Paustian *et al*., 2004).

Efficient and direct recycling of manure and slurry is the best option to reduce GHG emissions as this practice avoids long-distance transport (ITC, 2007). In organic farming systems, cropping depends on nutrient supply from livestock and the combination of cropping and livestock provides an efficient means of mitigating GHG emissions especially CH_4.

High energy products fed to animals produces manure with more volatile solids emitting more CH_4 (Greenpeace, 2008). However, CH_4 emissions per kg-feed intake and per kg-product are invariably reduced by feeding more concentrates and replacing forages (Blaxter and Claperton, 1965; Lovett *et al*., 2003; Beauchemin and McGinn, 2005).

Kotschi and Müller-Sämann (2004) reported that animal longevity is greater in organic cattle farms and this contributed to a reduction in CH_4 emissions. However, milk yields were lower in organic cows due to higher roughage in the diet and this might increase CH_4 emissions per unit milk yield

Although research on CH_4 emissions in organic and conventional paddy rice production is still in its infancy, employing better rice production techniques such as using low CH_4-emitting varieties (Yagi *et al*., 1997; Aulakh *et al*., 2001), using composted manures with low C/N ratio (Singh *et al*., 2003), adjusting the timing of organic residue additions (Xu *et al*., 2000; Cai and Xu, 2004) and using mid-season drainage or avoiding continuous flooding have been shown to reduce CH_4 emissions (Smith and Conan, 2004). However, Akiyama *et al*. (2005) reported that the benefit of draining wetland rice may be offset by increased N_2O emissions.

Increases in soil carbon sequestration

Soil carbon sequestration refers to the storage of carbon in the terrestrial soil in the medium to long term (15 to 50 years) (Goh, 2004). Mechanisms of soil carbon sequestration have been presented by Goh (2004). Soils contain about 1500 Gt of organic carbon (Batjes, 1996) which is about three times that in the vegetation and twice that in the atmosphere (Schlesinger, 1995; IPCC, 2000). Thus a small change per unit area in the soil carbon pool can have important implications in the global carbon balance and climate change.

Organic farming practices such as the use of green manure, animal manure, composts and rotation with intercropping and cover crops enhance soil carbon sequestration and reduce soil carbon losses by soil erosion in addition to increasing soil fertility and physical conditions for plant growth (Reganold *et al*., 1987; Goh, 2004). Although soil carbon sequestration varies considerably, results from long-term farm comparison and field trials showed that organically managed soil have higher soil organic matter content than those of conventional systems (Table 2, ITC, 2007).

Table 2. Carbon sequestration rates in organic farms[a].

Trial	Variant	Result
DOK trial, Switzerland, data for 1978-1998 (Fließbach *et al*., 2007)	Biodynamic with composted farmyard manure	Level of soil organic matter remains stable
	Conventional stockless (mineral fertilizer only)	Decrease in soil organic matter: 191 kg ha^{-1}compared to the biodynamic variant (= -13%)
Bavarian farms, Germany (Küstermann *et al*., 2007)		Sequestration rates of 110-396 kg ha^{-1} $year^{-1}$
		Lost 249 and 55 kg C in fields managed with integrated pest control
Rodale experiments (Pimentel at al. 2005)	Manure-based organic system	Soil C increase 981 kg ha^{-1}
	Legume-based system	Soil C increase 574 kg ha^{-1}
United States farming trials (Marriott and Wander, 2006)		14 % higher soil organic C in organic than in conventional systems

[a] Source: ITC (2007).

Many long-term field trials have also shown that regular additions of organic materials maintained or increased soil organic carbon and soil productivity (e.g. Powlson *et al*., 1998, Nyamangara *et al*., 2001). For example, results of long-term trials comparing organic and standard conventional cropping systems in the United States showed that organic amendments and cover crops resulted in greater accumulation of soil organic carbon than either N fertiliser or conventional practices (LaSalle *et al*., 2008; Sainju *et al*., 2008). Long-term Rodale Institute Farming Systems Trial showed that composting enhances soil carbon accumulation. Other trials also reported that compost recycled nutrients to plants (Poudel *et al*., 2002; Pimentel *et al*., 2005; Miller *et al*., 2008). Recently, Nayak *et al*. (2009) reported that long-term applications of compost invariability led to increases in soil organic carbon, even when it was applied once a year.

Under permanent organic cropping systems, higher organic carbon accumulation was obtained from the addition of organic manures, plant residues, mixed cropping, legume-based pastures in crop rotation or agroforestry (Drinkwater *et al*., 1998; Kumar and Goh, 2000; Goh, 2001; 2002).

On the other hand, the use of mineral fertilisers in conventional agriculture contributes to increasing oxidation of soil organic matter and thus increased soil carbon losses (Bellamy *et al*., 2005; Khan *et al*., 2007; Lal, 2009; Schipper *et al*., 2009). Bellamy *et al* (2005) reported 92 % of soil carbon losses in 6,000 soil samples in Wales and England between 1978 and 2003. Annual CO_2 emissions from intensively cropped soils could be as much as 8 % of national industrial CO_2 emissions (Bellamy *et al*., 2005).

Effects of organic farming practices on reducing greenhouse gas emissions, and enhancing soil carbon sequestration

- Effects of major organic farming practices which reduce GHG emissions and enhance soil carbon sequestration are related to the following:
- less fossil fuel consumption and energy inputs,
- using organic biomass as a substitute for fossil fuel,
- enhancement of soil carbon sequestration in organic farms compared with conventional no-till or minimum tillage cropping systems
- less carbon losses due to soil erosion,
- enforcing certification and monitoring of organic farming practices.

Reduction of fossil fuel consumption and energy inputs

Both conventional and organic agriculture relies on solar and fossil fuel energy for food production. The use of fossil fuels in agriculture produces globally the second major source of GHG emissions and thus any reduction on fossil fuel use mitigates climate change.

According to Pimentel (2006) the conversion to organic farming systems can reduce the dependence of farmers on energy and increase the efficiency of energy us per unit of production. Results from Rodale Institute Farm Systems Trials (21 years, 1981 to 2002) showed that fossil fuel energy inputs for organic corn production were about 30% lower than that for conventionally produced corn (Pimentel *et al*., 2005; Pimentel, 2006). Topp *et al*. (2007) reported that the energy inputs per unit area required for organic grown crops are typically 50 % of those in conventional crops due to the lower or no fertiliser and pesticide input in organic agriculture, although this is partially offset by mechanic cultivation in organic farms.

Leake *et al*. (1997) showed that three times more machine energy was required to produce an organic than a conventional crop. However, when the external energy inputs of fertiliser and pesticide production were taken into account, organic farming systems required only half the energy input of the conventional system (Topp *et al*., 2007).

Using data from a long-term silage experiment in Scotland, Topp *et al*. (2007) showed that in spite of comparable outputs of energy in the biomass of conventional and organic systems, higher output/input energy ratio was obtained for organic than for conventional systems (Table 3).

Table 3. A comparison of energy use in the production of silage from a conventionally managed grass ley and one under organic management[a].

	Conventional		**Organic**	
	Nutrient input/grass yield (kg ha^{-1})	Energy (MJ ha^{-1})	Nutrient input/grass yield (kg ha^{-1})	Energy (MJ ha^{-1})
Nitrogen	125	7692	168	none
Phosphorus	40	469	35	none
Potassium	60	452	20	none
	Conventional		**Organic**	
	Nutrient input/grass yield (kg ha^{-1})	Energy (MJ ha^{-1})	Nutrient input/grass yield (kg ha^{-1})	Energy (MJ ha^{-1})
Machinery field work		2570		2570
Field work fuel		3530		3530
Sprays, etc.		418		none
Total		15131		6100
Grass yield	4400	27720	5350	33705
Energy output/input		1.83		5.53

[a] Source: Topp *et al*. (2007).

The difference was attributed to the energy required for N fertiliser manufacture which is not needed in organic agriculture. Organic farming systems are generally self-sufficient in N requirements relying on the recycling of manures from livestock, composts and crop residues especially N-fixing residues. Thus, N fixation by legumes plays a critical and important role in mitigating climate change. The biological N fixation by forage legumes is a major N input in Australian arable farming systems (Haynes *et al*., 1993, Nguyen *et al*., 1995; Goh and Williams, 1999). Badgley *et al*. (2007) estimated that as much as 154 million tonnes of N can be obtained from biologically fixed N, which exceeds N fertiliser production from fossil fuel. This source of N should be exploited for agriculture to mitigate climate change.

The energy required for off-farm agriculture practices such as the production and use of fertilisers and pesticides (Table 3) is regarded as indirect energy causing indirect GHG emissions (Greenpeace, 2008). Indirect GHG emissions should be included in estimating total GHG emissions from agriculture. According to Greenpeace (2008), the production of fertiliser is the largest single emitter, followed by the use of farm machinery, irrigation and pesticide production (Table 1).

The overall efficiency of organic livestock farms tends to be higher than that of conventional farms because of higher production from organic systems and also the absence of dedicated fertility-building crops which utilise energy without a saleable product in the organic systems (ADAS Consulting Ltd., 2000). In addition, energy consumption in organic livestock farms is 70 % lower due to reduced imports of feed (Lampkin, 1997).

Organic biomass as a substitute for fossil fuel

The use of plant biomass as a substitute for fossil fuel provides a high potential for the avoidance of GHG emissions. According to Lal (2002), a real mitigation using this technique is only achievable if the biomass production does not generate additional GHG emissions due to the need of fertilisers input and the removal of large quantities of nutrients from the soil by biofuel plants. Organic agriculture is well positioned for this technique as N fertilisers are not applied (Kotschi and Müller-Sämann, (2004). However, the organic biofuel production system also needs to be not on the same land used for organic food production so as to avoid competition for land.

Enhancement of soil carbon sequestration in organic farms compared with conventional no-till and minimum tillage cropping systems

There is scepticism whether organic farming systems can improve soil carbon sequestration compared to conventional minimum tillage or no-till systems because tillage is required in organic farming to control weeds since herbicides are not permitted.

In conventional agriculture, the conversion of till to no-till has been reported to enhance soil carbon sequestration in the topsoil (0-5cm) (Lal and Kimble, 1997; Paustian *et al*., 1997; Sainju *et al*., 2008) although this may not occur below 7.5 cm soil depth as higher carbon below the topsoil in tilled areas has been reported depending on soil texture, due to residue incorporation at greater soil depths (Jastrow, 1996; Clapp *et al*., 2000; Sainju 2008). Six *et al*. (2000), reported that the gains in soil organic carbon in minimum tillage systems were offset by the increases in N_2O emissions from mineral N fertilisers applied. Many of the improvements in no-till cropping systems are due to increases in soil organic carbon resulting in improvements in soil aggregation, water-holding capacity, and nutrient cycling (Weil and Magdoff, 2004; Grandy *et al*., 2006).

Teasdale *et al*. (2007) recently reported that a nine-year comparison of organic corn production system which included the use of tillage with selected conventional tillage systems showed that in spite of the use of tillage in the organic system, soil carbon concentrations were higher at all depths to 30 cm in the organic system than in the other systems (Table 4).

Table 4. Total soil carbon averaged over 2001 and 2002 at the conclusion of the cropping systems comparison[a].

	Soil depth, cm		
System	0-7.5	7.5-15	15-30
Soil C		g·kg-1	
No-tillage	15.5c†	11.1c	7.1b
Cover crop	17.3b	12.4b	7.8b
Crown vetch	14.4c	11.1c	7.4b
Organic	19.2a	15.9a	10.3a

† Values within a soil depth range followed by the same letter are not different at $P<0.05$.

[a] Source: Teasdale *et al*. (2007).

The higher accumulation of soil organic carbon in the organic system was attributed to the incorporation of high amounts of organic inputs from manure, composts and cover crops in organic systems. Teasdale *et al*. (2007) concluded that if adequate weed control could be achieved in the reduced tillage organic system, this system would provide improved soil quality and yield-enhancing benefits compared with no-till conventional systems.

Reduction of soil carbon losses due to soil erosion

Soil erosion is the major cause of soil organic carbon loss, affecting climate change. It has been estimated that in the United States alone, water and wind erosion remove about 1.5 to 2.5 billion tonnes of soil annually (Wojick, 1999).

The application of improved agricultural techniques in organic agriculture such as the addition of crop residues, green and animal manures, and composts together with the use of rotation, intercropping and cover crops converts soil carbon losses into gains (Goh, 2001, 2004). In addition, this leads to improved soil structure, increases in soil water infiltration and storage (Goh 2001, Lotter *et al*., 2003), and reduces soil erosion and carbon loss. Under organic farming, the soil organic matter captures and stores more water in the crop root zone and can be 100 % higher in organic than in conventional fields (Lotter *et al*., 2003).

Certification of organic agriculture provides an assurance strategy for mitigating climate change

Unlike conventional agriculture, organic agriculture follows detailed standards of production and processing, which are enforced by inspection and certification (IFAOM, 1998). Thus, organic agriculture provides a strategy to ensure that farming practices which result in mitigating climate change are favoured and enforced.

This also allows organic agriculture to be extended to meet the standards of the Clean Development Mechanism (CDM) of the Kyoto Protocol (IPCC, 2000). The CDM is a compensation scheme, which allows industrial countries to obtain carbon emission reduction credits with emission reduction projects in developing countries (IPCC, 2000).

Unconfirmed benefits of organic agriculture in mitigating climate change

Two major benefits of organic agriculture in mitigating climate change require further research and confirmation. These are related to:

- composting and biogas production,
- direct effects of N fertilisers on CH_4 emissions.

Composting and biogas production for mitigating climate change

Although organic agriculture has been in the forefront of biogas production for many decades, this option is not restricted to organic agriculture only. In addition, in the context of climate change, the benefits of aerobic fermentation of manure by composting are ambiguous because a shift from anaerobic to aerobic storage of manure can reduce CH4 emissions but will increase N_2O emissions by a factor of 10 (Kotschi and Müller-Sämann, 2004), thus resulting in no beneficial mitigation in climate change.

Direct effects of nitrogen fertiliser applications on methane emissions

The consumption of CH_4 by CH_4-oxidising (methanotrophic) micro-organisms in oxic or well drained soils determines whether a particular soil is a net source or sink of atmospheric CH_4. Under anoxic conditions as in waterlogged paddy rice soils, methanogenic bacteria produce CH_4, which is released to the atmosphere as a GHG. It has generally been accepted that N fertiliser applications inhibit CH_4 consumption and led to enhanced CH_4 emissions (Steudler *et al.*, 1989; Hütsch, 2001; Le Mer and Roger, 2001). However, recently, it was found that ammonium-based fertilisers stimulated the growth and activity of methotrophic bacteria in the rhizosphere of rice, enhancing CH_4 emissions (Bodelier *et al*., 2000a, 2000b). Thus, further research is needed to elucidate the regulatory effects of N fertiliser application on CH_4 emissions (Bodelier eat al, 2004).

Adapting organic agriculture to mitigate climate change

Organic farming systems are generally regarded as highly adaptable to climate change compared to conventional agriculture due to:

- higher resilience and adaptation under extremely wet or dry weather conditions,
- greater application of traditional farmer's skill and knowledge,
- higher diversity.

Adaptation to extreme climate conditions

The higher organic matter content in organically managed soils compared to that of conventional agricultural soils has been shown to lead to increased soil water use efficiency in organic systems. During torrential rains, it has been shown that organic fields captured 100 % more water that that of conventional fields (Lotter *et al*., 2003). In addition, it has been found that organic fields are less prone to soil erosion and carbon loss (Mäder *et al*., 2002; Pimentel 2006).

Organically-grown corn and soybeans have been shown to be more resistant to drought, out-performing conventional crops by 30, and 50 to 100 %, respectively in Rodale long-term field trials (Delate and Cambardella, 2004; Pimentel *et al*., 2005; LaSalle *et al*., 2008). Thus, organic agriculture has the capability of creating more food security in areas with erratic and extreme weather conditions.

Application of traditional skills and knowledge

Organic agriculture has always been based on the application of traditional skills and knowledge to manipulate complex agro-ecosystems to produce food (IFAOM, 1998). This reduces the reliance on external inputs and provides the key to adaption to mitigate climate change. Organic agriculture has been described as the 'reservoir of adaptations' by Tango and Belfrages (2004).

Enhancement of diversity

Organic agriculture provides a diversity of crops, rotations, landscapes and farming activities (ITC, 2007). This high degree of diversity enhances farm resilience (Mäder *et al*., 2002; Bengtsson *et al*., 2005; Hole *et al*., 2005) and positive effects on pest prevention (Pfiffner and Luka 2003; Zehnder *et al*., 2007) and better utilization of soil water and nutrients (Altieri *et al*., 2005).

Future strategies for improving the effectiveness of organic agriculture in mitigating climate change

- A number of strategies is needed to improve the effectiveness of organic agriculture in mitigating climate change. These include:
- greater recognition and acceptance by IPCC and the public,
- better accounting measures of climate change mitigation potential related to carbon footprint and resource use,
- better technology transfer to improve organic yields

- adopting the application of biochars as a farming practice for improving climate change mitigation potential,
- more research in improving organic yields and climate change mitigation potential.

Greater acceptance and recognition of organic agriculture

Although IPCC recognises the benefits of soil carbon sequestration for mitigating climate change (SRLUCF, 2000, Goh, 2004) the sequestration of carbon in soils is not included in the Clean Development Mechanism (CDM) of Kyoto Protocol (ITC, 2007) nor in the 'gold standard' of the World Wide Fund for Nature (WWF, 2006). This was attributed to the temporary nature of the carbon being sequestered as it will be released back to the atmosphere when a change in land use occurs. However, not all the carbon stored in soils are released when a land use change occurs as some of the carbon is stored in stable forms and is not easily released to the atmosphere (Fließbach and Mäder, 2000; Goh, 2001; 2004; Ellis, 2008). In addition, soil carbon sequestration provides a means of buying time for the development of renewable energy methods to reduce GHG. Kotschi and Müller-Sämann (2004) recommended that initiatives should be lobbied in various countries to include organic agriculture in their national GHG inventories.

According to the Stern (2007), organic agriculture is generally regarded as a valuable 'niche' market opportunity and not a major agricultural policy measure. A wider promotion of organic agriculture including its benefits in mitigating climate change should be implemented.

Better measures of climate change potential

The organic farming generally supports the development of a localised food economy and the transport of farms produce is less important compared to that of export-oriented conventional agriculture (Stern, 2007). However, the expansion of organic farming will inevitably result in the export and trade of organic food. The contribution of food transport leads to increased fossil fuels consumption and therefore enhances GHG emissions and exacerbates climate change (Ludi *et al*., 2007).

The globalisation of food flows and its environmental implications requires attention. The use of 'food miles' (Paxton, 1994) is flawed by the fact that GHG emissions by transportation and packaging are minimal compared to the energy consumption in the production of the food especially for food produced in unsuitable region or climate. The environmental impact of international-traded food commodity can frequently be less than that of locally produced food (Ludi *et al*., 2007). For example, Saunders *et al*. (2007) found that there was less energy consumption involved in the importation of lamb from New Zealand to the United Kingdom compared with that involved in the local produced United Kingdom lamb, in spite of transport savings. This was due to the higher energy intensity of animal feeds, and machinery fuel consumption together with greater use of N fertilisers in the United Kingdom compared with that in New Zealand

Pretty *et al*. (2005) measured the full costs of weekly United Kingdom food basket (12 commodities) from farms to consumer's plate including food production, farm externalities, domestic road transport, government subsidies and shopping transport. Their results indicated that organic farming, localised food systems and sustainable transport reduced the environmental costs of the United Kingdom food system.

Several attempts have been made using life cycle analysis to assess environmental impact of plants (e.g. Matsson, 1999; Payraudeau *et al*., 2005) and animal production (e.g. Haas *et al*., 2001; Payraudeau *et al*., 2005). The life cycle analysis involves a holistic assessment of raw material production, manufacture or processing, distribution, packaging, use, and disposal including all the intervening steps in the transportation or cause of the existence of the product (Wikipedia, 2008). Most of the recent studies on these aspects focussed on nutrient use efficiency and less on energy and water use (Topp *et al*., 2007).

Future studies involving the potential of organic agriculture in mitigating climate change, especially in comparing with that of conventional agriculture, should measure the 'carbon footprint' of the product which includes the total GHG emissions and related energy use throughout the whole life cycle of the product. Both direct and indirect GHG emissions produced in production methods, packaging, storage, disposal, and transportation should be taken into account. Applications of the life cycle analysis method for comparing organic and conventional agriculture will provide more accurate assessments of their relative impact on the environment.

Better measures of resource use

Opinions differ with regard to the amounts of energy used in organic and conventional agriculture (Pimental, 2005; 2006; Topp *et al*., 2007; Greenpeace, 2008). Climate related criteria are not included in the organic standards (IFAOM, 1998). According to Topp *et al*. (2007), in the assessments of the environmental impact of agriculture, reliable energy use data on cultivation and management practices have major impacts on both energy use and nutrient losses (Lobb *et al*., 2007). Care must be taken in defining the spatial and temporal boundaries of the system as the results can be expressed on either an output or an area basis.

Because of generally lower productivity in organic agriculture compared to that of conventional agriculture, energy consumption based on per land area favours organic agriculture while that based on per crop or livestock yield favours conventional agriculture.

There is also interest in developing environmental impact indicators which take into account improved soil quality, biodiversity and eco-system quality in the organic system compared to conventional agriculture (Halberg *et al*., 2005).

Better technology transfer to improve organic yields

Yields of organic agriculture are generally reported to be lower than those of conventional agriculture (Goh and Nguyen, 1992, Nguyen *et al*., 1995; Badgley, *et al*., 2007).The key question that is often being asked is whether organic agriculture is productive enough to meet the world's food needs (Vasilikiotis, 2000). This hinders the adoption of organic agriculture for mitigating climate change (Trewavas, 2001).

The productivity of organic agriculture is often under-estimated by scientists and policy makers. The United Nation Environmental Programme (UNEP, 2008) analysed 114 farms in 24 African countries and concluded that in terms of yields, organic farms out-performed industrial, chemical-intensive conventional farms in addition of providing environmental benefits. A group of scientists from University of Michigan (2007) recently reported that a change to organic farming will not reduce the world's food supply but could even enhance food security in developing countries.

Badgley *et al*. (2007) modelled the yields of 293 farms in developed and developing world and concluded that average yields of organic crop and livestock production are 92 % of those in conventional agriculture. In wheat, organic yields varied between 58 % and 98 % compared to those of conventional yields (ITC, 2007). Furthermore, a wide range of yields were obtained in organic farms. The surveys showed that organic yields could be improved by better technology transfers from research to farming practices.

Adopting the application of 'biochars' as a farming practice for improving climate change mitigation potential

Recently, it has been proposed that 'biochars (charcoals from pyrolysis 400-600 ºC in the absence of oxygen) produced from biomass (wood, plants, plant waste) when applied to soils can enhance not only crop yields but also increase soil carbon sequestration in mitigating climate change (Glasser, *et al*., 2002; Lehmann *et al*., 2003; 2006; Steiner *et al*., 2007; Novak *et al*., 2009). This practice was used by ancient agriculturists to produce food in the Amazon basin in the form of 'slash and char' agriculture, resulting in the formation of the black soils known as 'Terra Preta'.

Applications of composts, manures and plant residues to soils are standard farming practices in organic agriculture (IFAOM, 1998). If the practice of adding charcoals and biochars to soils is adopted in organic agriculture, it can result in longer term storage of soil carbon, thereby enhances the mitigation of climate change. Biochar carbon is more recalcitrant than biogenic soil organic carbon (Sombroek *et al*., 2003; Goh, 2004; Liang *et al*., 2006). This is more important under tropical environment where added organic matter is rapidly oxidised and added bases are readily leached (Tiessen *et al*., 1994).

Furthermore, one of the major difficulties of using soil organic carbon for mitigating climate change is the difficulty of measuring and verifying the small changes in soil carbon with time due to its temporal and spatial heterogeneity (Goh, 2004). The addition of biochars to soils overcomes this difficulty because substantial amounts of carbon are added to soils when biochars are applied (Novak *et al*., 2009), thus improving the accuracy of monitoring soil carbon changes with time.

More research in improving organic yields and climate change mitigation potential

Current global agricultural research is mainly in conventional agriculture and very little research is conducted on organic agriculture. For example, almost all (99 %) of the present European public and private research funding is for improving conventional farming systems (ITC, 2007). More research funding is needed for organic agriculture on aspects related to improving organic yields, especially in developed countries, and also in improving the mitigating potential of organic agriculture in climate change.

It is widely recognised that GHG emissions are expected to increase in most regions of the world and more research is needed to counteract these increases (Müller, 2009). The IPCC (IPCC, 2007) proposed that an increase in agricultural research and development together with increased knowledge and technology transfer is needed.

Conclusions

The solution to global warming and present-day climate change problems caused by agriculture lies in changing farming practices in agriculture, and adopting the best form of agriculture to provide cost-effective high-yielding agricultural production with minimum adverse effects on the environment and climate

The world-wide acceptance and adoption of organic agriculture for agricultural production at present depends on its ability to 'feed the world'. It has been shown that organic farms out-performed conventional farms in terms of yields, especially in developing countries. It has also been shown that the negative impact of climate on agricultural production is region-specific, and is more severe in developing countries. Thus, organic agriculture is the best form of agriculture for agricultural production in developing countries, and at the same time, provides mitigation for climate change.

In both developed and developing countries, organic agriculture has considerable potential in mitigating climate change due largely to its ability to reduce GHG emissions and in enhancing carbon sequestration in soils. Furthermore, its functioning mechanism of certification and inspection guarantees transparency and compliance of principles and standards. This approach allows the enforcement of adopting new and improved farming practices aim at mitigating climate change. In addition, organic agriculture is highly adaptable to climate change and it also provides a high degree of diversity in the eco-systems.

More research is needed for improving this potential and also in increasing organic yields especially in developed countries.

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The situation of organic farming and the development of the organic sector in European countries

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Abstract

The organic sector in Europe has grown steadily in recent years and Organic Farming has created a niche in many European countries. Organic Farming became an accepted form of agriculture which is highly appreciated by many consumers. Several factors have contributed to a widely positive development of the organic sector in Europe; a) the willingness of consumers to pay a price premium because they perceive organic products to be more healthy, environmentally friendly and animal friendly than products from conventional agriculture; b) the incentive of many farmers who converted to Organic Farming and developed the system further, for many years without the support of a wider public c) by the implementation of a legally binding regulation on Organic Farming in 1991 (EU regulation 2092/91) the European Union created a well functioning legal frame work in order to protect consumers as well as producers from fraud; d) organic Farming is included in the agri-environmental schemes of the EU and eligible for payments; the different member states are free to adapt the payments according to their specific needs. From 1985 to 2007 the acreage under organic management in Europe rose from 0.1 Mio hectares to 7.2 Mio hectares that is about 2 percent of the agricultural land. Nevertheless, large differences exist between European countries with well developed organic markets and high shares of land under organic management and countries with emerging markets and a very small organic sector. In 2007, the average growth of the European organic market was about 10 per cent and the total market volume was about 16 billion euros. Well developed organic markets exist mainly in Western and Central Europe while organic production is mainly geared to export in Southern and Eastern Europe. Currently, the impact of the financial crisis on the organic sector is not yet foreseeable. The organic market in the EU is still growing, albeit at a slower pace.

Keywords: Organic farming, organic management, consumers, market development

Introduction

Organic farming has a long tradition in Europe originating in the first alternative movements founded in the 1920s of the last century as a reaction to the accelerated industrialisation and modernisation of agriculture, rural life and of society in general. Nevertheless, for many decades, the organic farming pioneers had only a very limited impact on farming practice as well as on science (Conford, 2001). Then, starting in the 1970ies Organic Farming gained impetus especially in Western Europe driven by the growing environmental awareness of larger parts of the population. However, it took almost another 20 years until 1990s to change the situation of Organic Farming in Europe markedly. Towards the end of the last century, the organic farming left its' niche and became a widely accepted form of agriculture which even benefited and still benefits from different forms of governmental support. Many European consumers are familiar with organic products and decide to buy them despite a sometimes considerable price premium compared to conventional products.

Still, the organic sector in the different member states of the European Union is far from uniform. At the same time fully developed markets with a high consumer demand on national level exist (e.g. UK, Germany); at the same time export driven organic farming with a comparatively high share of organic area and organic farms but low local consumption is prominent in some countries e.g. Greece, Poland, Spain. In other countries, especially in the new eastern European member states, the organic sector is still in its infancy.

This paper describes the current situation of the organic sector in Europe, tries to analyse the reasons for the recent development and will give a short outlook on new tendencies related to organic food and farming.

Development of the organic sector in Europe from the 1990ies to 2009

Farming sector: Organically managed area and number of organic farms

Organic farming remained on a very low level up to the 1990s, but accelerated growth started in the 1990s (Figure 1). After this period of rapid growth a slower but steady growth followed at the beginning of the new millennium. Today, 7.2 million ha on 180.000 farms are under organic management making up roughly four percent of the agricultural area in Europe (Willer, 2009). The current growth is driven by a steadily growing consumer demand and by financial support within the agri-environmental schemes (see Chapter 3).

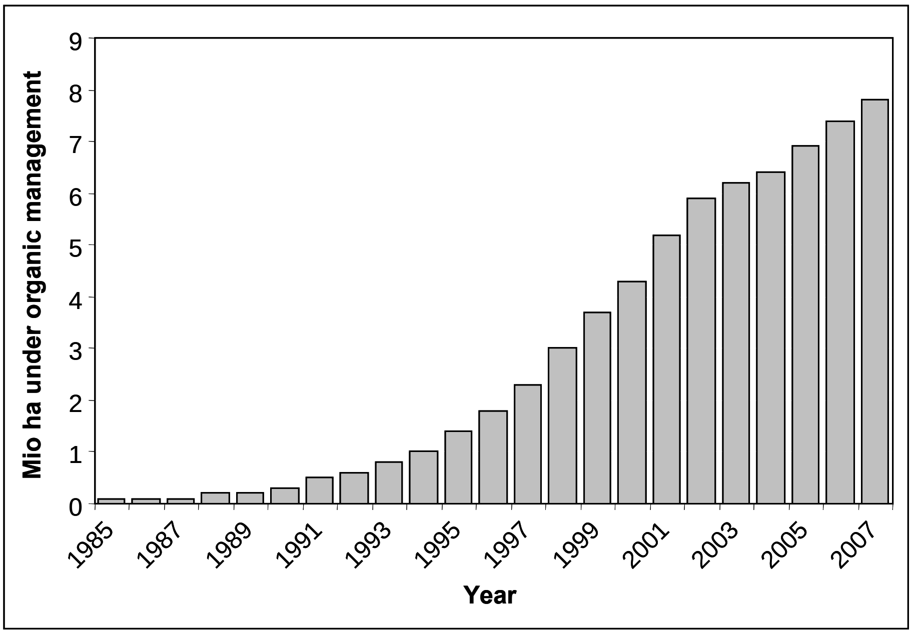

Figure 1. Development of organically managed farm land from 1985-2007 in Europe (Source: Institute for Rural Sciences, Aberystwyth University, UK and FiBL, Frick, Switzerland in Willer, 2009)

Table 1 shows the total agricultural area under organic management as well as the percentage of organically managed land of the usable agricultural area (UAA) per country. The countries with the largest amount of organic farm land were Italy, followed by Spain, Germany and the UK. In Italy as well as in Spain, organic production is mainly driven by export to western and northern

Table 1. Total usable agricultural area (UAA), agricultural area under organic management and percentage of organically managed land as share of the total UAA, number of organic farms per country and average farm size of organic farms in the European Union member states for 2007.

Country	Total UAA	Area under Organic Management	Percentage of organically managed agricultural land	Number of organic farms	Average farm size
	ha	ha	% of total UAA		ha
Belgium	1374430	33057	2,4	821	40
Bulgaria	5116200*	13646	0,3	240	57
Denmark	2662590	145393	5,5	2835	51

Germany	16931900	865336	5,1	18703	46
Estonia	906830	79531	8,8	1211	66
Finland	2292290	148760	6,5	4406	34
France	29413900	557133	1,9	11978	47
Greece	3983800	278397	7	23769	12
United Kingdom	17400367	660200	3,8	5506	120
Ireland	4139240	41122	1	2574	16
Italy	12744200	1150253	9	43159	27
Latvia	1773840	173464	9,8	4018	43
Lithuania	2648950	120418	4,5	2855	42
Luxembourg	130880	3380	2,6	81	42
Malta	10330	12	0,1	30	0
The Netherlands	1914330	47019	2,5	1374	34
Austria	3189110	372026	11,7	19997	19
Poland	15477190	285878	1,8	11887	24
Portugal	2473940	233475	9,4	1949	120
Romania	13820200	131407	1	2238	59
Sweden	3118000	248143	8	2380	104
Slovakia	1396690	117906	8,4	280	421
Slovenia	498620	29322	5,9	2000	15
Spain	25265000	988323	3,9	18226	54
Czech Republic	3518070	312890	8,9	1318	237
Hungary	4228580	122270	2,9	1242	98
Cyprus	146000	1979*	1,4	305*	6
Total	**176575477**	**7160740**	**4,1**	**185382**	**39**

* Data for 2006; Source: ZMP, FIBL, Eurostat in BÖLW, 2009 and own calculations

Europe while Germany as well as UK has large national organic markets (see chapter 2.2). Italy, Greece and Austria have the highest number of organic farms, in case of Italy and Greece these are mainly directed towards export. Farm sizes in the these countries are rather small, in the case of Italy and Greece intensive cultures like vegetables and perennials like grapes, fruits and olives make up a major part of the organic products (Willer, 2009). The different farm sizes of organic farms in Europe reflect mainly the different agricultural structures from very small family farms in Austria to rather large agricultural holdings e.g. in Slovakia or the Czech Republic (Tab. 1).

Figure 2 gives an overview of the land uses for the area under organic management in the year 2006. In the last years, the proportion of the different land uses was rather stable. In 2009, about forty-four percent of the total area under organic management in Europe is grassland, which means that about 6 percent of all grassland in Europe is organic (Schaack, 2009). As extensive grassland is comparatively easy to convert to organic farming, it makes up the major proportion of organic land in several countries of the EU, e.g. Ireland or the Czech Republic, whereas the cultivation of perennials like grapes, citrus or olives takes place mainly in the Mediterranean countries. The share of arable land and grassland is almost equal.

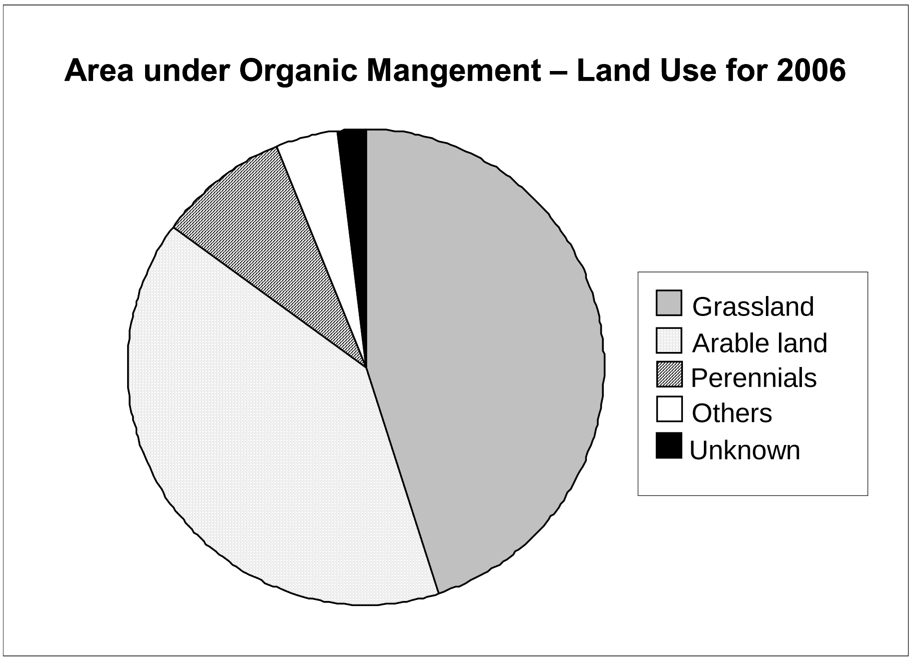

Figure 2. Area under organic management: Land uses in Europe for 2006. Source: Willer, 2007.

Market development and market structures

In the last 10 years the development of the organic market was characterised by a steady growth (Padel et al, 2009; Richter et al, 2007; Richter and Padel, 2005). For example, in 2007 the average growth rate for all European countries was over ten percent with rates as high as plus 70 per cent in less developed markets like the Czech Rebuplic; however, this growth was not only determined by growing demand, but also by rising prices (Padel et al., 2009). Currently, the total value of the European organic market is about 16.2 Mrd. EUR (Padel et al., 2009). Table 3 shows the revenues per country: The largest markets are Germany, UK, France and Italy (BÖLW, 2009).

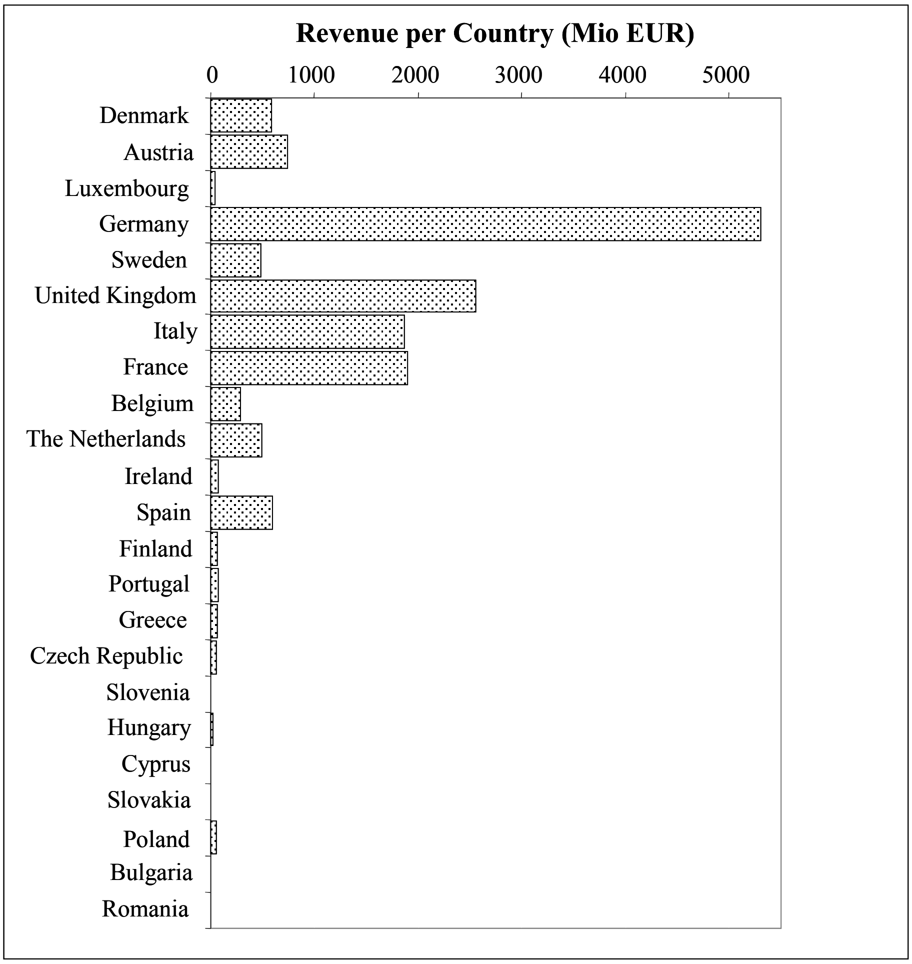

Figure 3. Revenue (Mio €) from organic products in selected European countries for 2007. Source: Source: Fibl, ZMP, Aberystwyth University in BÖLW (2009).

The range of revenues differs very much between the member states. Especially the revenues in the Eastern European countries are very low, reflecting a) the lower purchasing power of the consumers and b) less developed market structures characterized by a lack of organic processors and by limited access to organic products. Generally, organic markets in most countries in Southern and Eastern Europe as well as in some countries in Northern Europe are in the stage of emergence (Schaer, 2009). These markets are oriented towards export; the revenues in the country are usually very low, e.g. Spain generated 280 Mio € with the export of organic products in 2006 but revenues on the home market were only 70 Mio € (Agra-Europe, 2008). In certain very well developed markets, e.g. Germany, the demand of products like vegetables or fruits is very high leading to increasing imports (BÖLW, 2009). Figure 4 shows the rapid development of the German organic market – a similar market development occurred in the UK and in France.

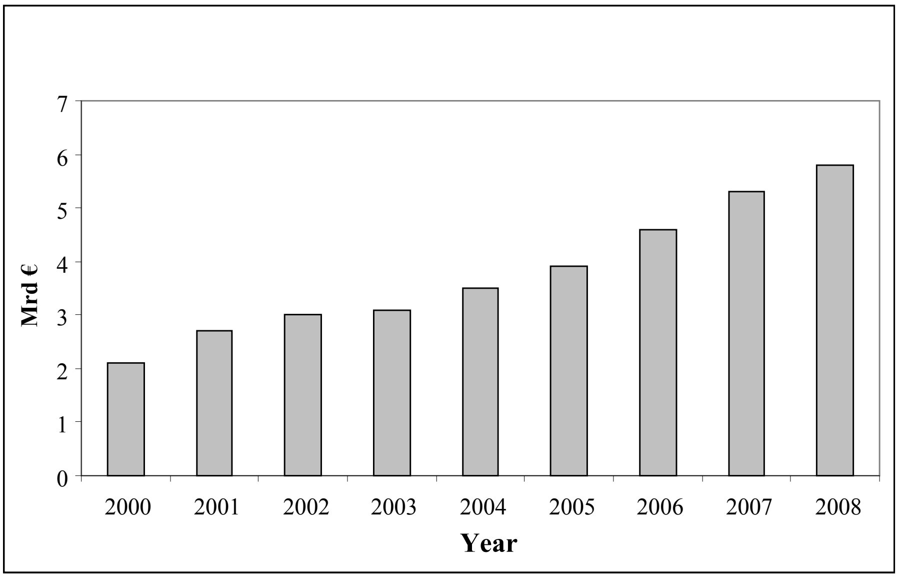

Figure 4. Development of revenues for organic products in Germany for the period from 2000 to 2008; Source: Hamm, ZMP in BÖLW (2009).

In countries with well developed markets organic products are sold via many different sales channels: specialized organic retailers, conventional retailers, discounters, on-farm-shops, farmers' markets and specialised organic food stores. The importance of the different market channels is not homogenous in European countries; e.g. in France general retail trade and specialised retailers cover 39% and 37% respectively of the trade with organic products while in Denmark conventional retailers cover about 80% (Schaer, 2009). Conventional food retailer realise currently the largest growth rates of sales of organic products (Agra-Europe 2008). Today, the organic sector is the most rapidly growing part of the food industry in Europe.

Organic products in well developed European markets are sold with price premia, though the increasing importance of discounters and conventional retailers led to a decline of consumer prices for organic products in the last years. Currently, the organic market seems to be rather stable and resists the economic crisis (Padel et al., 2009).

Main drivers of the Development

EU Policy

Subsidies and agri-environmental measures

Today, agricultural subsidies in the European Union in the framework of the Common Agricultural Policy (CAP) consist of two parts: The so-called first pillar for market support and direct payments and the so-called second pillar for rural development including agri-environmental programmes. In 2009, the EU agricultural budget is about 56,1 Mrd. €. The first pillar contains 40 Mrd € and 13,6 Mrd € percent are available for the second pillar (European Commission, 2009b). For the first time in

1992, a part of the subsidies was – and still is - coupled to the implementation of a more environmentally friendly way of farming. The so-called agri-environmental measures are part of the second pillar and encourage the use of farming methods which exceed the “good farming practice” and contribute to the protection of the environment and to the preservation of the country side (European Commission, 2009b). Different farming practices e.g. fertiliser reduction, no use of pesticides, no-till or reduced tillage, extensive pasture management and many others - including Organic Farming - are part of these measures. However, the design of the agri-environmental programmes and payments differ considerably between the member states according to their needs and preferences. The payment per hectare compensates for the loss of income resulting from the application of a certain measure and the additional costs associated with the measure; in addition the payment contains a financial incentive for the farmer (see EEC 1257/1999, European Commission, 1999). Organic Farming is widely promoted within these programmes since 1994 in most member states. Other main reasons for financial support of organic farming are the reduction of production surpluses due to lower yields as well as the creation of job opportunities in rural areas (BMELV, 2009).

The payments for organic farming vary for area in conversion or fully converted agricultural land and different land uses e.g. grassland/pasture, arable farming or perennial cultures receive different amounts of supporting payments (Zander et al., 2009; for details see Tab. 2). Organic farming payments play an important role for conversion and maintenance of organic farming in Western Europe as well as in Eastern European countries: They make up 10 to 30 percent of the family farm income in Western European countries and sometimes even 75 per cent in Eastern European countries in 2004/2005 (Zander et al. 2008). Therefore, they can be considered as a major drive for the accelerated growth of organic farming in Europe during the last years (Dimitri and Oberholtzer, 2005).

Table 2. Payments for the maintenance of organic farming in selected European countries for the years 2004/2005

Land Use	**AT**	**DE**[1]	**DK**[2]	**IT**[3]	**UK**[4]	**CZ**	**EE**	**HU**	**PL**	**SI**
	€ ha^{-1} a^{-1}									
Arable Land	324	102-255	117	111-600	0-51	110	97	127	131	460
Grassland/pasture	96-251	102-255	117	85-525	0-51	34	74	59	57	230
Permanent crops	799	358-924	117	298-900	0-44	381	241	281	337	795
Vegetables	509-654	128-410	117	295-600	0-51	344	241	202	206	544

Source: Zander et al., 2008

AT, Austria; DE, Germany; DK, Denmark; IT, Italy; UK, United Kongdom; CZ, Czech Republic; EE, Estonia; HU, Hungary; PL, Poland; SI, Slovenia.

[1] Payments in DE vary according to federal states

[2] DK has not offered specific organic farming maintenance payments since 2004. Instead, alternative agri-environmental support measures were introduced, in which mainly organic farms participate. The numbers presented here for 2004/2005 belong to this measure

[3] Payments in IT vary according to region. In some cases there exist other (additional) classifications, so that these numbers only can serve as an approximation.

[4] Payments in the UK vary according to region

Legislative Aspects – European Council Regulation

As organic farming standards refer to "credence qualities" of the products, the buyers of organic products cannot detect the "organicness" of the product by merely looking at it or tasting it nor can "organicness" be determined by laboratory methods. Therefore, the development and implementation of defined, legally binding regulations for organic agriculture, processing and trade are crucial for the development of a functioning organic sector. Without legally binding regulations the label "organic" is not properly protected and the standards for claiming a price premium remain unclear, undermining consumer trust. In addition, legally binding regulations provide security for farmers and processors a) regarding their own production and processing methods and b) by protecting them from fraud by competitors.

Until 1991, when the first EC 2092/91 Regulation on organic farming and organic products was established, different private standards existed in Europe. These standards were defined mainly on a national level by the respective organic farming associations. In the process of shaping the first EU regulation, organic farming NGOs, especially IFOAM, but also others, were involved (IFOAM EU Group, 2009). In 1991, only crop production and plant products were included in the regulation, animal husbandry followed later. Today, the legal framework of the EC Regulation includes production, processing, trade, labelling and control. In addition, organic farming associations in Europe kept their private, often stricter standards, which coexist with the EU regulation. As culture, climate, animal husbandry systems and crop production methods vary widely across Europe, the regulation provides a certain flexibility for adaption.

After more than 10 years of working with and adapting the EC 2092/91 Regulation to new circumstances, the need for action grew in order to simplify certain parts, to incorporate missing topics and to give detailed definitions for organic farming. After a sometimes difficult and troublesome process involving the European Commission, the European Council and the European Parliament as legal entities as well as different stakeholders from the organic sector all over Europe, the new EC 834/2007 was implemented in 2009.

The main progress of the first EU Regulation was to set common minimum standards for organic farming throughout the EU. Thus, consumers trust was strengthened: The consumers purchase products and rely on identical standards for all member states. Without a common regulation for organic farming in the EU the growth of the organic sector during the last years would have been impossible.

Organic Action Plans

The European Action Plan on Organic farming was published in 2004 aiming at the following targets: Development of the organic market by integrating policies, improving information flows, improving standards, providing transparency on all levels of production, processing and trade in order to support an environmentally sound way of farming. In addition, the strengthening of consumer trust is a major objective (European Commission, 2009c). To ensure the success of the Organic Action Plan, stakeholders from the organic sector contributed largely to the plan's development. This is all the more important as the organic farming movement had a strictly bottom-up approach since its beginnings in the 1920s and was promoted mainly by dedicated producers as well as consumers. The EU Organic Action Plan has no budget and does not aim at quantitative measures. The two major outcomes of the action plan are the implementation of the new EC Regulation EC 834/2007 on the production and labelling of organic products and a new consumer campaign financed by the European Commission (Schmid et al. 2008).

Consumers' demand and consumers' attitudes

The growth in organic food consumption results to a large degree from a shift in consumer attitudes, but partly also from an increased supply. As stated in chapter 3.1.1, the implementation of payments stimulated the conversion to organic farming and - as more products became available at cheaper prices – also the number of organic consumers (Oughton and Ritson, 2007).

Albeit the reasons why consumers buy organic food differ between European countries, four objectives are essential for most consumers, independently from their nationality: Health aspects, environmental aspects, animal welfare and enjoying good food (Zanoli at al., 2004). Especially health – the consumer's own health and/or the health of his/her children - plays an important role. The participants in the study of Zanoli et al (2004) perceived organic food as healthier than conventional food while altruistic aspects of organic food production like environmental protection were less important. In addition, the European food scares of the last years - e.g. BSE - contributed to a growing consumption of organic food (Dimitri and Oberholtzer, 2005).

Regular organic consumers have a higher education and a higher income than those who rarely buy organic products, they more often have children and they are in the age group between 25-60 years (Zanoli et al., 2004). The image of the organic consumer changed in the recent years from "alternative do-gooders" to the current LOHAS (Lifestyle of Health and Sustainability) who merge a sustainable life style with a hedonistic approach on product quality and design. This new trend offers an option to address new consumers for organic products.

European consumers usually pay price premia for organic products reflecting the good quality of the products but primarily the additional costs associated with organic production e.g. yield decreases, higher labour input. The price premium ranges differ widely for different products and between member states. Often, the price premium is considered to be a barrier for the purchase of organic products (e.g. Zanoli et al., 2004; Bruhn, 2002), but a new study with German consumers puts this into perspective (Plaßmann and Hamm, 2009).

Outlook

After almost two decades of rapid growth, the organic sector in Europe faces today several challenges: Large conventional retailers and multinational companies entered the sector, global trade in organic products is growing steadily, organic supply chains become more and more similar to conventional ones: Increasing consumer interest, increasing numbers of farmers and of organically managed area led to the so-called conventionalisation of the sector. Nevertheless, many new tasks lay ahead: The use of GMOs in conventional agriculture strongly affects organic farming, seeds and breeds adapted to organic farming conditions are still largely missing, social issues like rural development and fairness within the food chain gain a growing importance, the mitigation and adaptation potential of organic farming to climate change is discussed. This list of new challenges is far from complete. Currently, stakeholders – farmers, consumers, processors, traders, NGOs, researchers, governments – are contributing to the solution of open questions, create new platforms for information exchange and incorporate new ideas in existing structures. The organic sector in Europe is very dynamic and will contribute to improve sustainable farming systems also in the years to come.

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How to minimize postharvest losses of organic produce

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Abstract

Fruit and vegetables are living products even after harvest, and therefore careful harvesting, postharvest handling and temperature management throughout the supply chain are fundamental keys to minimising postharvest losses of organic produce. Secondary to correct handling and storage is the use of various physical, chemical and biological postharvest treatments to maintain quality and minimise losses. It is important to take a systems approach to minimising postharvest losses and maintaining quality during storage and marketing. No single postharvest treatment in isolation can totally prevent losses in the supply chain. An integrated approach to maintaining quality and reducing postharvest losses relies on understanding and managing each horticultural product, its production and supply chain. A range of treatments are briefly discussed, as are three important aspects of postharvest organic treatments which require particular attention; sanitation, decay control and market access.

Keywords: Fruit and vegetables, postharvest losses, supply chain, marketing

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Background

Fresh fruits and vegetables are living biological products that continue to respire and deteriorate after harvest. The rate of deterioration and loss after harvest depends on the type of produce and postharvest management. This is the most critical stage of the horticultural production, marketing and supply chain where it is estimated that up to one third of fresh produce harvested worldwide is lost at various points in the supply chain between the farmer and the consumer. Specific supply chains studies have shown that losses in vegetable supply chains in South East Asia are around 17 percent of the total harvest, with a value of approximately US$ 60 per metric ton produced (Genova et al., 2007). These studies have further shown that the physical losses were greatest for farmers, i.e. roughly twice that for middlemen and about 30 percent higher than retailers, while the monetary losses were highest for retailers. These losses are hugely uneconomic and not sustainable, particularly as the producer has already invested significant inputs to produce safe nutritious fruit and vegetables. However poor postharvest handling, transport and storage can significantly reduce fruit and vegetable quality and therefore grower returns.

Handling and storing organic produce does pose significant challenges, but basic postharvest handling and storage (temperature) are the foundations of minimising postharvest losses.

Simple direct supply/marketing chains, where the fruit or vegetable is quickly transferred from the farmer directly to the retailer or even consumer results in minimal loss of quality with minimal risk of spoilage. However with horticulture production areas becoming increasing distant from the eventual retailer/consumer, there has been the development of complex handling and marketing systems. These systems often involve increased storage and marketing times, putting pressure on the fruit and vegetable quality. However correct postharvest practices can minimise postharvest losses.

The successful handling, storage and marketing of fruit and vegetables adds significant value to the produce. It is estimated that the value of fresh produce may increase 7-fold from the time the produce is harvested to the time it is purchased by the consumer. Each step in the supply chain costs money, but when conducted properly, this can add value along the supply chain. However this can only be achieved with properly managing product quality and ensuring its safety.

The causes of postharvest losses are many and varied. However the main postharvest losses arise from either pathological (e.g. decay), pest (e.g. insect) or mechanical damage (e.g. bruising). Other losses can also occur due to water loss, which reduces the weight of the product and may cause wilting symptoms and loss of consumer appeal.

Postharvest management

The most important principles for the successful handling and storage of organic (or conventionally grown) fruit and vegetables are the correct harvesting and handling conditions and the appropriate storage environment.

Handling

Good harvest and handling practices are essential for the successful marketing of organic produce. Simple handling practices such as avoiding unnecessary wounding or bruising are essential to optimise product quality and minimise the risk of decay. The effects of harvest and handling on postharvest decay have recently been reviewed by Michailides and Manganaris (2009). Harvesting in the cool of the day, and keeping the produce cool as possible, even simple things like moving the produce into the shade or covering the harvested produce with a cover can significantly help maintain product quality. In addition, the use of clean transport containers and packing material also reduces the risk of decay.

Storage temperature

As the storage temperature affects the rate of postharvest deterioration, the control of the postharvest temperature environment is the most important factor in maintaining the quality of fruit and vegetables. For ideal storage life, fresh produce must be maintained within certain temperature ranges. Each type of fruit and vegetable has an ideal storage temperature which is listed in Table 1. For example many temperate fruit and vegetables, such as apples and broccoli, should be stored just above their freezing point (0°C). These low storage temperatures reduce the respiration and deterioration rate and therefore increases the storage/market life of the product. However many tropical fruits and vegetables suffer chilling injury when stored at these low temperatures and should therefore be stored at higher temperatures (5 - 13°C) (Table 1).

Organic treatments to minimise postharvest losses

Ensuring the correct storage temperature and proper postharvest handling are the two fundamental keys to manage organic and conventionally grown horticultural crops. However the postharvest storage and handling of organic produce presents some specific challenges, particularly in decay control. There are a range of organic physical, chemical and biological postharvest treatments to maintain quality and minimise losses.

The organic standards for postharvest (and all agriculture) are specific for each country, and if applicable to the importing country. For example, ethylene is a natural ripening hormone that is produced naturally by all horticultural produce. However its application for artificial ripening is often restricted. Operators must contact their own organic certification office for advice before using ethylene gas for ripening as some countries have restrictions on its use for ripening. For example the European Union and Japan only allows its use for banana ripening.

A similar situation also occurs with the application of postharvest waxes on fruit and vegetables. The postharvest application of fruit waxes is a useful way of maintaining the quality and shelf life of fruit by reducing water loss. However organic fruit waxes must not contain prohibited substances. The use of carnauba or wood extracted wax are acceptable in Australia but fruits coated with these waxes must be labeled on the shipping container or packaging and comply with importing country requirements. However fruit waxes are not acceptable in the European Union market. It is therefore the onus on operators to ensure conformance with specific regulations for the country they are exporting to.

Physical treatments

Physical treatments to minimise losses of organic produce include the use of heat treatments (Lurie, 1998), curing, controlled atmosphere storage (DeLong *et al.*, 2004) and physical treatments (e.g. brushes) (Porat *et al.*, 2000). Curing and heat treatments have long been used as a non-chemical decay control measures. For example, curing of sweet potatoes under high humidity (90 - 95% RH) and elevated temperature (29°C) for one week stimulates periderm formation in the skin which assists in maintaining quality and limiting water loss during storage. Hot water dips, vapour heat treatment and hot air have also been shown to be effective for fungal pathogen control, as fungal spores and latent infections are often either on the surface or in the first few cell layers under the peel of the fruit or vegetable. These treatments are reviewed by Lurie (1998) and show considerable promise as organic postharvest treatments. Israeli researchers have also developed a non-chemical method for rinsing and disinfecting fruit and vegetables with hot water and brushes. Rinsing the fruit with sprays of hot water as they move along a set of brush rollers has been shown to simultaneously clean and disinfect the fruits whilst also improving their general appearance and maintaining quality (Porat *et al.*, 2000).

Chemical treatments

There are a range of organic chemicals treatments to minimise postharvest losses that are approved by many local organic certification organisations. These include (but not limited to):

- Acetic and related acids
- Alcohols
- Detergents (natural and biodegradable)

- Hydrogen peroxide
- Peracetic acids
- Natural Soaps

In addition, organic treatments such as natural food additives and substances listed as GRAS (Generally Regarded as Safe) are being actively researched (e.g. Palou *et al.*, 2008). Natural compounds obtained from plants, animals or micro-organisms including some volatiles, essential oils, phenolic compounds, plant extracts, peptides, alkaloids, lectins, propolis, latex or chitosan, and other chemicals such as calcium polysulfide or ammonium molybdite are being investigated and assessed. An excellent summary of these compounds and their potential as postharvest treatments is discussed by Barkai-Golan (2001) and Troncoso-Rojas and Tiznado-Hernández (2007).

Biological treatments

Biological treatments such as the use of microbial antagonists have been subject to intensive investigation and several commercial products are now available (Kabaluk and Gazdik, 2004). In the last few decades, numerous strains of yeasts (e.g., *Candida oleophila*), bacteria (e.g., *Bacillus subtilis*) and filamentous fungi (e.g., *Trichoderma viride*) have been selected, identified and characterised because of their biocontrol activity against postharvest decay (Kabaluk and Gazdik, 2004, Palou *et al.*, 2008). There are at least two postharvest biological products registered for general use against postharvest rots of citrus fruit that are available on the market: Aspire™ (*C. oleophila*, limited to the USA and Israel) and BioSave™ (*P. syringae*, limited to the USA) (Palou *et al.*, 2008).

There are three important aspects of postharvest organic treatments which require particular attention; 1. Sanitation,

2. Decay control, and

3. Market access.

Sanitation

Food safety is the most important aspect of any production system. Preventative food safety programs, sanitation etc are integral to every part of every postharvest system. This is particularly important in organic production where organic loads transferred on the product can be high. Proper use of disinfectants in the postharvest wash and cooling water can help prevent both postharvest decay on the produce, but also prevent food borne illness. Pathogens such as *E. coli* 0157:H7, *Salmonella*, *Shigella*, *Listeria*, *Cryptosporidium*, Hepatitis, and *Cyclospora* are among the disease-causing organisms that have been associated with fresh fruits and vegetables. Suslow (2000) reviewed the sanitation and water disinfestation requirements for the organic postharvest handling of organic crops, but is specific of the USA organic requirements. Food safety cannot be over-emphasised. Organic alternatives to synthetic chemical disinfectants such as organic acids (e.g. acetic acid) are essential in any sanitation situation.

Decay control

Postharvest losses due to fungal and bacterial pathogens can be substantial and represent a major limitation to the expansion of the organic fruit and vegetable market. To tackle this persistent challenge, it is important to take an integrated approach to disease management, rather than rely on a single 'silver bullet' (solution) postharvest treatment. Integrated disease management is essential to manage postharvest decay. This system is based on the knowledge of pathogen biology, its epidemiology and the consideration of all preharvest, harvest and postharvest factors that may influence disease incidence. It is also important to minimise decay losses with no adverse effects on fruit quality and should be also be done by taking cost-effective actions (Palou et al., 2008).

It is important to consider and manage all preharvest, harvest, transport, storage and marketing factors which affect decay and quality. The control of postharvest pathogens can be improved with reduced inoculum and infection levels in the field, effective fruit and packinghouse sanitation to reduce atmospheric and superficial inoculum levels, appropriate practices during handling and storage to maintain fruit resistance to infection; and if applicable, the adoption of suitable organic treatments to minimise decay. As mentioned previously, according to their nature, these alternative decay control methods can be physical, chemical or biological.

Market access

An important barrier to the international marketing of horticulture produce to other countries are phytosanitary (quarantine) barriers. These often relate to the possible presence of insects that are usually absent or of restricted occurrence in the importing country. There is a range of control measures such as area freedom or crop freedom status, pre-shipment treatment with chemical and non-chemical agents, in-transit cold treatment, inspection and/or fumigation on arrival. However there is currently a dependence on chemical treatments for many products and markets and therefore in those instances there is no approved control suitable for organic products. Chemical treatments, such as methyl bromide fumigation on arrival, disqualify the organic status of the produce.

A systems approach to market access which ensures that the phytosanitary and organic certification requirements are needed to supply export markets. This involves a field-to-market approach with the use of non-chemical treatments and systems. Holmes et al. (2003) reviewed the use of disinfestation technologies to deliver organic fruit and vegetables to export markets with phytosanitary barriers. Physical treatments such as heat and cold may be used for disinfestation of a range of pests and have been demonstrated to be effective against fruit fly in a number of commodities. Controlled atmosphere and alternative fumigants have also been extensively researched. The type of disinfestation treatment that may be effective is governed by both the pest species and the ability of the commodity to tolerate the treatment. While a range of potential disinfestation treatments have been researched, only a few protocols have been implemented for a limited variety of products (Holmes et al., 2003).

Case study

A case study of organic treatments to control superficial scald, a physiological storage disorder in the long term storage of apples is presented below.

Superficial scald (scald) is the major physiological disorder that occurs during cold storage of apples. Scald is characterized by brown irregular patches that appear on the skin during long-term cold storage and can greatly downgrade fruit quality and grower returns.

Scald is a postharvest storage disorder of some important apple varieties, particularly Red Delicious and Granny Smith, and is essentially a long-term storage disorder. It can be seen within three months of harvest and increases with time in storage. Scald symptoms develop only slowly in cold storage but they rapidly increase in severity within a few days at normal air temperatures. Although scald has been a significant storage problem in apples for over 100 years, we still know little about its physiology and control. In conventionally grown and treated apples, scald is currently controlled by the postharvest application of diphenylamine or 1-methylcyclopropene. However, there are some options available for the organics producers.

Alternatives to diphenylamine pre-storage treatment

The simplest solution to the scald problem would be to only grow apple varieties that do not scald. However, plant breeding is a long-term solution and many of the scald susceptible varieties have desirable commercial attributes that warrant development of measures for controlling scald. There are a growing number of potential postharvest treatments to control scald. These potential treatments are still undergoing further research and development and include:

- application of vegetable oils
- initial ethanol vapour treatment
- hypobaric storage
- pre-storage heat treatment
- intermittent warming during storage
- initial high carbon dioxide stress
- initial low oxygen stress and CA, and
- dynamic controlled atmosphere storage

Dynamic Controlled Atmosphere (DCA) storage

Since its introduction in 2001, the chlorophyll fluorescence-based 'Harvest Watch' technology has attracted significant research and industry interest. DCA involves reducing oxygen in the storage atmosphere to the lowest level tolerated by the fruit (De Long *et al.*, 2004). Fruit quality loss during DCA storage is assumed to be slower than in normal ultra low oxygen storage. Storage conditions below the critical oxygen level will cause anaerobic conditions followed by severe quality losses in stored fruit. DCA systems detect this low oxygen point by measuring changes in chlorophyll fluorescence of the stored apples. The oxygen concentration in the storage room is then increased slightly to prevent anaerobic respiration while also maximizing storage life. Most DCA research and its application have been in the storage of apples, especially organic and residue free fruit (De Long *et al.*, 2007). Currently it is in commercial use in over 250 DCA rooms in over seven countries. Over 20 apple varieties have been successfully stored in DCA. Varieties which are susceptible to superficial scald like 'Delicious' and 'Granny Smith' can be particularly benefited as DCA systems can prevent scald, even after long-term storage (> 8 months). Some research has also shown that DCA is superior to ultra-low oxygen storage (< 1%O_2) in retention of fruit quality parameters. In some reports DCA even matches 1-MCP in maintaining fruit firmness.

Conclusions

There are tremendous opportunities for the marketing of organic produce. A range of organic postharvest treatments are already successfully used to maintain the quality and minimise losses, and new research is continuing into new and effective organic treatments. However no single postharvest treatment can provide a total solution. It is important to take an integrated approach to quality and disease management. Minimising decay and the potential for infection are crucial to controlling postharvest diseases. Future research into organic physical, chemical and biological treatments to minimise losses must be scientifically rigorous and include the practicalities of potential treatments and their economics.

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Women in organic agriculture: Sustainable food production and social development in equality for all communities worldwide

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Abstract

The development of organic agriculture worldwide has brought about a radical change of paradigm from the conventional agricultural production methods which developed into a global agro-industry over the past 70 years. The industry has developed with a strong bias in favour of big institutionalized, corporate based production and distribution of agricultural food and non-food products, a value chain inclusive of research and development in the hands of a few for the entire globe. Proponents of organic agriculture claim a more sustainable development of communities through the adoption of organic agriculture, as organic agriculture is based on both formal science and technology (S&T) and local and traditional knowledge. Organic agriculture addresses not only production and productivity, but also the multi-functionality of agriculture with regards to the wellbeing of humankind. It might therefore not be surprising that organic agriculture is bringing more women into farming after agricultural production became increasingly the domain of men, perhaps because of mechanization and further industrialization of agriculture. Agricultural machines are often heavy, their design made for use by men, and they require mechanical knowledge, considered a male quality, not to be taught to women. Women in developed countries engaged in organic agriculture are joining the small scale farmer women of the South, where women are still responsible and/or heavily involved in farming. Women have played a big role in developing organic agriculture. Women like Lady Eve Balfour, who in 1945 wrote "The Living Soil", was founder and leader of the Soil Association in the UK. Rachel Carson who 20 years later wrote the book "Silent Spring", was an influential exposition of the drawbacks of intensive chemical farming. These women contributed strongly to the organic agriculture movement development in its first years together with thousands of women practitioners, advocates and scientist who followed their footsteps to further develop organic agriculture and enhance its benefits. Today it can be positively affirmed that greater and more effective involvement of women and use of their knowledge, skills and experience will advance progress towards sustainability, food security, health and wellbeing of communities. In the development of conventional agriculture, women farmers, processors and farm workers have surely benefited less than men overall, and poor women least of all. Organic and sustainable agriculture system can help to redress persistent biases in their access to production resources and assets, occupational education and training, information and extension services.

Keywords: Organic agriculture, women, good governance, gender equality

Organic Agriculture as an alternative food production system

The development of organic agriculture worldwide has brought by a radical change of paradigm from the conventional agricultural production methods which developed into a global agro-industry over the past 70 years. An industry, which was developed with a strong bias in favour of big institutionalized, corporate based production and distribution of agricultural food and non-food products, a value chain inclusive of research and development in the hands of a few for the entire globe. Today, so it seems, that the conventional agriculture industry is integrating bits and bites of research and development results from the organic and sustainable agriculture sector, wherever it is suitable and profitable. But given the structure and the global financial interests of this industry sector, it is very resistant to radical change, and in embracing underlying values which then would lead to change in all aspects of agricultural undertaking from research and development, adoption of appropriate technologies, forms and terms of trade etc.

Organic Agriculture as a sustainable production system with inherent feminine principles

Proponent of organic agriculture claim a more sustainable development of communities through the adoption of organic agriculture as organic agriculture is based on both, formal science and technology (S&T) and local and traditional knowledge. Organic agriculture addresses not only production and productivity, but also the multi-functionality of agriculture with regards to the wellbeing of humankind. Organic Agriculture affirms life and the understanding that agricultural production systems must be based on a healthy ecology, inclusive of the economic and social aspects of agricultural production and trade. Thus the aim for sustainability in organic agriculture expresses the desire to provide the best outcomes for the human and the environment both now and into the indefinite future. In organic agriculture the building of a harmonious, prosperous and sustainable global community which is capable of meeting its needs without causing prejudice for future generations to meet theirs starts with the soil. One of the unifying principle of the organic community worldwide is the understanding that community is dependent on the soil and healthy foods that come from healthy soil. Many organic and traditional agriculture communities feel the spiritual power of the earth, and many religious and spiritual beliefs lead people to embrace organic agriculture once they become aware of the consequences of toxic agro-chemistry, which leads to the disintegration of natural systems. Toxic agro-chemistry based agriculture, also referred to as conventional agriculture has led and is leading to death and destruction in the soil, in wildlife, in the farming and urban communities, and is continuing to debase the food we eat. Over the past seventy years, this agricultural system has become increasingly the domain of men and a few industries controlling the agricultural production worldwide, to the extent that even men farmers are not in control of the production system anymore. While it may be true that women have been pushed out of agricultural production due to its mechanization and industrialization, I dare to put forward the argument that the feminine principles of life and in this context of Mother Earth or Ecology in its widest sense have equally been pushed out of the development of agriculture through the development of the conventional agriculture, as the toxic agro-chemistry approach tends to favour the masculine values of domination over nature, people and gender, as versus the feminine values and principles based on the biological and regenerative powers of the earth, the life-giving forces and powers of the earth, but also the interdependence of communities, thus striving for harmony with nature, maintaining the quality of environment, all inherent values and principles of organic agriculture.

It might therefore not be surprising that organic agriculture is bringing women back into farming. With the development of organic agriculture over the last thirty years, with more women engaged, these women in developed countries are joining the small scale farmer women of the South, where women are still responsible and/or heavily involved in farming.

Women have played a big role in developing organic agriculture. Women like Lady Eve Balfour who in 1945 wrote “The Living Soil”, founder and leader of the Soil Association in the UK. Rachel Carson who 20 years later wrote the book “Silent Spring”, an influential exposition of the drawbacks of intensive chemical farming. These women contributed strongly to the organic agriculture movement development in its first years together with thousands of women practitioners, advocates, scientist who followed their foot steps to further develop organic agriculture and enhance its benefits. Women continue bringing forward their own visions of how the feminine principles embodied in the earth should be lived, how food should be healthy and their production contribute to healthy families and communities for a more equitable development of nations who will then be able to become part of a harmonious global community. The pioneering women and all women currently engaged in organic agriculture and its development are responsible for making the organic movement a remarkable agent of change, and are more often than not contributing to the improvement of their family’s quality of health and income. It is because of these many dedicated women who have helped shape and guide the organic movement over the past 30 years that organic agriculture has developed into a credible production system providing healthy and safe food and promoting sustainable development.

- Without recognizing women’s contribution to the history and development of organic agriculture, our understanding of organic agriculture would be incomplete.
- Women have been contributing and continue contributing substantially to the development of organic agriculture for decades through farming, education, marketing, organizational development, policymaking, science, research and more.

Women are different from men and yet there is a man in every woman and a woman in every man

To capture the essence of organic agriculture and to provide a base and inspiration for actions, IFOAM has developed the four principles of organic agriculture: Ecology, Health, Care and Fairness. It is essential that women are equally included in the interpretation of these principles and the actions of implementation in the development of organic agriculture as even with the best intention in mind, they will be corrupted if men only will use their sensibilities and skills to further develop them into agricultural production system, organic or not. I dare to demonstrate this thought on the principle of CARE and diversity as a part of the principle of ECOLOGY.

Following the principle of CARE for crops, has led to the development and application of pesticides in the men dominated conventional or toxic agro-chemical agriculture. In this system, killing on one hand is used to protect on the other hand. Applying the feminine interpretation of CARE would favour the protection over the killing, thus initiating the search for solutions that avoid killing.

Applied to organic agriculture using the principle of CARE and ECOLOGY, wherein a production system based on respect and observation of nature, inclusive of microbial life in the soil, diversity of crops, insects, animals, maybe even diversity of skills and resources of farmers and their respective communities, will seek solutions other than killing, which ultimately leads to the dominance of one over the other, may it be a crop varieties, animal breeds, insect and pests, or even entire industries over the interests of communities, which disenfranchise people over their capacity to design their life, their livelihood, their communities.

Today's challenge is to allow ourselves to accept that women are different from men and men different from women, but that we all have both, female and male qualities in different degrees, which when united and kept in balance bring the best out in us as individuals and as communities. If we are thoughtful, apply the principles of CARE and FAIRNESS, are respectful of one another to allow both women and men to equally participate in life and social processes, we will be able to achieve our goals in diversity and unity.

Today it can be positively affirmed that greater and more effective involvement of women and use of their knowledge, skills and experience will advance progress towards sustainability, food security, health and wellbeing of communities. In the development of conventional agriculture, women farmers, processors and farm workers have surely benefited less than men overall and poor women least of all. Organic and sustainable agriculture system can help to redress persistent biases in their access to production resources and assets, occupational education and training, information and extension services.

Global Development, Good Governance and Gender Equality

The debates on good governance in global development initiatives which has evolved since the 1990s have been based on the realization that conventional development efforts had failed to achieve desired goals namely to eliminate poverty and inequality and to promote the respect of human right.

The priorities of good governance, which include greater considerations for the way in which power is exercised in the management of economic and social resources development are very much in tune and compatible with the principles of organic agriculture, the principles of ecology, health, care and fairness, as well as traditional and sustainable agriculture systems which are based on the knowledge of the farmers, the needs of the communities and deep respect for ecological processes, which are used for the benefit of improved productivity.

The debates and initiatives to achieve good governance in development work as well as the specific development of organic and sustainable agriculture, do not automatically address the question of gender inequality despite the fact that if good governance means improved distributional equity, then gender equality should stand high on the agenda of all development, organic and sustainable agriculture projects.

It is therefore important, to give voice to women's needs and concerns in all organic and sustainable agriculture development initiatives and in all R&D work which should pay special attention to include this component as to assist the farmers women and communities to effectively develop their production systems, their value chains and the socio-economic organization of their communities.

The contributions of women in form of paid and mostly unpaid labor, their knowledge and experience shall be made visible and duly recognized. Such recognition of the significance of women's contributions shall be translated into accurate development of institutionalized rules, policies and laws which protect women's rights, which allows women to be represented on an equal basis and which enhance governmental capability to design, formulate and implement programs which include gender equality concerns and citizen participation.

- Development tools
  - Any organic and sustainable agriculture development project shall include the gender mainstreaming perspective in an organized, structured, systematic and standardized way and empower women to fully participate and take responsibilities in the leadership.

What actions are possible to give voice to women's needs and concerns?

No need to reinvent the wheel to give voice to women's needs and concerns, carving out spaces for equal participation of women and men in governance, and improving accountability and responsiveness of governance institutions to poor women's interests. Simply support what they are doing "naturally".

Women take important roles in the entire organic food chain.

- In the farm, women are very important for saving seeds, maintaining biodiversity, production of traditional crops and livestock.
- To safeguard traditional seeds and breeds also means to improve them, means to study them and to develop appropriate production systems that can meet increased needs of the communities. Women should be recognized for their contributions and be given the opportunity to actively assist in the process of safe-keeping and improving as to assure an equitable approach in the development of new and improved production systems.
- Organic, sustainable and traditional production systems provide healthy and safe food, which improving women's and the family's health. This in return eases the pressure on women who traditionally are the caregivers of sick family members. .
- Improved women's and family health means improved quality of life, wellness and productivity.
- Direct involvement of women in food production allows them to decide on crops to be produced, thus giving them the power to saves the culinary heritage and culture and create new produce and products for the organic food chain.
- Being part of the organic food chain gives women the power to create, innovate, safeguard and earn.
- To promote organic agriculture and additional income, women take leading roles in eco-tourism and didactic farm activities.
- Eco-tourism is a sustainable and innovative form of tourism allowing people to enjoy discovering the world, while safekeeping the environment and social structures. Organic agriculture is an important component of eco-tourism as to provide safe and healthy food. Women are playing a crucial role in this and should be recognized and assisted to institutionalize its development as part of a green development strategy.

- In the North as in the South, in urban and in rural areas, women decide what to buy for their families. They are leading the increasing consumer demand for organic products. They are claiming the rights for healthy food for their families, are requesting for organic canteens in their children's' schools and are rethinking maternity practices related to organic and biodynamic philosophy.
- Governments, in particular public health officials should work hand in hand with women as to assure public health programs which include organic and safe food, are sustainable and affordable.

Why women have joined and are joining the organic movement in the North

Example form the CCOF (California Certified Farmers)

- For some women, growing up on a farm was their introduction to agriculture, and made them decide to continue farming, but the organic way.
- Others start out through seeking a career in organic agriculture by earning a degree in agriculture related university courses.
- Yet others came to the organic movement via their work experiences in conventional agriculture fields as diverse as farm workers unions, government agencies and others. Their initial concern often was to care about reducing toxic agro-chemicals in agriculture, food safety and environmental health

Today, women continue engaging themselves for organic agriculture as commitment to the community, environment, and the sustainability of the land. She farms organically to protect beneficial insects, wildlife and to create natural habitat without the use of chemicals.

Women and organic agriculture in the South

Example from the Sindh Rural Women's Uplift Group in Pakistan

In the rural areas of Pakistan, agriculture land is owned by men and they use family labour including women for producing crops, thus traditionally, women are not getting paid for their labour and live in dependence of their families. Sindh Rural Women's Uplift Group tried to help women by engaging a number of them on the farm under the guidance of women farm supervisors and paid them the same salaries as were paid to men, giving them similar jobs to perform. Their full time employment in sustainable agriculture in the past 2 years has changed the life pattern of a group of 12 women consisting of one couple of parents, their daughters, daughter-in-laws and nieces. In two years since starting of the operations house-hold life patterns of these families have changed. In the beginning men took away all the salaries of women but gradually women have asserted themselves and have started to manage or co-manage the funds. A big change to them is that they decided to send their children to school. It seems that men's attitude toward the social set-up in the house has changed somewhat became a little more considerate but, time may bring about further changes. …

But this project has also proven women in Pakistan agriculture, can perform the following functions as good as men:

- Transplanting of vegetables, rice, and bare root plants;
- Inter-cultivation of vegetables, removal of weeds and unwanted growth;
- Picking of cotton, small fruits, vegetables, berries of all types, harvesting of wheat, rice and other crops;

Women excel men in all those operations which require squatting to carry out operations near the ground and keep moving simultaneously.

Conclusions

It is clear that women fit perfectly with organic agriculture and that women can play an important role in promoting and developing organic agriculture. An yet, despite all the contributions of women in organic agricultural and food production, consumption, sustainable development activities, women are still not well enough represented in decision making bodies. And, without exaggeration, it can be said, that governments and decision making bodies do not sufficiently recognize, reflect and respect the women's role and the importance of gender equality for a sustainable development. Thus, it is important to clearly give support to women's role and initiatives in organic and sustainable agriculture.

Or, as put in the Gender Study of IFOAM "Organic Agriculture and Women's Empowerment" by Cathy Farnworth and Jessica Hutchings: "Gender relationships are fundamental worldwide to the way farm work is organised, the way assets such as land, labour, seeds and machinery are managed, and to farm decision-making. Given this, the lack of adequate attention to gender issues within the organic and sustainable farming movements is worrying. The revolutionary potential of sustainable approaches to farming to reshape our food systems, and the way humans interact with those systems, will not be realized unless there is a concerted effort by committed sustainable farmers and consumers to work towards gender equality.

We need

- to create space for linking and learning in the best tradition of action-oriented participatory development initiatives to facilitate the equal inclusion of women at all levels for a more sustainable development to meet the needs of all, women and men alike in all communities around the globe.
- encourage women to take up public leadership and encourage governments, intra-government organizations, NGOs and corporate leaders to seek gender equality in their policies
- Include gender mainstreaming perspective in an organized, structured, systematic and standardized way in all its work and make an effort to empower women to fully participate in all organic agriculture projects

Rationale

Gender equality is, first and foremost, a human right. Women are entitled to live in dignity and in freedom from want and from fear. Empowering women is also an indispensable tool for advancing development and reducing poverty.

In reality access to equal rights and equal opportunities varies from country to country. In some countries and cultures the inequality between men and women is leading to different forms of violence against women up to date, though equal rights for women is declared as a Universal Human Right:

"In 1993, 45 years after the Universal Declaration of Human Rights was adopted, and eight years after CEDAW entered into force, the UN World Conference on Human Rights in Vienna confirmed that women's rights were human rights. That this statement was even necessary is striking –

women's status as human beings entitled to rights should have never been in doubt. And yet this was a step forward in recognizing the rightful claims of one half of humanity, in identifying neglect of women's rights as a human rights violation and in drawing attention to the relationship between gender and human rights violations."

Yet, discrimination against women and girls – including gender-based violence, economic discrimination, reproductive health inequities and harmful traditional practices remains the most pervasive and persistent form of inequality. This to the point that the UN has adopted in October 2007 during its 62nd General Assembly a new MDG Framework, which among others includes Goal 3"Promote Gender Equality and Empower Women".

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Organic vegetable: Trend in breeding and selection for our Asia-Pacific region

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Abstract

Organic production systems have been focusing mostly on soil nutrient and pest management. Varieties and seeds being used generally are the commercially available and conventionally bred. In plant breeding parlance Phenotype (P) = Genotype (G) + Environment (E) + G × E. That is, the performance of a variety (phenotype) depends on the genetic trait (genotype), the effect of the environment (E) and the interaction between the variety and the particular environment. Organic production has been focusing on E, which is more on cultural management, organic fertilizers and pest management. G if ever it is considered is not purposive. Organic vegetable breeding by the public sector in Asia-Pacific region has just started very recently. In the Philippines it started around 1995 informally, and formal funding only began in 1999. In the rest of Asia, organic breeding particularly in vegetable is almost non existent except at AVRDC as a part of the Seed and Safe Vegetable Production Systems Program. However, based on the targets it would still just be evaluation of varieties under organic condition and not active breeding. Organic growers however, have been doing variety selection and seed production at varying levels of sophistication. Notable examples are in Malaysia and Thailand. The involvement of the formal seed sector in organic vegetable breeding is also very minimal because of small market size. Even organic seed production has not yet caught up with the sector. Only one seed is into organic vegetable breeding in the Philippines. However, at different levels of sophistication organic vegetable producers are already doing a variety selection and seed production.

Keywords: Organic production system, variety selection, seed production, vegetables

Introduction

Organic agriculture, particularly organic vegetable production in the broad sense have had a long history in the Asia-Pacific region. However as currently defined and based on standards it is rather recent. World organic area stands at more than 31 million hectares (2006) and Asia accounts for only 13%. Most of the world's organic land is in Australia / Oceania (39 %), followed by Europe (21 %) and Latin America (20 %). North America contributed 4 % and Africa ,3 %. (Willer and Kilcher, 2009) The total organic area in Asia is nearly 3.1 million hectares, managed by almost 130’000 farms. This constitutes ten percent of the world’s organic agricultural land. The leading countries in Asia-Pacific are China (2.3 million hectares), India (528’171 hectares) and Indonesia (41’431 hectares). (Willer and Kilcher, 2009)

Organic production systems focus mostly on soil nutrient and pest management. Varieties and seeds being used generally are the commercially available and conventionally bred. In plant breeding parlance Phenotype (P)= Genotype (G) + Environment (E) + GxE. That is, the performance of a variety (phenotype) depends on the genetic trait (genotype), the effect of the environment (E) and the interaction between the variety and the particular environment. More technically the model is $\mu_{ij} = \mu + G_i + E_j + (GE)_{ij}$ for the expected phenotypic response for genotype i (i = 1,…,I) in environment j (j = 1,…,J), μ_{ij}, where μ stands for the general mean, Gi is the genotypic main effect expressed as a deviation from the general mean, and Ej symbolizes the environmental main effect, again expressed as a deviation from the mean and GE as the interaction between specific genotype and environment (van Eeuwijk, *et al*. 2004).

Organic production has been focusing on E, that is more on cultural management, organic fertilizers and pest management. G if ever it is considered is not propulsive. Compare this to conventional agriculture where G (especially in GMO) is central.

Organic vegetable breeding by the public sector in Asia-Pacific region started just very recently . In the Philippines it started around 1995 informally and formal funding was only in 1999. In the rest of Asia, organic breeding particularly in vegetable is almost non existent except at AVRDC as a part of the Seed and Safe Vegetable Production Systems Program. However, based on the targets it would still just be evaluation of varieties under organic condition and not active breeding.

Even Australia, which has the biggest organic production area in the World, is still into organic seed production using conventional varieties whether OPV or hybrids or heirloom varieties (Neeson, 2005)

Private sector involvement in organic vegetable breeding is also very minimal because of small market size. Even organic seed production has not yet caught up with the sector. Only one seed company (based on personal knowledge) is into organic vegetable breeding, in the Philippines. However, at different levels of sophistication organic vegetable producers are already doing variety selection and seed production.

‘…The organic system wants to emancipate from conventional seeds but with the right tools, that probably are not (only) the regulation compulsory requirement for organic seed use.’(Micheloni and Roviglioni, 2007) but for emancipation to be realized active organic breeding, including the enhancement of land races, should be done coupled with systematic organic seed production to be able to obtain high quality seeds at competitive prices.

Based on personal communication and review of literature below are the trends in organic vegetable breeding and selection in the Asia-Pacific region.

India

The organic sector in India consists of a small export-focused cultivation industry, and a large “wild harvest” industry. (Johnson et. al., 2008). Areas of production are reported variously as a large “wild harvest” industry of > 2.5 million ha, sourcing a range of “organic” herbs, spices, and medicinal products. The area of certified production was variously reported at 339,113 ha for 2006-2007 (APEDA, 2008) and more than 500’000 hectares (Ong Kung Wai, 2008)

In general however, varieties being used are the traditional or landraces as well as the conventional varieties. Seed production by growers is generally by mass selection as in most farmers.

Indonesia

Similar to the other Asian countries organic vegetable production in Indonesia is being done based on indigenous knowledge and varieties. Growers generally practice mass selection based mainly on fruit characters. The major vegetables of interest are cucumber, hot pepper, muskmelon, shallots and tomato. In the latter the wild type is being used the growers. There is no formal organic breeding and selection for vegetables.

Japan

Organic production area in Japan is 6,074 in 2006 or about 0.2 percent of total domestic agricultural production and barely growing (Ong Kung Wai, 2009). The number of certified organic farms is 2’258 as of 2007.

Generally organic farmers create a special setting mimicking the natural environment of the plant. They use ancient knowledge in cultivating the land such as observation of the tide, exploitation of fermentation in nutrient cycling and the like.

Just like conventional farming, hybrids or F1 varieties are being used in organic and natural farms. Mr. Masamitsu Matsuzawa, a natural farmer, said that he buy seeds at the store for the moment. He finds it difficult to produce his own seeds. According to Mr. Isamu Noguchi, owner of Noguchi Seed Company, the agriculture industry in Japan has been overtaken by private seed companies. Almost 100% of farmers use hybrids. At present Noguchi Seed Company is perhaps the only seed company in Japan breeding for open pollinated varieties and has selection program for heirloom seeds. The company has promising selections for radish varieties, which is one of the most important vegetable in Japan. It is also currently breeding for tomato, pepper and cherry tomato cultivars. The company produces seeds in Japan, Europe, China, United States and New Zealand.

Malaysia

Organic production area in Malaysia is reported at 1,000 ha, constituting 0.01% of total agricultural area. At least one grower is doing varietal selection in their organic production (Chu, 2009, personal communication). This is also a result of problems with the use of conventional varieties. There has always been breeding and selection work done for vegetable and fruit crops in general and they have proven to be more disease resistant and have better yields etc. To date, their farms are using the department's selected varieties of long bean, ladies finger, tomato, cangkuk manis and bitter gourd. Where possible they produce their own seeds for as many as the crops as they can, including of those from the Agriculture Research Center, Semonggok, Sarawak.

They are also starting to do active breeding to be able to develop better varieties for their own organic vegetable production. Based on personal communication also the public sector in Malaysia has not yet gone into R and D on organic breeding in vegetables. However, the organic group in Sarawak is trying to get the government to spearhead organic research and development.

Philippines

The reported organic area is only 5,691 ha, 0.05% (FiBL, 2008) but in other reports it is around 39,458 ha (2005-2006 estimates) or 0.36% of total agricultural area.

There are only around 17 certified organic farms in the Philippines by the Organic Certification Center of the Philippines (OCCP). These farms rely mainly on commercial hybrids and open pollinated varieties as planting materials because also on unavailability of organic seeds and varieties.

The national vegetable program for the masses is a national program which promotes vegetable production and consumption among school children and communities at risk. Through the program the government is pushing for seed saving and organic farming as an alternative technology for farmers to adopt. Each household is expected to maintain at least 10 sqm. plot for home consumption. Open pollinated varieties are distributed to and seed saving encouraged sustaining food production. In cases when there is insufficient space, especially in the case of urban centers, families will have the option to group together and cultivate available space for vegetable production and seeds. As of May 2009 around 18,000 households have been served by the project.

Another project, GMA PAMANA, designed to provide organically produced seedlings to urban communities uses OPV. Seedlings are produced organically and the households are also trained on the non-chemical way of producing vegetables for the kitchen.

The author has done breeding work and selection on organic vegetables since 1995 and has developed several organic varieties and recommended them to organic growers. (Maghirang, *et al*., 2002). Among these are the following:

Eggplant:

Concepcion – oblong, green with white stripes and very firm

98-455 – long, dark purple, smooth shiny, very firm and very prolific

00-182 – F1 hybrid, harvested at 65 days after planting (DAP), 110g/fruit, round, dull green with white stripes, firm flesh, good storage and shipping

Arayat – land race, harvested at 58DAP, 105g/fruit, round, dull green with prominent white stripe, very firm, very tasty, good storage and shipping

00-373 – F1 hybrid, harvested at 58DAP, 175g/fruit, shiny dark long purple with green calyx, firm flesh, very few seeds, good storage and shipping

00-374 – F1 hybrid, harvested at 58DAP, 121g/fruit, shiny long purple with green calyx, firm flesh, very few seeds, good storage and shipping

A300- land race, striped, harvested at 58DAP, 70g/fruit, dull purple with white stripes, with green calyx, firm flesh, good storage and shipping

Tomato

Pinusyo- land race, harvested at 64DAP, 39g/fruit, long oval shape , red orange when ripe, good storage and shipping, moderately resistant to bacterial wilt (BW) (LB strain), tolerant to tomato yellow leaf curl virus (TYLCV)

Elma-2 – A selection from farmer's field, harvested at 64DAP, 53.4g/fruit, oblong with slightly pointed end, red orange when ripe, firm and thick juicy flesh, sweet taste, good storage and shipping, tolerant to BW (LB strain), susceptible to TYLCV and fruit worm

Elma-3 – A selection from farmer's field, harvested at 64DAP, 72g/fruit, square round with pointed end, red orange when ripe, firm flesh, good taste, high yielder, good storage and shipping, tolerant to BW (LB strain), susceptible to TYLCV and TMV

00-280 – F1 hybrid, harvested at 64DAP, 70.2g/fruit, square round, orange when ripe, firm, sweet taste, high yielder, good for processing, storage and shipping, moderately resistant to BW (LB strain), highly susceptible to viruses

Grandeur – F1 hybrid, harvested at 64DAP, 137.8g/fruit, long flat round, red orange, thick and juicy, firm flesh, resistant to BW (LB strain)

Pepper

99-232-1- A selection from previous trials, harvested at 59DAP, 7.40g/fruit, dark green, long, slender, thin flesh, mild pungency, tolerant to fruitfly

99-232-4 – A selection from previous trials, harvested at 43DAP, 11.75g/fruit, dark green, long, slender, thin flesh, very mild pungency, ideal for cooking

99-232-5 – A selection from previous trial, harvested at 43DAP, 10g/fruit, dark green, slightly wrinkled, long, slender, thin flesh, very mild pungency, ideal for cooking

00-396 – F1 hybrid, harvested at 49DAP, 7.7g/fruit, dark green, shiny, smooth, long, slender, thick flesh, very pungent, good for processing

HP-21 – dark green, smooth waxy surface, mild pungency, processing type

C-1550 – light green, long, slightly wrinkled, moderately pungent, sinigang-type

00-375 – F1 hybrid, harvested at 49DAP, 9.5g/fruit, yellow green, slightly wrinkled, long, slender, thin flesh, sweet taste and smell, easily detached, very susceptible to fruit fly, very prolific, good for cooking

00-377 – F1 hybrid, harvested at 49DAP, 7.7g/fruit, dark green, shiny, smooth, long, slender, thick flesh, very pungent, good for processing

Inokra – light green, slightly wrinkled, not pungent, sinigang-type

Paras- land race, medium fruits, dark green, very pungent

In eggplant, selections included Mistisa, Concepcion, and Arayat; in tomato, Grandeur, Elma-2 and Pinusyo; hot pepper, Inokra and Paras; pole sitao, UPLS1, Line 228-1, CSL 15; bush sitao, UPLBS3 and CBD3; cowpea, CCD 10-1, CCD 10-10 and CCD 10-15; pole snap beans, B21 and Taichung #1; bush snap beans, Hab 63; squash, Sorsogon and Suprema; cucumber, White Lion and line 00-357; cabbage, Tropical King; crisphead lettuce, President; leaf type lettuce, Denies Red and Denies Green; cos/Romaine type lettuce, Line 00-134 and Cos; cauliflower, Lines 98-255 and 98-272; and broccoli, Silver Cup. (Maghirang *et al*, 2009).

These selections are also being used by researchers on other projects on pest management and disease resistance aside from the organic growers themselves though in limited scale because of insufficient materials.

As a follow through of the formal project ' Varietal evaluation under organic condition', a national project on 'Variety Evaluation, On-Farm Trials and Seed Production of Organic Vegetables in The Philippines' will be started this year under PCARRD funding. This will be done in six region in the Philippines.

Table 1. List of priority crops by region.

Region	Crops
CAR	cabbage, potato, carrot, garden pea, tomato, and Chinese cabbage
Region 1	eggplant, pepper, tomato, okra, pole sitao, garlic, and ampalaya
Region 2	Tomato, eggplant, squash, garlic and pepper
Region 3	eggplant, string beans, pechay, tomato, squash, okra, onion, muskmelon and ampalaya
Region 4	eggplant, ampalaya, tomato, sitao, lettuce, pepper, squash and cucumber.
Region 10	eggplant, tomato, ampalaya, cucumber, pechay and sweet pepper

In the trainings on organic vegetable production by the author one of modules is Organic Seed Production, to train participants not only on organic seed production but also selection and basic hybridization. The trainings had been conducted throughout the country both to growers and trainers. Apart from this PCARRD is publishing a Training Manual on Organic Agriculture where one of the modules is Organic Vegetable Seed Production.

Being developed also by FAO is Farmer's Field School Training Manual for Organic Agriculture with Organic Seed Production including hybridization as one of the modules. The objective is to capacitate growers themselves not only on organic seed production but also variety development and organic hybrid seed production.

Under deliberation in the Congress and Senate is the 'Organic Agriculture Bill of 2009'. Initially the bill was focused on crop production with organic fertilizer and biopesticides highlighted but after a series of consultation the importance of genetic material was also addressed; from genetic conservation to organic breeding and seed system.

Republic of Korea

Currently, there are more than 8'000 hectares under organic management in Korea; most of the certified organic farmers are vegetable producers, growing up to 30 different vegetables. (Ong kung Wai, 2008)

Since spring 2005, the Research Institute of Organic Agriculture of Dankook University has offered courses on organic agriculture teaching the principles of organic agriculture and practical skills of organic rice, fruit and vegetable cultivation, and organic animal husbandry. Dankook University also offers Master and PhD courses on organic agriculture.

Chinese Taipei

The discussion on Chinese Taipei will focus on the R and D of AVRDC on organic vegetable production.

The organic area in Chinese Taipei is 1746 ha, or 0.21% of the total agricultural area. Based on the 'Report of the 7th External and Program Review, March 3, 2008…'In many ways organic farming systems offer the "gold" standard in moving production systems to sustainability and the production of safe produce. These combine market certification with stringent management of input use. The management system depends critically on the development of non-input techniques for managing pests and diseases and soil fertility - appropriate varieties, integrated pest management, and integrated soil fertility management, all areas in which the center currently works. Techniques developed in the pest and soil management area can be equally applied in organic systems, as well as systems that seek to rationalize their input use.'

For Theme 3, Seed and safe vegetable production systems with Dr Jaw-fen Wang as coordinator the expressed Vision is 'To improve seed supplies of superior vegetable varieties for poor farmers and to provide research and outreach leadership to help them produce vegetables safely.' Among the outputs and activities for 2007 are the 'Evaluation of vegetable species and varieties suitable for organic farming systems' and 'Preliminary trials to evaluate at least ten vegetable species conducted at AVRDC organic farm'. From these two to 12 varieties each of cabbage, cucumber, sweet pepper, vegetable soybean, and tomato should have been evaluated at AVRDC organic farm.

The Output Targets for 2008: Preliminary trials to evaluate at least ten other vegetable species conducted at AVRDC organic farm. From this at least six varieties of cucumber, sweet pepper, and broccoli should have been evaluated at AVRDC's organic farm

The Output Targets for 2009: Superior varieties of target crops suitable for organic cropping systems recommended

While the importance of organic variety and seeds is beginning to be appreciated active organic breeding is still not yet in the pipeline. Activities will still be on evaluation of varieties. This is the logical move during the first two years but after that active breeding should already be started as was experienced by the author… present variability in the conventional varieties is not sufficient for many vegetable crop species for a successful organic production.

Thailand

The certified organic area in Thailand is 21,701 ha or 0.23% of the total agricultural area in 2006. The vegetable crops being grown organically are baby corn asparagus, okra, tomatoes, (Wanlop Pichpongsa, 2008) eggplant, herbs, cucumber, yard long beans. The National Committee for Organic Agriculture Development was founded in 2007 to design the national strategy which integrates the OA related works of different government agencies. However, there is limited support for research, development and extension (Wanlop Pichpongsa, 2008)

There are also no reports on formal organic vegetable breeding. However, the organic center in Chon Buri province under Miss Tippawan has been doing active breeding since 2002 on melon and other vegetables. Many growers are also using heritage varieties or land races. Organic growers are also doing some degree of varietal selection. Variety selection in various vegetable crops such as eggplant, tomato, bitter gourd, cucumber, yard long bean, wax gourd and various herbs is being done. However, most selection is done only focusing on the female parent in the case of cross pollinated and often-cross species.

Viet Nam

The organic area in Viet Nam is 21,867 ha, or 0.23% of the total agricultural area in 2006. Based on personal communication with Dr. Nhoung there is no organized organic vegetable breeding and seed production in Viet Nam. There is no company that produces organic seeds and it is difficult to find sources of untreated conventional seeds. Organic vegetable growers are forced to use treated seeds of conventional varieties, of which the consumers agreed upon for the moment.

Pacific Group

Organic agriculture is not a new concept in the Pacific; it is very much the traditional farming system that Pacific forefathers practiced sustainably for centuries. Today, current farming practices in many communities are still based on 'age-old' systems that are free from the residues of agrichemicals and where environmental integrity remains largely intact (Mapusua, 2008)

Organic agriculture is also being investigated by universities and other competent agencies in the region. Organic aquaculture, sustainable forestry; sustainable fisheries and sustainable tourism are generating interest by governments throughout the region, and there is full support from local stakeholders involved to collaborate in supporting regional development. However, there has been VERY little research done in the Pacific islands on organics, and even less on vegetables (Mapusua, 2008)

Conclusions and Recommendation

Organic vegetable breeding is just starting to be appreciated in the Asia-Pacific region. However there has always been some degree of varietal selection in the grower's fields and farmer seed saving is generally being done at various levels of sophistication but usually involving mass selection. Organic breeding is being done in the Philippines and in Chinese Taipei (AVRDC). The private seed industry is still reluctant to go into organic seed production because of the small market size. However, at least one seed company is into organic vegetable breeding.

During the Organic Asia Conference in Sarawak, Malaysia in 2008 the need for a Regional RDE network was emphasized. This should be a healthy mix of private and public sector efforts. This would fast track exchange of information as well as organic germplasm. Among the areas that can be in the agenda are:

Conservation and enhancement of native/heirloom/ land races

National and regional organic seed system (to include, varieties, seeds, seed production technologies)

Organic vegetable breeding network/cooperative doing active breeding.

Enhancement of organic selection system

Enhancement of organic seed production system

Among the selection criteria/traits to be considered are: Socio-cultural traits, off-season adaptation , habitation for natural enemies, tolerance to stress including weeds, root system re: nutrient utilization, symbiosis, eating quality and shelf life, seed quality including shelf life, resistance to seed borne diseases.

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Integrated pest management in small-scale low input vegetable production in Thailand and Viet Nam

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Abstract

Integrated pest management (IPM) is founded on good ecological understanding of the agro-ecosystem. By emphasizing biological means to keep pests and diseases in check, integrated pest management strategies enable farmers to take advantage of existing natural mortality factors, thereby minimizing external inputs. This low-input approach is sustainable and capable of bringing about profitable yields, especially in organic vegetable production. IPM should be viewed as an introduction to more efficient agriculture and has become an integral part of good agricultural practices (GAP). Examples of alternative methods of managing insect pests in vegetable production in Thailand and Viet Nam are provided, including the use of rice husk ash to deter flea beetles, biological control of imported leaf miner fly on beans, and diamondback moth management.

Keywords: Integrated Pest Management (IPM); biological control; Good Agricultural Practices (GAP); sustainable agriculture

Introduction

With the significant achievements in raising living standards across Asia over the last half century the quality of life throughout the continent has reached new heights; an Asian renaissance is underway (Mahbubani, 2008). To suggest there is no further need to address development in Asia, however, neglects the ongoing challenge to alleviate rural poverty and provide safe, healthy food for all. Development efforts in most countries neglect rural populations and agriculture (IFAD, 2001). Nearly three-quarters of the world's 1.2 billion poor people live in rural areas; to reach them, national planners and international donors must refocus their efforts, improve services to rural communities, and bridge knowledge gaps, particularly in agriculture.

In the wake of globalization, agriculture has become more knowledge-intensive. Institutional policies and incentives for farmers to adopt and adapt agricultural knowledge to local conditions are needed (World Bank, 2003). This paper reviews several examples of alternative methods of managing insect pests in vegetable production that have been applied in Southeast Asia: The Royal Project Foundation (HRDI, 2007) in Thailand has achieved some success in sustainable agricultural development through the adoption of integrated pest management in organic farming; and AVRDC – The World Vegetable Center is extending IPM practices through experiments in Thailand and Viet Nam (Le and Ooi, 2009).

Rice husk ash to keep populations of flea beetles down

In Viet Nam, flea beetle *Phyllotreta* sp. (Coleoptera: Chrysomelidae) (Fig. 1) is the most serious pest encountered in crucifer cultivation in the low land. Cruciferous crops are the pest's main food source, but this insect also can live on legumes, cotton and cereals. Flea beetles have long back legs that allow them to jump when disturbed. After mating, females lay eggs in the soil near food plants. The larval stage takes about four to five weeks under the soil, probably feeding on roots and subterranean stems. The larvae pupate in the soil. The whole life cycle takes about three to four weeks depending on the environment and climate (Shepard *et al*., 1999). In the life cycle of this pest only adults feed above ground and are most dangerous to the plants.

Damage by flea beetles is most evident on seedlings of *Brassica* crops. Severe damage can be caused by adults feeding on the seedlings below the soil surface prior to emergence. The beetles make holes in the cotyledons, giving a characteristic shot-hole appearance.

As *Phyllotreta* sp. could reproduce within the crop, effort to reduce breeding of the insect within the crop was attempted in Viet Nam. In Viet Nam, Le and Ooi (2009) used rice husk ash to manage flea beetles feeding on *Brassica* crops in the province of Tra Vinh. Some level of success was obtained and many farmers adopted the use of rice husk ash in the preparation of the beds for planting (Fig. 1).

Besides rice husk ash, it was reported in Thailand that an entomogenous nematode was available to control the flea beetle. Hence, a study was organized for participants of the ARC-AVRDC 27th Regional Training Course (RTC). A group of RTC participants experimented with four non-chemical approaches, including the use of ash, soil solarization, use of a commercially available *Bacillus thuringiensis* (Bt) and the nematode, *Steinerma* sp. to control the flea beetles (Fig. 2). The results suggested that non-chemical methods for flea beetle control are available in Thailand. These non-chemical control methods should be evaluated in other countries. The experiences in the province of Tra Vinh, Viet Nam could be shared with other provinces as well as with other neighboring countries.

Biological control of imported leafminer fly on beans and ornamentals

Coenosia exigua Stein (Diptera: Muscidae) or tiger fly is a predator commonly found in the region. *C. exigua* adults resemble the common house fly, *Musca domestica* L. (Diptera: Muscidae), but are somewhat smaller size and paler. From a resting place on a leaf edge, a *C. exigua* adult flies up and catches prey with its legs, then flies back to the same location. *C. exigua* adults kill their prey using a mouth hook located at the end of the proboscis and feed on the body fluid. This predatory fly feeds on several important insect pests including aphids, fungus gnats, leafhoppers, leafminer flies, whiteflies and vinegar flies. The immature stages are found in vegetative matter where *C. exigua* larvae can predate on other fly larvae such as the fungus gnat larvae.

The tiger fly is considered a very effective predator of the exotic pest *Liriomyza huidobrensis* (Blanchard) (Diptera: Agromyzidae), or leafminer fly, which feeds on beans and ornamentals. To encourage the growth of tiger fly populations, efforts were made to provide an environment in which *C. exigua* can multiply (Winotai and Chattragul, 2007). Breeding troughs (Table 1) with fungus gnats attract *C. exigua* to breed.

A cost-benefit analysis showed that setting up breeding troughs for *C. exigua* and avoiding spraying registered higher benefits of 3.54 THB/m^2 as compared with a similar sprayed field (0.69 THB/m^2) (Winotai and Chattragul, 2007). The role of *C. exigua* extends beyond vegetables; breeding the tiger fly is now a routine activity at the Bhuping Palace in Chiang Mai to keep down the population of leafminer fly (Fig. 3).

Diamondback moth (DBM) management

The diamondback moth (*Plutella xylostella* (L.) (Lepidoptera: Plutellidae) is the most important pest of crucifers in the cooler parts of Thailand (Rowell *et al*., 1992); it has developed resistance to several insecticides (Rushtapakornchai *et al*., 1992). In Malaysia (Ooi and Lim, 1989; Ooi, 1992) and Viet Nam (Ooi *et al*., 2001), successful suppression of diamondback moth populations by the introduced parasitoid *Diadegma semiclausum* (Hellén) (Hymenoptera: Ichneumonidae) have been reported (Fig. 4).

At the start of the 1950s, the problem of controlling the DBM in Indonesia with chemical insecticides was reported by Ankersmit (1953). This was followed by a report from Malaysia by Henderson (1957). Sudderuddin and Kok (1978) reported a resistance factor of 2096 to the insecticide malathion for DBM collected from Cameron Highlands. The history of failures of the chemical control of DBM in Malaysia was chronicled by Ooi (1985) which subsequently led to a program to introduce effective parasitoids (Ooi and Lim, 1989). After a period of almost 12 years, the parasitoid, *D. semiclausum* was able to achieve its potential in keeping the DBM population in check in parts of Cameron Highlands where farmers do not use chemical insecticides (Ooi, 1992).

D. semiclausum is a larval parasitoid that attacks young DBM larvae (about 1st and 2nd instar) (Ooi, 1980). As a result of its effective searching abilities, this parasitoid was able to reduce the populations of the DBM to a level where it does not become a pest anymore. This successful suppression in Malaysia and Viet Nam (Ooi, 1992; Ooi *et al*., 2001) encouraged the introduction of *D. semiclausum* into Thailand. Lessons learnt in both countries suggested that the parasitoid would establish better in organic farms in Doi Ang Khang. Indeed, this was proven when reduced populations of larvae and high percent of parasitism in all three zones of organic fields in Doi Ang Khang were recorded (Table 2). Often, the use of parasitoids can be enhanced by farmer education (Ooi *et al*., 2001). Indeed, the success of this parasitoid in controlling DBM is confirmed by a review of Talekar and Yang (1992).

Conclusions

Successful integrated pest management involves a combination of strategies to keep pests in check because complete reliance on one method alone seldom achieves the desired goal. In the case of the flea beetle, rice husk ash is useful, but must be integrated with other control methods. Farmers with a sound appreciation of ecological relationships will understand the need to protect diamondback moth parasitoids by not spraying pesticides, and establishing conditions for the promotion of tiger fly predators to check leafminer fly. It is important for farmers to understand the ecology and biology of a pest to safely exploit its weaknesses. It is important to note that effective natural enemies usually exist in vegetable fields and efforts such as providing breeding sites for tiger fly predators will encourage their activities to keep pest populations in check. However, if a pest is of exotic origin, introduction of parasitoids that are specific to the pest should be considered.

An important outcome of the IPM experiences shared in this paper is the need to share experiences and adapt these into each situation and/or economy to achieve successful organic farming. Lessons learned from the past 50 years have shown that complete reliance on chemical control has time and again proven to be unsustainable, leading towards increasing difficulties in controlling insecticide resistant pests, as in the case of the DBM.

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(A)

Figure 1. The flea beetle, *Phyllotreta* sp., adult (A) and a study to compare the use of rice husk ash in the cultivation of crucifers in Tra Vinh (B).

MECHANICAL AND BIOLOGICAL CONTROL OF FLEA BEETLE (*Phyllotreta* spp.)

Mak Chan Ratana, Son Huyen Linh, Surin Sablap, Chansamone Phommachan, Assadullah Sultanzai and Francisca Soares Sarmento

Introduction

The genus *Phyllotreta* (Coleoptera: Chrysomelidae) is one of the largest and most economically important group of flea beetles. It is a serious and almost cosmopolitan pest of cruciferous plants. The damage caused by the adult flea beetle reduces crop quality which leads to serious losses. To manage the pest, farmers usually use non-sustainable pest management practices such as the application of chemical pesticides but with limited success. Thus, the efficiency of using other alternatives to control flea beetles, such as mechanical and biological control strategies need to be explored.

Objective

The study was conducted to determine the efficiency of the use of different mechanical and biological control methods for the management of flea beetle.

Methodology

The experiment was conducted from 29 December 2008 to 11 January 2009 at AVRDC-ARC's organic research field using Chinese kale as the study crop. The randomized complete block design (RCBD) was used on the following treatments which were replicated thrice: T1– Ash, T2-soil solarization using black polyethylene plastic, T3-*Bacillus thuringensis* (Bt), T4-Nematodes (*Steinernema*) and T5-Control. Ash was applied a week after seed sowing and was maintained by adding a thin layer after irrigation. Soil solarization (T2) started two weeks prior to seed sowing. Bt (T3) and *Steinernema* (T4) were applied immediately after seed sowing and one week after seed sowing using the rates 8cc/2 L water/30m2 and 7.5 g/ 2 L water/ 30 m2 respectively. A plastic fence (1 meter in height) was set up around the study area to minimize infestation from adjacent fields. Data gathering started 7 days after seed sowing and six consecutive times thereon with two day intervals between each data gathering. Data on the rate of damage from flea beetles and the population of flea beetles (using yellow sticky traps) were collected and analyzed.

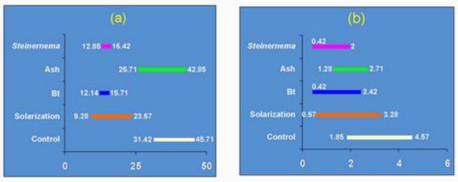
[1]van den Berg, H., Ooi, P.A.C., Hakim, A.L., Ariawan, H. and Cahyana, W. 2004. Farmer Field Research: An Analysis of Experience in Indonesia. FAO Regional Office for Asia and the Pacific. 70 pp.

Results

Effects of mechanical and biological control methods on the leaf damage and population of flea beetles on Chinese kale.

Treatment	Average number of damaged leaves*	Flea beetle population (no/m2)*
T1 (Ash)	30.83 [a]	2.33 [a]
T2 (Solarization)	13.33 [b]	2.75 [a]
T3 (Bt)	19.17 [b]	2.58 [a]
T4 (*Steinernema*)	15.00 [b]	2.25 [a]
T5 (Control)	36.25[a]	3.25 [a]

* Means within a column followed by the same letter are not significantly different (p=0.05).



Comparison of damaged leaves (a) and number of Flea beetles (b) per m^2 using overlap test[1].

The results summarized in the table above show that the use of Bt (T3), *Steinernema* (T4), and soil solarization (T2) significantly reduced damage from flea beetles. The effects of soil solarization, Bt and *Steinernema* are comparable as indicated by the average damaged leaves. All the treatments used did not have any significant effect on the population of flea beetles. The overlap test supports the findings on the effect of soil solarization, Bt and *Steinernema* on reducing leaf damage caused by flea beetles.

Discussion and Conclusion

Based on the data gathered, soil solarization (using black polyethylene plastic), Bt and *Steinernema* can significantly reduce the damage caused by flea beetles. It is recommended however, that the use of the abovementioned flea beetle management strategies should be accompanied by the use of a plastic fence (at least 1 meter in height), to avoid possible flea beetle infestation from adjacent fields. Moreover, further studies to identify the combined effects of the treatments on the population and damage from flea beetles should be conducted until harvest. Multi-location and seasonal trials may also be pursued.

Acknowledgement

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Figure 2. Mechanical and biological control of flea beetle (Phyllotreta spp.) poster.

Figure 3. Minimizing infestation of leaf miner fly in Bhubing palace by promoting tiger fly population poster.

(A) Adult *P. xylostella*

(B) *P. xylostella* caterpillar

(C) *Diadegma semiclausum* examining 2nd instar caterpillar of *P. xylostella*

Figure 4. The diamond-back moth (DBM), *Plutella xylostella* (A): adult and (B): larva and the parasitoid, *Diadegma semicluasum* (C) introduced to control the DBM.

Trust and organic food marketing in Japan

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Abstract

The recent organic boom in Europe and North America is said to be brought by the aggressive sales of organic foods at supermarkets. However, despite the growing attention and popularity in organic foods, finding them in Japanese supermarkets is not an easy task. In fact, major players in organic food retailing in Japan have been the smaller entities, such as specialized home delivery companies or consumer co-ops, or otherwise, farmers selling produce directly to consumers. The distinctive characteristic shared among these services is that they sell the products predominantly to specified consumers who are delineated from non-buyers. This paper explores the question how the Japanese organic food market has come to have the current shape that looks so different from other major markets. First, the paper attempts to fit this question into the theoretical frameworks developed around the issue of "trust" production. Then, based on the interviews to traders handling organic products and reviews of literatures related to Japanese organic marketing initiatives, the paper analyzes how trust was formed in the early stage of the development and how it has been altered in later stages. Then, the "ability to trust" is presented as a prerequisite of the successful sales of organics in open outlets represented by supermarkets. Finally, based on the analysis, implications for a sound development of organic food market are discussed.

Keywords: organic food market, Japan, trust

East-West Disparity of Organic Food Market

Japan is the third largest economy of the world, and ranked 24th in terms of per capita GDP based on purchasing power parity. However, organic foods are not as widely consumed as in Western countries. No official or private statistics on Japanese organic food market is available at this moment, but IFOAM and FiBL estimated it to fall between 350 and 450 million US dollars as of 2003[1]. France, United Kingdom, and Italy had at least 4 times more sales in the same year, while Germany and the United States exhibited 7 times and 30 times more sales respectively. Since these

[1] Helga Willer and Minou Yussefi (Eds.), The World of Organic Agriculture 2003 - Statistics and Future Prospects, IFOAM, February 2003.

countries showed no sign of slow-downs in the growth of organic industry, it would be reasonable to regard the gap has not been filled up.

For the period between 2003 and 2007, organic food supply in Japan has increased as well, but without expanding much revenue received by organic community. The quantity of organic produce certified according to Japanese organic regulation increased by 467% during 2003 to 2007, but more than 99% of the increase came from those produced outside Japan, which are mainly used as ingredients for processed foods. Domestic production of organic primary products increased only by 3.7% annually and is equivalent to 0.18% of total quantity of domestic agricultural production as of 2007. The quantity of certified organic processed foods increased by 15% annually during the same period.

The extent to which organic foods are penetrated into a economy's food sector is better explained by the size of the organic food market on per capita basis. Table 1 shows per capita GDP and the value of organic food sales divided by the economy's population. Since the data for the size of Japanese organic food market is not available, it is assumed here that the market has grown by 15% annually from the midpoint of the 2003 estimate for the purpose of comparison[2]. Knowing that per capita GDP can easily fluctuate along with exchange rate, consumers in countries listed here can be considered to have similar level purchasing power. However, Japan, together with other advanced economy in Asia, exhibits much lower level of organic food purchase.

[2] Even with the higher growth rate assumed for the calculation does not change the assertion made here. If Japanese organic market grew at 20% or 25% annually during the 2003 – 2007 periods, per capita purchase of organic foods would be 6 or 8 U.S. dollars, respectively, which is still a lot lower than the average consumption level in Western countries.

Table 1: Per capita GDP and organic food consumption in 2007 for selected countries

(US $)

APEC Economy/Country	**Per capita GDP** Purchasing power parity *	**Per capita organic food consumption****	**APEC Economy/Country**	**Per capita GDP** Purchasing power parity	**Per capita organic food consumption**
Denmark	37,089	147	Ireland	43,414	23
Switzerland	41,265	143	Norway	51,953	23
Austria	38,181	124	Australia	36,215	23
Luxembourg	81,058	116	Spain	30,116	18
Germany	34,205	90	Finland	35,206	16
United States	45,778	88	Portugal	21,784	9
Sweden	36,696	73	Greece	29,098	7
United Kingdom	35,601	58	Czech Republic	24,088	7
Italy	30,479	44	Korea	26,523	7
Canada	38,614	42	Japan	33,573	5
Netherlands	38,995	42	Slovenia	27,901	3
France	33,424	41	Slovak Republic	20,275	1
Belgium	35,363	37	Singapore	50,346	1
New Zealand	26,664	31			

Source: * IMF, World Economic Outlook Database, April 2009

** Organic food sales divided by population (from U.N. World Population Prospects). Japan: Obtained as stated in preceding paragraph. New Zealand: Organic Pathways http://www.organicpathways.co.nz/business/story/592.html. Singapore: Department of Primary Industries of Singapore, "Singapore Organic Food Market Overview," November 2007. Korea: USDA, http://www.fas.usda.gov/gainfiles/200809/146295782.pdf. United States: OTA, http://www.organicnewsroom.com/2009/05/us_organic_sales_grow_by_a_who.html All other countries: Willer, Helga and Lukas Kikcher (Eds.): The World of Organic Agriculture. Statistics and Emerging Trends 2009, FiBL-IFOAM Report, FiBL, Frick; IFOAM, Bonn; ITC, Geneva

What causes this East-West disparity? The most supported idea to explain it is the price competitiveness of organic foods in Western countries, because of the ease of domestic production (extensive farmland and cooler & drier climate) and availability of governmental subsidies. However, in this globalized economy, Japanese consumers could have always accessed to cheap organic foods imported from big exporters surrounding the Pacific. In addition, pioneers of organic movement have devised ways to supply organic produce at prices that are not too high or sometimes even lower than conventional counterparts. Therefore, it would be sensible to suspect the existence of other factors that prevent reasonable growth of the organic food sector in Japan.

One possible explanation is the difference in the way how organic foods are sold to consumers. Historically, organic foods have predominantly been sold through direct or shortcut channels in Japan, where consumers are identified as members who regularly purchase organic foods, and in so doing support organic farmers. On the other hand, majority of organic foods are sold to anonymous buyers in European and North American countries either via conventional or specialized stores, or through farmers' market. In fact, intense sales at supermarkets are said to be the major driver of the recent growth in these countries, making organic foods omnipresent. The question then translates into an inquiry that why organic foods are not widely sold in supermarkets and other freely accessible outlets in Japanese organic food market? Following sections explore the possible answer to this question based on the theories of trust production.

Production of Trust

In countries where organic foods have historically been marketed to anonymous consumers, sellers need to put an "organic" label on the product, and develop a system of certification to warrant contents of the claims. On the other hand, in markets where consumers repeatedly make purchases from the same supplier based on a long-term contract, such claims are often felt unnecessary. What guarantees the quality of the products there is the trust privately formed between consumers and producers. Thus, the way how consumers trust that the product is truly of organic quality can be considered to affect the manner by which organic foods are supplied in a market.

Organic foods are probably one of the most trust-demanding good. In order to justify the payment of price premium, a rational consumer need to trust that there are ample benefits associated with the purchase of organic foods, which are often so vague and controversial that they lack in public recognition. Also, consumers need to trust what farmers and intermediaries declare as to the means of production and handling of organic foods. Moreover, since much benefits linked with organic foods are public good, consumers would need to trust that reasonable number of people are ethical enough to choose organic foods where affordable, so as to avoid free-riding. Therefore, what validate the organic premiums depends highly on the consumer's ability to discern the benefits, and detect truth behind the hidden information or behaviors.

Some researchers and thinkers have mentioned that there are two types of the means by which people obtain trust under imperfect information. According to Zucker (1986), in a society, trust is either formed by actors' background expectation shaped through past transaction experience, or produced by more formal, institutional mechanisms such as common rules and laws to which actors should adhere. The latter action is more often observed in places where actors are highly heterogeneous by such reason as high density of immigrant workers, mixture of urban-rural population or people with different geographical origins, concentration of wealth and resulting gap in income levels, and specialization of firms that leads to higher frequency of transactions between actors with diverse geographical and cultural origins. In a highly heterogeneous society, trust formed by background expectation can easily be disrupted, because actors lack in sufficient transaction history to enable a good reasoning on the behaviors of the other party.

However, institutional mechanism is not the sole formula that produce trust under the risks arose from increased heterogeneity. Williamson (1975) states that, given the bounded rationality and opportunisms of actors, likely reaction to the highly uncertain situation is the formation of hierarchical organization by which actors internalize transactions that used to take place in the market, because doing so would lower the transaction cost. However, Zucker (1986) states the effect of such "governance structures" is limited because its efficacy is confined to the internal actors of the organization, whereas "the firm is likely to be under the increasing pressure to extend trust to the arena existing outside." This point can be translated into the concept of opportunity costs, which is reasonably considered to swell up in increasingly modernizing society.

Besides, the formation of hierarchical structure might only be partially effective in prescribing actors' behaviors. Granovetter (1985) warns that we should not overestimate the effect of social context on people's behavior, because actors are embedded in "concrete, ongoing systems of social relations" instead of selflessly conforming to orders in hierarchical structures or behaving as "atoms" outside a social context. Therefore, even though some reacts to the rising heterogeneity by internalizing transactions and in so doing rests their trust on traditional background expectation, such attempts are likely to be imperfect or short-lived, and hence need to be complemented by more formal, institutional method of trust production.

If both reactions are reasonable, which one is more suitable to take for the Japanese organic food industry? Jacobs (1994) states "guardian" moral syndrome that govern the behaviors in hierarchical structures use "threats" to discipline the actors, while allowing them to be dishonest in occasions where needed to achieve the purpose of the structure. In contrast, "commercial" moral syndrome disciplines actors through repeated dealings or commercial contract law, more peaceful manner than the other, and rests the efficacy of the system on actors' honesty. Therefore, "commercial" moral syndrome is more civilized engine to implement actor's intended action, and more compatible with modern ethics that cherish honesty.

Yamagishi (1999, 2008) favors commercial solution of trust formation with more clarity in voice. According to Yamagishi, based on his experimental studies conducted both in Japan and the United States, concluded that inhabitants in a society where actors' behavior is disciplined by threat have low ability to make good estimates under uncertainty and imperfect information. In a threat-disciplined society, actors need not invest much energy in trying to examine whether the other parties in transaction are trustworthy or not. Due to the lack of the ability to trust, actors tend to underestimate others' good will, resulting in eventual undersupply of public goods.

Though the five theorists cited above have developed their hypotheses based on different academic backgrounds, they all acknowledged the dichotomy and tensions between the approaches by which actors form trust to fulfill transactions under uncertainty. Two types of trust formation coexist in a society, but the extent to which either type dominates the other would likely to differ, because the level of heterogeneity of population varies by place, and even in highly heterogeneous society some actors react to increasing uncertainty by internalizing transactions within the hierarchical structure in which traditional approach to trust rules.

Framework of the Analysis

What determines the occurrence of different reactions to the similar level of heterogeneity? One possible explanation would be the inefficiency of trust formation through institutional infrastructure among "late adopters," as observed by Zacker (1986). So the marginal cost of institutional trust production is considered to be larger among "late adopters," while that of internalizing transactions is relatively lower, increasing the likelihood that the latter option is taken. If trust-producing institutional infrastructure is underdeveloped, opportunity cost that actors in hierarchical organization face would be lower. This attempt to interpret Zacker's hypothesis is shown in Figure 1. The cost of both method of trust formation is considered to increase as heterogeneity level rises, but at different rate. Marginal cost of trust production through institutional infrastructure (MCTP) would decline as heterogeneity increases, because the society is better equipped with systems by which successfully design and enforce the rules that discipline the actors' behavior. Actors are increasingly accustomed to this method of trust formation, and thus more easily accept the promulgation of new rules. On the other hand, marginal cost of trust formation through internalizing of transactions (MCIT) would likely to increase progressively as heterogeneity increases. This is mainly due to the opportunity costs of confining trust formation within organizational boundary. To the right of the point H, where the cost of institutional trust formation is lower than the other, makes actors more in favor of this approach.

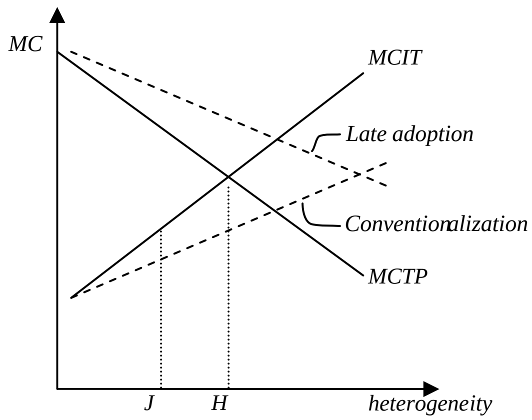

Figure 1

Let us now use this framework to explain the situation of Japanese organic food market. Japan is the economy with low heterogeneity in population; let's say at point J, because of its strict immigration policies and smaller income gap between the rich and the poor. Therefore, MCIT has probably been lower than MCTP for a long time. So it is reasonable that internalizing transactions, or the "private" formation of trust, has dominated the organic food market. In the absence of a rigid certification system, it was the expansion of geographic coverage or vertical integration of the operations for organic market initiatives to solve the mounting opportunity costs. However, various factors, such as globalization of the economy, inclusion of more women in core labor force, collapse of lifetime employment, and resulting income gap, have undoubtedly increased the heterogeneity in the economy; let's say to the point H. When the economy finally established organic certification system in June 2000, basic principles and procedures was already determined as "Codex guidelines" that were based on earlier experience held among Western countries. Since the guidelines have legally binding characteristics due to its status of being "reference points" in conflicts fought under the WTO, the economy had no choice but to design its system to be compatible with them. This late adoption of the certification system is likely to have shifted the MCTP upwards, and hence, many actors in the Japanese organic food market probably sense that the transactions based on organic certification is still more costly.

Teikei Blues

Let's now look at what had actually occurred in the Japanese organic food market in detail. Several researchers have documented the historical background and actual paths taken by the pioneers of organic agriculture movement to precision, including Masugata and Kubota (1992), Masugata (2007), Yasuda (1984), Adachi (2003), and Hatano (1998). According to Masugata (2007), except for some pioneer attempts before 1970s, organic foods were not easily available until early 1970s when an innovative marketing method called "teikei" was invented by the leaders in organic agriculture movement. The word "teikei" means "partnership" in Japanese, and as the name indicates, it is a marketing device of organic products based on amicable consumer-producer relationship. In a teikei scheme, producers are expected to provide fresh, safe and high quality produce to consumers, who are expected to purchase all the supply produced as such at appropriate prices, and reform their lifestyle so as to fit themselves to the seasonal limitations and whimsical fluctuations of agricultural supply. A set of practical recipes for a successful teikei were identified out of experiences in earlier schemes, and Japan Organic Agriculture Association (JOAA) wrote up "Ten Principles of Teikei" in 1978, with which what perceived as teikei schemes today ought to comply, at least in their efforts. The concept of teikei was intentionally created as antithesis to the ongoing mainstream market for fresh produce, and meant to clearly differentiate teikei from mere commodity transactions taking place in conventional market, the modern machine that propelled use of pesticides and other industrial inputs among farmers.

Early teikei schemes thus created started operation by 1973, and by its success, piers in the movement soon followed suit. A while later, many new comers, inspired by the novel "*Fukugou Osen* (Multiple Pollutions)" written by Sawako Ariyoshi, started reproducing their practice, making teikei a nation-wide movement. Masugata and Kubota (1992), in their nation-wide surveys conducted in 1980, 1984, and in 1990, identified 303, 245, and 832 teikei groups respectively. These numbers should be dealt with caution, since the selection method used in each survey varied.

Teikei, however, did not grow much further. According to Masugata and Kubota (1992), half of respondents in their 1990 survey reported decline of membership, and the majority of them reported the level of activities is shrinking. In 1990 survey, many groups reported lowered participation rate to meetings and events because increasing number of consumers has obtained jobs. This is problematic because chores necessary to manage teikei were impartially concentrated to a small number of committed members. Also, many groups reported that they failed to attract younger generation and that aging of members was diminishing their capacity to support farm economy. The fact that teikei has lost the passion and buoyancy held at its initial stage was widely recognized by today's organic community.

Researchers pointed out both internal and external factors that caused stagnation of teikei movement (See for example, Adachi, 2003). Internal factors include the failure for the existing members in recruiting new membership, renewing leaders, and maintaining passion and motivations in continuing teikei as a social movement. Short of new, younger membership naturally leads to the waned capacity to consume food, and physical strength to participate in chores to run the group. External factors include the change in consumer needs and preferences in general, and availability of other channels to sell or purchase organic foods.

Unlike young mothers in 1970s, those in 80s and 90s have more access and necessity to jobs, and their opportunity cost of participating social movement has risen. Japanese economy has reached its maturity in 1980s, and consumers started to base their decisions and behaviors more on diverse interests and preferences than they used to. Adachi (2003) points out the fact that increasing people are unwilling to participate in close personal communication that is a crucial factor in teikei management. Internal conflict that arose from the diversity of consumers propelled the split of groups (Hatano, 1998) or contributed to the formation of teikei networks aimed at improving the efficiency and convenience of teikei (Park, 2002).

Emergence of competitors is also seen as the major cause for the decline of teikei. In late 1970s, organic foods have started to be sold through newer initiatives started by young people, many of whom were former activists in student movement. *Daichi wo Mamoru kai*, a specialized wholesaler and a home delivery service with more than 70,000 consumer members, started its operation as a small open-air shop that sold organic vegetables to residents in large apartment complexes in Tokyo (Fujita 2005). Around the same time, some other young people started pulling rickshaw carts to sell organic vegetables to urban residents, and later formed a network of organic shops and specialized wholesaler, called *Polan Hiroba*. The wholesalers in the network also launched home delivery service that now supply organic vegetable box to more than 10,000 consumers. Later in 1988, an environmental group established *Radish Boya* Co., Ltd., now providing 100,000 consumers with organic vegetable box. These companies and many other smaller intermediaries appeared by mid 1990s, formed long-term relationship with farmers and consumers, and adopted principles looser but similar to teikei's.

With the rise of concerns toward food safety, many conventional retailers started handling organic foods in late 1980s. Consumer co-ops started dealing organic foods by 1980s in attempts to shift their focus from price to safety, especially in direct seller-buyer contract called *Sanchoku.* Organic foods also appeared in store shelves of many grocery tenants in department stores and "exclusive" supermarkets that specialize in high quality foods.

Along with the rapid boost of farmers and agricultural cooperatives that started organic production, the government and policy makers started to pay attention to organic farming by mid 1980s. An office specialized to tackle issues of organic farming was installed in the Ministry of Agriculture, Forestry and Fisheries (MAFF) in 1989. Around the same time, grocery stores are flooded by foods falsely labeled as "organic" and the need to create a labeling system to exclude fraudulent claims was shared widely. National organic certification system was preceded by the initiatives taken by some local governments and private organizations (Ogawa, 1999). In 1988, Okayama prefecture launched state organic certification system followed by several other municipalities. Many consumer co-ops and specialized traders have written up their own standards and labeling system from the end of 1980s to early 1990s, and in 1989, traders of fresh fruits and vegetables set up third-party certification group to practice organic certification that resembles those in Western countries. In 1992, MAFF set up "guidelines" for the labeling of organic and low input products, but this was not a legally binding standard, still allowing many pseudo organic foods to be marketed. In 1993, by the initiative of MAFF, the Japan Agricultural Standards (JAS) Law was reformed so as to allow for organic certification system to be installed within it, but it was not until June 2000 that organic certification system was finally introduced.

The delay was caused by fierce oppositions from organic community and consumer groups against the creation of organic standards and certification system. According to Honjo (2004), the opponents insisted simply standardizing production method of organic farming would trivialize its meaning and impair the appropriate understanding by wider public. Also, they maintained inclusion of organic certification system in JAS Law, a mere labelling regulation for general food commodities, is appallingly unsuitable. Moreover, they feared certification might simply increase the burden incurred on farm economy. Even after eight years of promulgation, the JAS organic certification system is hardly accepted by key speakers in organic community, and perceived to be badly designed by many practitioners (Kikou Shobou, 2008). Above all, the fact that more than 90% of organic production certified under JAS is taking place outside Japan is often cited as evidence of the Ministry's intention to ease the imports of organic foods to Japanese market.

Trust Production in Japanese Organic Food Market

As seen above, trust was formed by internalizing transactions in early development of organic food market in Japan. In teikei schemes, decisions are made so as to benefit both producers and consumers. Since the transactions are locked up inside the scheme, they share the common destiny in a boat, and the risk of defection is minimal. Also, the very fact that teikei principle denies "commodity transaction", and regarded payments to producers as token of gratitude, shows that actors differentiated their activities from market transaction. However, consumer heterogeneity started to cause troubles in teikei activities, i.e. increasing number of members cannot fulfil their responsibilities as expected. The geographical expansion of specialized wholesalers and home delivery services can be considered to have emerged in an effort to decrease mounting opportunity cost of limiting the sales to specified members. Though they do not deny commercial activity and operate more on contract basis than teikei, rules are written more to encourage better practice, than to penalize defections (Taniguchi, 2008). The call for the rigid labelling and certification system in late 1980s arose out of the widespread sales of organic foods and their imitations. This suggests the further advance of heterogeneity in actors surrounding organic market and the shift in preference toward institution-based trust production. However, the response to such social needs came out badly. The organic certification system thus created was developed despite the fierce opposition of organic community, and many stakeholders believe the system was poorly designed. As a result, perceived cost of certification is so high that it renders private trust formation to play yet a major role in Japanese market.

Discussions

The analysis above is based on Zucker's hypothesis that says we will be put under the increasing pressure to commercialize activities along with the advances of heterogeneity. While this explains Japan's situation quite well, recent resurgence of teikei-like activities in Western countries requires more scrutiny. Consumer Supported Agriculture (CSA), North American version of teikei, was born in 1986 and the number of CSA is still on the rise, reaching estimated 1,500 to 1700 schemes by 2005 (Henderson, 2007). In France, AMAP, the French version of teikei, was initiated in 2002 and grown to an estimated 500 to 700 schemes by 2008 (Lamine, 2008). Following the framework of trust production, this suggests either the decreased efficiency of institutional trust production, or decreased opportunity costs of hierarchical solution. The former shift is probable because growing demand for more ethical values to organic foods makes standardization and monitoring prohibitively costly. The latter shift is also likely because conventionalization of the retail sector and resulting disparity in bargaining power would lower the farmers' opportunity cost of supplying to supermarket.

If teikei schemes regain popularity under the highly heterogeneous society, what would be the significance of the efforts to create rigid institutional infrastructure? Such effort is probably justifiable if we take the consumers' ability to trust into consideration. To succeed in supplying organic foods in general store shelves, where no safeguarding measures to protect farm economy is taken, consumers need to be able to evaluate organic foods rightly, trust honesty of producers, and have strong preference to socially and ecologically conscious food. Thus, in markets where organic foods are already omnipresent, many consumers are considered to have acquired such skills to enable the continuous supply of organic foods in the market. Therefore, while teikei is undoubtedly not doomed to vanish under highly diversified society, institutional trust production is still encouraged to adopt. Besides, as Yamagishi (2008) pointed out, there could be a welcome byproduct: since organic farming serves to produce various public goods, the ability to trust "good-will" of other consumers would facilitate the provision of public goods.

Conclusions and Implications to Policy Makers

This paper made an adventurous attempt to apply the framework of "trust production" to explain the causes of the difference in the shape of organic food market between Japan and Western countries. The analysis in this study revealed that the Japanese organic food market was first developed by devising an innovative marketing system, teikei, in which trust was formed based on close human relationship, i.e. by internalizing transaction so as to minimize the risk of trust to be disrupted. As opportunity cost of such schemes rises, organic food sector grew to supply still differentiated, but wider population. However, pseudo organic foods that flooded store shelves prompted introduction of organic certification system, an institutional approach to produce trust. Unfortunately, it lacks wide support from organic community and is poorly designed. Therefore, it is likely that many practitioners feel being certified is more costly than forming trust by traditional manner. The recent resurgence of teikei-like activities in Western countries can be reasonably explained by the same framework of analysis, and thus suggesting that teikei will continue to play roles of forerunner in organic movement.

Nevertheless, Japanese organic sector will not grow further if policy makers fail to develop efficient infrastructure to allow the marketing of organic foods to anonymous consumers. It is imperative to reform the organic certification system so as to minimize the cost of certification, especially by taking into account the opinions of practitioners. Organic community would also need to devise ways to reduce the burden on farmers by making such efforts as reducing the social cost of input evaluation, which is now undertaken by each and every farmer. Policy markers should also acknowledge the importance of building consumers' ability to independently trust and make the right choice in increasingly heterogeneous society, rather than exercising guardianship that provide assurance to consumers in exchange for their patronage. Consumers' ability to trust would lower the cost of trust production because, among other things, with such capacity consumers would be able to differentiate intentional cheating and careless mistake.

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Current research on organic agriculture in the Asia-Pacific region and worldwide

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Abstract

Consumer and government attention to organic products has been growing worldwide. Researches show that such growth in attention is not only in developed nations such as countries in Europe but also in developing nations such as countries in Asia-pacific region, where organic agriculture is still in the beginning phase. This presentation reviews current activities of universities, research institutions, and societies/networks on organic agriculture worldwide. IOL at University of Bonn (D), Witzenhausen campus of University Kassel (D), Wageningen University (NL), and Corvinus University of Budapest (Hungary) are the leading Universities which offer courses and conduct research on organic agriculture. Secondly, FiBL (Research Institute of Organic Agriculture - CH), Rodale Institute (USA), SÖL (Stiftung für Ökologishce Landwirtschaft - D), HDRA (The Henry Doubleday Research Association - UK), Organic Centre at University of Wales (UK), Bioinstitut (Institute for Ecological and Sustainable Landscape Management - CZ), and Technical Center of Organic Agriculture (Tunisia) are the best institutions follow organic agriculture. Thirdly, conferences and network on organic agriculture were reviewed. Among the numerous international events, ISOFAR Conferences, ISOFAR Symposiums, QLIF Conferences, IFOAM Organic World Congress, and 'Wissenschaftstagung' (Scientific Conference of the German Speaking Countries on Organic Agriculture) are well-known conferences discussed in this presentation. ENOF (European Network of Organic Farming) and Core Organic (Coordination of European Transnational Research in Organic Food and Farming) are the most active network. Lastly, current institutions, education, and society/network on organic agriculture in Asia-Pacific Regions are reviewed: RIOA at Dankook University (S. Korea) and National Pingtung University of Science and Technology (Chinese Taipei), Division Organic Agriculture at National Academy of Agriculture Science (S. Korea), Korean Society of Organic Agriculture, Japanese Society of Organic Agriculture, ARNOA (Asian Research Network of Organic Agriculture) and East Asian Forum of Organic Agriculture (EAFOA).

Keywords: Organic products, consumers, universities, networks

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Introduction

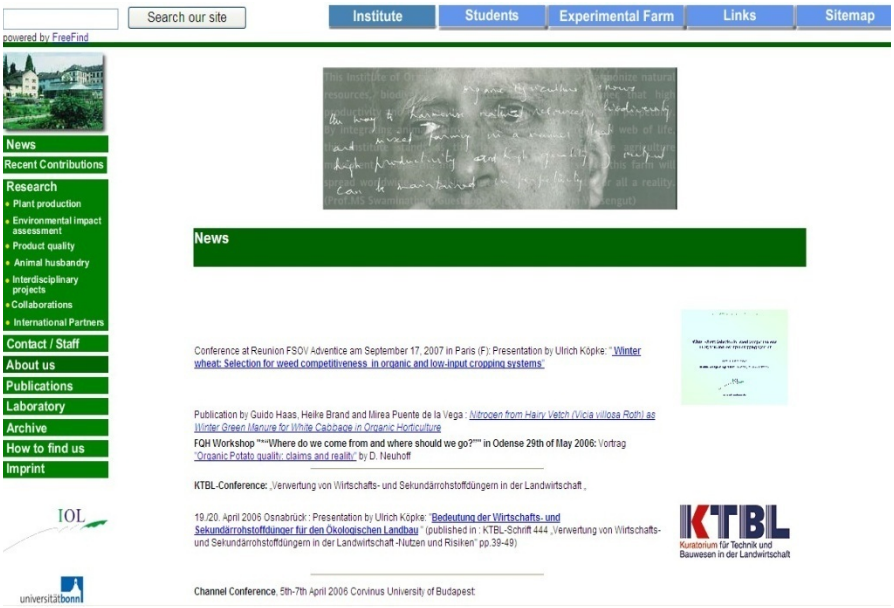
Consumer and government attention to organic products has been growing worldwide. Research shows such growth not only in developed nations such as France and Germany, but also in developing nations such as countries in the Asian-Pacific region, where organic agriculture is still in the beginning phases.

This presentation will review current activities of Universities, research institutions, and societies / networks on organic agriculture worldwide.

Current Activities in the Universities

IOL at the University of Bonn (D), Witzenhausen campus of University Kassel (D), Wageningen University (NL), and Corvinus University of Budapest (Hungary) are the leading Universities which offer courses and conduct research on organic agriculture.

1. IOL at University of Bonn (D)



In the IOL, at the University of Bonn, there are 7 areas of research programs. These are plant production, environmental impact assessment, product quality, animal husbandry, interdisciplinary projects, collaborations, and international partners.

In plant production (agronomy), there are 7 working areas. These include nutrient management, weed control, pests and diseases, cereals, legumes, bio-dynamic agriculture and other topics.

Current projects on plant production are Faba Beans - Mechanical Weed Control, Direct Seeding of Faba Beans after Oats (High Residue Reduced Tillage System, HRRT), Intercropping of Faba Beans and Oilseeds, Intercropping of Oats and False Flax (*Camelina sativa*), Strategies for Black Scurf Control in Organically Grown Potatoes, Approaches to Wire Worm Control in Organic Crop Production, Sainfoin (*Onobrychis viciifolia*) Production in Organic Farming, Effect of Weed Management Strategies on the Risk of Enteric Pathogen Transfer into the Food Chain and Lettuce Yield and Quality, Yield Impacts of Biogenic Turbations of Soil Structure. Under the research topics of

Sustainable resource use (Environmental impact assessment), Lifecycle Assessment, Water Protection, Bio-diversity, Climate Change, Soil Protection- Soil Cultivation are the working areas. For the quality of agricultural products issues, they follow the current projects such as quality assessment on spring wheat with horn silica-plant extract applications using picture creating methods. On animal husbandry, they do research on endangered breeds-diversity of use versus high-performance. Here you can find some selected ongoing or finished research projects in interdisciplinary projects; weed control in organic farming-WECOF (www.wecof.uni-bonn.de), organic pilot farms in North Rhine-Westphalia (www.leitbetriebe.oekolandbau.nrw.de), DFG-research group "OSIOL"-optimizing strategies in organic farming (http://www.dfg.de/english/index.html).

2. Witzenhausen campus of University Kassel (D)

Agricultural education has a long tradition in Witzenhausen. In 1898 a School for Tropical and Subtropical Agriculture was founded to train agricultural experts in German colonies before World War I. Since 1971 Witzenhausen has hosted the Faculty of Agronomy, International Rural Development and Environmental Protection, which is part of the University of Kassel. For 20 years Organic Agriculture has been part of the curriculum. Since 1995 the faculty focusses on organic agricultural sciences and has changed its name to the "Faculty of Organic Agricultural Sciences"; a unique situation worldwide (http://www.uni-kassel.de/agrar/?c=63&language=en).

The faculty is known for its applied, interdisciplinary and open-minded education of students from different countries and cultures. The relatively small number of 600 students, the close proximity of all buildings, the individual contact to the staff and lecturers and the intimate atmosphere of a small town are advantageous factors.

The main focus of the study is to impart extensive expert knowledge, which is an essential pre-requisite of sustainable agriculture with regard to different agro-ecological and economical conditions. The general objective is the development of site-specific solutions with minimal use of non-renewable resources for the sustainable protection of the food basis of a rapidly expanding world population. These are the main topics we focus on:

- maintenance of nutrient cycles,
- the reflected use of means in organic agriculture and food production,
- balanced relation between productive and 'non-productive' areas such as landscape protection
- and the link between agricultural practice, regional market and rural development.

Teaching and research are directed towards these topics through elaboration of cause-effect-relationships in system approaches.

The Faculty of Organic Agricultural Sciences realises that important aspects of social justice need to be considered and protected to ensure the sustainable safeguarding of food. This has been the basis of our long-lasting international commitment. Therefore, all graduates will, through their course of study, be able to make socially responsible contributions with regard to sustainable agriculture, land use, food production and trade.

In order to gain a broad understanding of the field of organic agriculture, an interdisciplinary approach in teaching is very important. Students learn to work in a case-specific and methodical manner. In addition, they acquire key qualifications, such as team work ability, interdisciplinary thinking, and responsibility, enabling them to develop modern and practical solutions to problems. For a good example of our teaching methods, refer to "Project Ecology", which takes place at the beginning of our bachelor programme.

3. Wageningen University (NL)

The Organic Agriculture programme has been designed to train students in multiple aspects of organic agriculture and the associated processing and marketing chain. An important goal is to prepare the students for interdisciplinary teamwork at an academic level. This study is unique in that it combines detailed consideration of the underlying principles and processes from a natural science perspective with social and economic studies. Creative thinking is required to design new sustainable farming and marketing systems instead of simply optimising existing systems. The programme has an international character which uses case-studies and offers project opportunities in both the developed and developing world. The curriculum has been carefully formulated to provide a balance between fundamental and applied science. Various university groups such as agronomy, ecology, soil science, animal sciences, pest and disease management, food technology, sociology, communication science and economics participate, making this a well-rounded and holistic programme.

Current Activities in the Research Institutions

Secondly, FiBL (Research Institute of Organic Agriculture - CH), Rodale Institute (USA), SÖL(Stiftung für Ökologishce Landwirtschaft - D), HDRA (The Henry Doubleday Research Association - UK), Organic Centre at University of Wales (UK), Bioinstitute (Institute for Ecological and Sustainable Landscape Management - CZ), and Technical Center of Organic Agriculture (Tunisia) are the best institutions follow organic agriculture.

1. FiBL (Research Institute of Organic Agriculture - CH)

The Research Institute of Organic Agriculture FiBL Switzerland, FiBL Germany and FiBL Austria are centres for research and consultancy on organic agriculture.

FiBL Switzerland was founded in 1973. The close links between different fields of research, the rapid transfer of knowledge from research to advisory work, and agricultural practices are FiBL's strengths. FiBL Switzerland currently has over 120 employees on staff.

FiBL Germany is a non-profit association registered in Frankfurt. Its work is financed by means of projects as well as donations from foundations and members. 13 permanent members of staff are employed in Frankfurt, supported by experts on a contract basis. Very close cooperation takes place between FiBL and Frick. Since its foundation, FiBL has worked to establish scientific foundations for organic farming and species-appropriate livestock management.

Fruit, wine, vegetables and potatoes are the main subjects of crop research at FiBL. Trials have been conducted on resisting pests and diseases by promoting beneficial organisms, applying direct control measures, and improving cultivation techniques. Another key emphasis is to keep and to raise soil fertility. One division of the institute is dedicated solely to maintaining the quality of organic products and the processing involved. Veterinarians are engaged in research into udder health and parasites. They optimize husbandry, feeding and pasture regimes and test homeopathic remedies and plant preparations. The socioeconomics division analyzes business problems at organic farms, pricing of organic goods and cost recovery levels, agricultural support measures as well as any marketing issues. On the working farm in Frick the emphasis is on fruit, viticulture, arable farming, dairy livestock, and bees. Furthermore, numerous projects and data collection programmes are taking place on more than 200 working farms throughout Switzerland.

In Therwil, near Basel, the long-term DOK trial which started back in 1978 is still in progress. It compares biodynamic and organic agriculture with conventional systems. This trial has yielded a large amount of internationally recognized evidence for the ecological benefits of organic farming in comparison to conventional agriculture.

In conjunction with its research, FiBL operates an advisory service so that results can quickly have an impact on practice. Alongside the provision of advice to individual farms and to groups, the most important advisory channels are courses, the monthly journal "bioaktuell", the website "www.bioaktuell.ch" and FiBL's technical leaflets. The cantons, FiBL and the private organic organizations cooperate closely within an alliance of organic advisors (Bio-Berater-Vereinigung, BBV). Its office is based at FiBL.

FiBL media places the results of its research within the grasp of farmers as well as any other individuals with an active interest in agriculture, and disseminate these results to extension workers. Many of FiBL's publications are available in several languages and some are even distributed internationally.

FiBL technical leaflets give concise information on a topic and highlight solutions to key problems. They are an indispensable aid to working farmers. In its dossiers, FiBL provides evidence to support the case for organic agriculture. It publishes the monthly magazine "Bioaktuell" jointly with Bio

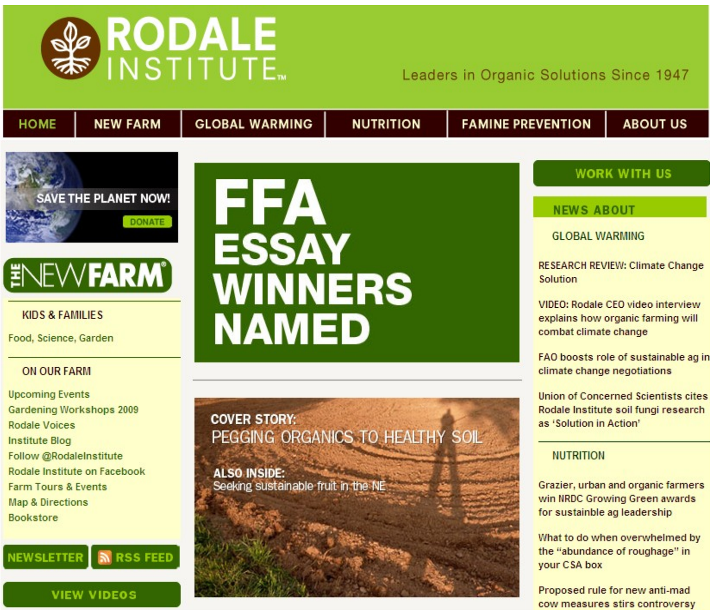
Suisse. A cooperation arrangement exists between FiBL and the German Foundation Ecology & Agriculture SÖL, the publisher of "Ökologie & Landbau" magazine which is aimed primarily at experts and researchers in the field.

2. Rodale Institute (USA)

Rodale Institute is a nonprofit organization that offers solutions to global warming and famine using organic farming techniques.

The institute was founded at Pennsylvania in 1947 by organic pioneer J.I. Rodale. Their findings are clear: a global organic transformation will mitigate greenhouse gas emissions in our atmosphere and restore soil fertility. Rodale's mission is to improve the overall health and well-being of this planet as well as the people who inhabit it.

Rodale Institute is located on a 333-acre organic certified farm in Kutztown, Pennsylvania. The entire farm is devoted to research, education and certified organic production. The farm is perhaps best known for its Farming Systems Trial (FST), the longest-running U.S. experiment specifically designed to compare organic and conventional farming practices. FST was established in 1981 and attracts interest from scientists, farmers and lay visitors from around the world.



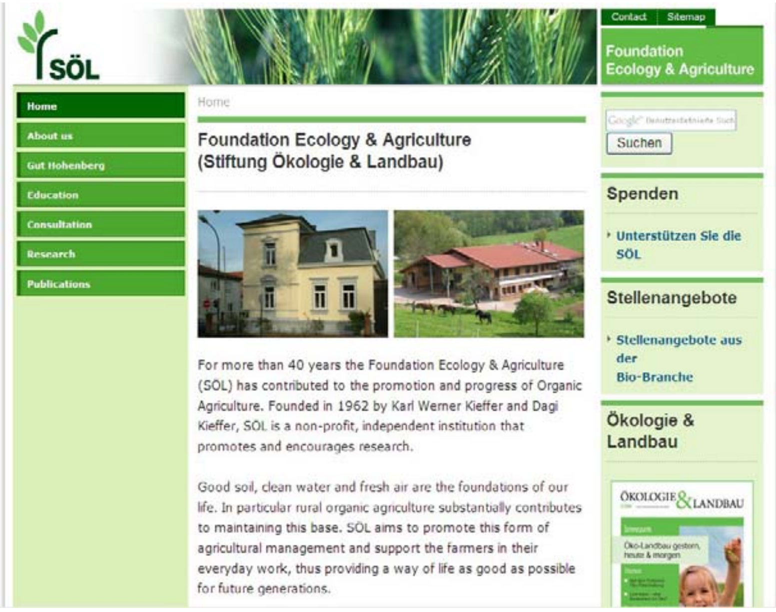
In addition to the research experiments, the farm's production and demonstration areas offer visitors an opportunity to learn how agriculture can either contribute to environmental problems or be a significant assistant in helping to solve global warming, improving human nutrition and preventing famine around the world.

FST is the basis for our practical training to thousands of farmers in Africa, Asia and the Americas.

3.SÖL(Stiftung für Ökologishce Landwirtschaft - D)

For more than 40 years the Foundation Ecology & Agriculture (SÖL) has contributed to the promotion and progress of Organic Agriculture. Founded in 1962 by Karl Werner Kieffer and Dagi Kieffer, SÖL is a non-profit, independent institution that promotes and encourages research.

Good soil, clean water and fresh air are the foundations of our existence. In particular, rural organic agriculture substantially contributes to maintaining this base. SÖL aims to promote this form of agricultural management and support the farmers in their everyday work, thus providing a better quality of life for future generations of farmers.



SÖL provides information via Books, Journals, Dossiers, and Websites. SÖL distributes professional information about organic agriculture by publishing the journal Ökologie & Landbau (Ecology & Agriculture), book series such as “Ökologische Konzepte“ (Ecological concepts) and “Praxis des Öko-Landbaus“ (“Organic farming in practice“), as well as several periodicals such as The World of Organic Agriculture and on the Internet (www.soel.de, www.oekolandbau.de).

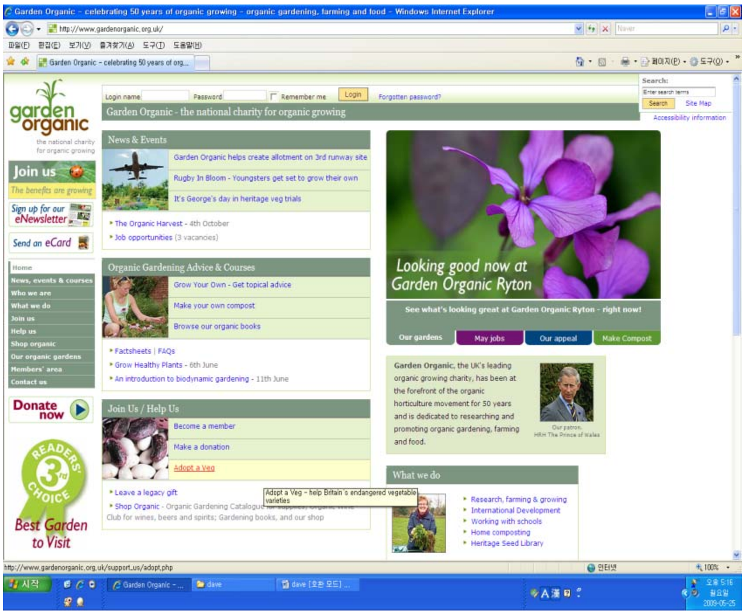
SÖL also initiates expert groups and scientific conferences. A major undertaking of SÖL is the setting up of seminars and conferences where people with different interests can come together to exchange knowledge and share experiences of organic farming and thus develop new ideas. Every two years, the SÖL coordinates the scientific conference on organic agriculture, where scientists present their latest research and findings. This conference was initiated by SÖL and covers the German language region.

The SÖL manages Commissioned work for the federal states of Germany and the German government. Through the contribution of its knowledge, they actively participate in a wide range of activities. On behalf of the German government, they coordinate 100 farms that serve as examples of organic farming to the public, organizes seminars for young farmers, and works on the website “http://www.oekolandbau.de.” The SÖL also performs studies and offers expert opinions.

The SÖL develops research projects. SÖL research projects continuously help develop the knowledge of organic farming. The long term research project, “Project Ecological Soil Management“ (PÖB) was carried out between 1994 and 2004 and investigated and demonstrated ecological soil management techniques. In other projects, business methods and models for farms are developed and tested in practice.

Research done on reduced tillage, organic grafted vines, and scientific conferences on organic agriculture are the main topics of SÖL at the moment. In the past, they focused on Project Ecological Soil Management (PÖB) (1994~2004) and Pilot Scheme Organic Farming (2004~2007).

4. HDRA (The Henry Doubleday Research Association - UK)



Garden Organic, the UK's leading organic growing charity, has been at the forefront of the organic horticulture movement for 50 years and is dedicated to researching and promoting organic gardening, farming and food. Garden Organic is a dynamic, influential and committed organization. They passionately believe in an organic approach to a sustainable future for future generations.

Garden Organic began life as the Henry Doubleday Research Association (HDRA) in 1954 as a result of the inspiration and initiative of one man; Lawrence Hills. As a horticulturalist, he had a keen interest in organic growing, but he earned his living as a freelance journalist writing for *The Observer, Punch* and *The Countryman*. While researching a book called *Russian Comfrey*, he discovered that the plant grown widely in Britain today was introduced in the nineteenth century by a Quaker smallholder named Henry Doubleday.

When Doubleday came across comfrey, he was so intrigued by its possibilities as a useful crop that he devoted the rest of his life to popularising it. Hills took up his crusade and before long, requests were coming from far and wide for plants and additional information.

Eventually, Hills was able to raise £300 to rent an acre of land at Bocking, near Braintree in Essex, and he began to experiment with comfrey. By 1958, the enterprise had reached a point where it had to become official or be dropped altogether. As a result, he decided to set up a charitable research association to study the uses of comfrey and - more significantly - to improve ways of growing plants organically. He named the association after his pioneering Victorian mentor.

Garden Organic has over 40,000 supporters and reaches more than 3,000,000 beneficiaries around the world through its expert advice and information. They are based at Garden Organic Ryton (http://www.gardenorganic.org.uk/gardens/ryton.php) in Warwickshire and celebrated their 50th year anniversary in 2008.

HDRA's Research can be summarized as follows:

Horticultural Cropping Systems involve vegetable variety trials, creating alternative non-animal based, nutrient sources for organic plant raising, organic vegetable seed production, as well as varieties and integrated pest and disease management for organic apple production. Also, horticultural cropping systems involve organic cane and bush fruit production and weighing the pros and cons of different break crops in organic arable rotations.

Pest, Disease and Weed Management Projects involve weed control strategies in organically grown carrots and onions, modelling growth and competition for weed control, forecasting systems for pest control, examining disease control strategies for organically grown field vegetables, and finally, participatory investigation of the management of weeds in organic production systems (DEFRA).

Economics, Marketing and Policy Projects involve the Sustainable Organic Vegetable Systems Network, the conversion to organic field vegetable production, the study of the market for organic vegetables, the economics of organic farming, organic fruit production, and EU Rotate N.

Soil Nutrient Dynamics Projects involves the optimization of nitrogen mineralization from winter cover crops and utilization by subsequent crops. It is also focused on utilizing nitrogen in cover crops, developing the use of green waste compost on agricultural land, understanding soil fertility in organically farmed soils, and considering the environmental implications of manure use on organic farming systems.

And finally, Landscape and Amenity Horticulture Programmes involves compost analysis and testing, growing media development service, organic standards for amenity horticulture and landscaping, organic audits, and commercial and professional membership help.

5. Bioinstitut (Institute for Ecological and Sustainable Landscape Management - CZ)

Czech Bioinstitut hosts Bioacademy in Lednice / Czech Republic every year. Bioacademy is one of the most important conferences on organic farming (OF) in the region of Central and Eastern Europe. As usual, it will be held in the premises of the Horticultural Faculty of the Mendel University of Agriculture and Forestry, in the South-Moravian town of Lednice. Not only is Bioacademy an opportunity to gain and exchange specialist information, it is also a platform for an annual meeting of about 200 people from more than 20 countries, including farmers, researchers, NGO workers and people from state administration within branches close to organic farming.

Current Activities of the Societies, Conferences and Networks

Thirdly, conferences and network on organic agriculture were reviewed. Among the numerous international events, ISOFAR Conferences, QLIF, IFOAM Organic World Congress, and 'Wissenschaftstagung' (Scientific Conference of the German Speaking Countries on Organic Agriculture) are well-known conferences discussed in this presentation. ENOF (European Network of Organic Farming) and Core Organic (Coordination of European Transnational Research in Organic Food and Farming) are the most active networks.

1. ISOFAR (International Society of Organic Agriculture Research)

ISOFAR (International Society of Organic Agriculture Research, http://www.isofar.org) promotes and supports research in all areas of Organic Agriculture by facilitating global co-operation in research, methodological development, education and knowledge exchange. They also support individual researchers through membership services, publications and events while also integrating stakeholders in the research process.

ISOFAR pursues its mission by:

1. supporting individual researchers, from both generalist organic systems and specialist disciplinary backgrounds, through membership services including events, publications, and relevant scientific structures;

2. facilitating global co-operation in research, education and knowledge exchange; encouraging conceptual, methodological and theoretical development, respecting the ethos of organic agriculture, in a systems/inter-disciplinary context;
3. encouraging the active participation of users and stakeholders, with their accumulated knowledge and experience, in the prioritization, development, conduct, evaluation and communication of research;
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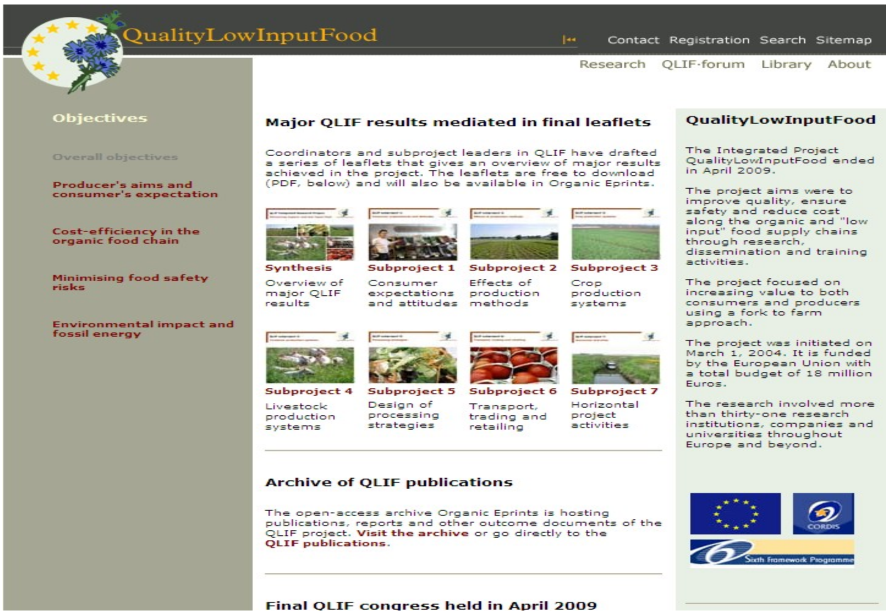
Publications of the International Society of Organic Agriculture Research

- ISOFAR Tropical Series: 'Organic Agriculture in the Tropics and Subtropics', first volume of ISOFAR's Tropical Series edited by Köpke (2008)

- RAFS - Special Issue: ‘Researching sustainable systems’, Special Issue of ‘Renewable Agriculture and Food Systems’ published in March 2008,
- ISOFAR Scientific Series: The ISOFAR Scientific Series presents the results of organic farming research carried out by members of ISOFAR. The first volume was published in May of 2006.
- Proceedings of the second ISOFAR Conference: From June 18th-20th, 2008 the second conference (http://www.isofar.org/modena2008/index.html) of the International Society of Agriculture Research was held in Modena, Italy, in conjunction with the 16th IFOAM Organic World Congress. The 1st volume deals mainly with various aspects of organic crop production, which traditionally represent the largest share of all papers submitted to conferences on organic agriculture. The 2nd volume gives insight into the increasing research activities on animal husbandry, socio-economics, and inter-disciplinary research projects. Furthermore, it contains the papers for the five workshops (http://www.isofar.org/ modena2008/qlif.html) of the Integrated project Quality Low Input Food which was held as part of the ISOFAR conference.
- Proceedings of the first ISOFAR Conference: ‘Organic Agriculture in Asia’ Proceedings of the regional ISOFAR Conference in the Republic of Korea edited by Sohn & Köpke (2008)
- Proceedings of the first ISOFAR Conference: The first Scientific Conference of ISOFAR was the conference ‘Researching Sustainable Systems’ held in Adelaide, Australia, 2005 in conjunction with the IFOAM Organic World Congress.
- Newsletter: Each issue of the Newsletter, published up to four times a year, contains a thorough coverage of events in the organic agricultural scientific community, research news, book reviews, etc.

2. QLIF

The Integrated Project QualityLowInputFood (http://www.qlif.org) ended in April 2009. The project’s goals were to improve quality, ensure safety and reduce costs along the organic and "low input" food supply chains through research, dissemination and training activities.



The project focused on increasing value to both consumers and producers using a fork to farm approach.

The project was initiated on March 1st, 2004, and is funded by the European Union with a total budget of 18 million Euros.

The research involved more than thirty-one research institutions, companies and universities from countries in Europe and around the world.

For society, organic and other “low input” farming systems provide an effective means of responding to the increasing consumer pressure to omit or reduce agricultural inputs (in particular pesticides, mineral fertilizers, veterinary medicines and growth promoters). However, in order to ensure that the European societies benefit optimally from this mechanism, it is necessary to address the actual and perceived problems or benefits which are of particular importance for low-input farming systems.

Lower production costs and coupling of lower production costs with improved quality and safety and consumer perceptions of higher quality and safety will enable low-input farmers to provide higher value-added food that maximizes benefits to consumers and producers alike. It is particularly important to ensure that consumers will be able to make their choices based on defined knowledge of the value provided by different types of products, and that these values may be reflected in more accurate and realistic business planning all along the production supply chain.

Quality and safety issues associated with organic and “low input” farming concern:

1. to understand the relative importance for different groups of consumers of different “added value” benefits of foods, as a necessary prerequisite to effectively improve the benefit/cost ratio.
2. the ability to provide food of high sensory and nutritional quality with good shelf life, with minimal spoilage due to pathogen/pest attack, while avoiding excessive or unacceptable processing .
3. to understand, and if relevant alleviate, actual and perceived health risks from enteric pathogens and noxious compounds (e.g. mycotoxins, heavy metals).
4. to document, improve or disprove alleged health benefits related to differences in food composition that are determined by the type of production system.
5. to ensure or improve impacts on the environment and animal welfare.
6. the need to optimize production efficiency to satisfy actual and potential consumer demand.

Strategies developed for organic production systems are nearly always transferable to “low input” conventional farming systems. On the other hand, a range of approaches used in “low input” systems are not permitted and/or against the principles of organic farming.

In order to make (a) maximum use of resources and (b) project deliverables applicable to all “low input” production systems, most agronomic strategies are therefore developed within the framework of organic farming systems and standards, supplemented with some novel methods and strategies, which may in the future become included in these standards.

3. IFOAM Organic World Congress

4. Wissenschaftstagung(Scientific Conference of the German Speaking Countries on Organic Agriculture)

5. ENOF(European Network of Organic Farming)

6. Core Organic(Coordination of European Transnational Research in Organic Food and Farming)

CORE Organic is a transnational partnership where resources within research in organic food and farming are joined. The goal is to enhance the quality, relevance and utilization of resources in European research in organic food and farming through coordination and collaboration.

The project is initiated as a part of the European Commissions ERA-NET Scheme, which intends to increase cooperation among national research activities.

CORE Organic funded research projects

As a result of the cooperation in the CORE Organic ERA-net, a pilot call for joint transnational research projects in organic food and farming was launched in late 2006.

Following a comprehensive evaluation procedure, eight research projects were selected for joint, transnational funding by means of a virtual, common pot approach.

- Methods to improve quality in organic wheat - AGTEC-Org (project no. 1180)
- Planning for better animal health and welfare - ANIPLAN (project no. 1903)
- How to communicate ethical values - FCP (project no. 1897)
- A tool to prevent diseases and parasites in organic pig herds - COREPIG (project no. 1904)
- More organic food for young people - iPOPY (project no. 1881)
- Assessing and Reducing Risks of Pathogen Contamination - PathOrganic (project no. 1888)
- What makes organic milk healthy? - PHYTOMILK (project no. 1921)
- How to assure safety, health and sensory qualities of organic products - QACCP (project no. 1885)

In September 2007, the first ERA-NET project period came to an end. At this time, eight transnational research projects initiated under the auspices of CORE Organic were launched. In order to continue the cooperation in CORE Organic and to start the new research projects, a two-day, kick-off meeting was held in Vienna on September 13th-14th, 2007.

At the meeting the new transnational research projects were presented and potential benefits and constraints for transnational research cooperation in organic food and farming through an ERANET were discussed. Likewise, the outputs, findings, and the "lessons learned" during the 3-year period of the ERA-NET project CORE Organic were presented and discussed.

Finally, the eleven partners in CORE Organic formed a network in order to continue their cooperation.

Current Activities of Universities, Research Institutions, and Societies / Networks in the Asia-Pacific Region

Current activities of institution, education, and society / network in Asia-Pacific Regions are still in the beginning stages when compared to Europe.

There are already 3 education & research institutions such as RIOA at Dankook University (S. Korea), National Pingtung University of Science and Technology (Chinese Taipei), and the Division of Organic Agriculture at National Academy of Agriculture Science (S. Korea). However, there exist only 2 societies such as Korean Society of Organic Agriculture and Japanese Society of Organic Agriculture, and only 2 research networks such as ARNOA (Asian Research Network of Organic Agriculture) and East Asian Forum of Organic Agriculture (EAFOA).

1. RIOA (Research Institute of Organic Agriculture) at Dankook University (Korea)

Dankook University offers B.Sc. course for Environmental Horticulture, M.Sc. & Ph.D. course for Organic Agriculture. RIOA (http://www.rioa.or.kr) which founded in 1989 at Dankook University offers Advanced CEO Course for Organic Agriculture (1 year course) since 2004 and also opened Organic Agriculture Academy in 2007. RIOA is the certification body for organic agriculture and GAP.

2. National Pingtung University of Science and Technology (Chinese Taipei)

3. Division Organic Agriculture at National Academy of Agriculture Science (Korea)

National Academy of Agriculture Science(NAAS, http://www.naas.go.kr) has several goals: to strengthen competitive spirit, to maintain a clean environment, to promote and develop safe agricultural products, to build a strong sense of tradition and to endorse and to promote certain traditional and cultural practices in affluent rural communities. Approximately four hundred researchers at NAAS are striving hard day and night towards achieving these goals.

Division of Organic Farming Technology

Applied Organic Farming Techniques

1,Rice straw application for soil Fertility management

2,Organic farming using duck

3,Crop rotation with hairy vetch and rye

-Development of organic farming model coincide with international standards

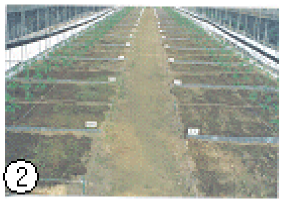
-Amendments proposal for international norms of organic farming

* CODEX coincides organic rice cultivation system (RDA/ARNOA)

-Soil fertility management by using crop rotation and organic material supplement

-Utilization and systematization of organic materials

Utilization Techniques of Organic Materials



1,Home-made organic materials

2,Soil environmental impact assesment

3,Effect of herbal organic materials on rooting

-Scientific inspection and standardization of organic materials

-Establishment of organic material utilization methods

-Development of substitutive materials for fertilizers and agro-chemicals

-Development of biological materials for organic forming

Pests and Weeds management

1,Banker plants of Aphidius colemani

2,Effect of PGPR

3,Weed control by allelopathy

-Monitoring and characterization of pests and weeds in organic farming crops

-Utilization of organic materials and biological control techniques

-Development of ecological technology and cultural practice

-Development of pests and weeds forecasting system

4. Korean Society of Organic Agriculture

The homepage of KSOA is

http://www.yougi.or.kr/

5. Japanese Society of Organic Agriculture

6. ARNOA(Asian Research Network of Organic Agriculture)

ARNOA was established in 2002 during the IFOAM-Asia conference which was held in Hangzhou / China.

ARNOA hosted the first activity in November 2002 in Suwon and Cheonan / Korea. The 1st, 2nd, and 3rd ARNOA International Conference were funded by RDA (Rural Development Administration, Ministry of Agriculture and Forestry in Korea) and organized by the Research Institute of Organic Agriculture of Dankook University. ARNOA Conferences were focused to develop the Basic Standard of Organic Rice Cultivation which reflects the Asian climatic, crop, cultivation, and socio-economic conditions.

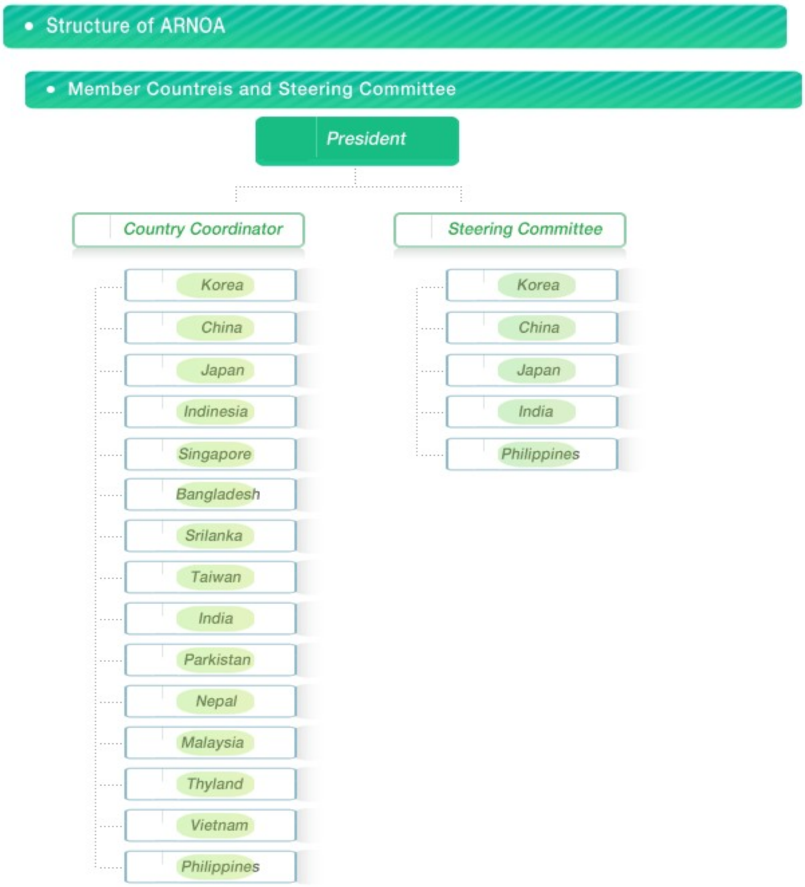
ARNOA was established to promote the Asian Worldview in the organic movement and to further develop the science and technology of organic production and processing guided by this Worldview. At this point, it has chosen the task of drafting and developing the standards for organic rice production and processing based on current science and technology of production coming from academic and research institutions as well as from the richness of the ordinary farmers' daily practices.

Rice has long been Asia's main food supply. The fact that its cultivation was maintained for thousands of years without creating irreversible ecological damage - except in recent years with the Green Revolution whose package of technology and point of view is essentially non-Asian - bespeaks of the wisdom and high level of skills of organic farmers, whatever label one attaches to them: traditional, indigenous rice farmers, what have you.

ARNOA intends to tap into this wisdom and abundant knowledge of the organic farmers. The first step has been made: establishing working groups that will link directly with the farmers as well as academe and research institutions.

The ARNOA Newsletter intends to strengthen this linkage.

The homepages of ARNOA is http://www.rioa.or.kr/arnoa/



Challenges in production of organic seeds

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Abstract

The use of organic propagation material is an essential part of the organic production chain. Moreover conventional produced plant material may carry over pesticides into the organic production chain. Therefore seeds (or other propagules as tubers, bulbs and cuttings) are obliged to be produced under organic production conditions. In Europe and North America this is the case with most food crops, for instance potato, lettuce, cucumber and tomato. However, for some crops there are no or insufficient organic produced seeds on the market and farmers can apply for a derogation to use conventionally produced seeds. The shortage of organically produced seeds for these crops is partly due to difficulties in seed production under organic conditions. Especially with biennial plants and hybrid seed production it can be a challenge to maintain the (inbred) parental plants healthy and productive.

Other challenges are to produce seeds free from seed borne diseases, non-chemical seed sanitation treatments, and to maintain seed vigour and seed purity. Solving these challenges will stimulate the seed companies to apply the developed methods also to conventional seed production and treatments. Some examples are presented from research performed in Europe to aid the seed industry and the organic food producers as pioneers in sustainable agriculture.

Keywords: Seeds; propagation material; seed health, seed treatments

Introduction

Seeds are the basis for most of our food production, although some major crops are propagated through tubers (e.g. potato), bulbs (e.g. chalots) or cuttings (e.g. fruit trees). Being in an integral part of the organic food production chain, propagation material should also be of organic origin (IFOAM standards). This principle is also laid down in the official regulations for organic production in the Europe Union (EU) (EU Council Regulation No. 834/2007) and North America (USA: National Organic Program, NOP, § 205.204; Canada: CAN/CGSB-32.310-2006). Derogation from this rule is only allowed if appropriate organically produced seeds of the desired or a related variety are not (or not enough) available on the market. In cases where conventionally produced seeds have to be used they should not have been treated chemically. Production of organic edible sprouts always requires the use of organic seeds. For most of the economically important organic crops there is enough organic produced propagation material available.

Next to the official rules, the principle of using organic propagation material is also important towards the consumers. In conventional seed production chemical pesticides are widely used and residues of these pesticides can often be traced back in or on the seeds. When conventional produced seeds are used, these residues will enter the organic production chain, which should be avoided.

A last important reason is that more seed companies will be stimulated to make their varieties available through organically produced seeds. Organic farmers will benefit from this through an increased choice of available varieties. Indeed, in recent years more seed companies are selling organic seeds and the number of varieties for which organic seeds are available has increased.

Figure 1. Organic cauliflower seed production under protective cultivation.

As mentioned, when organic propagation material is not available on the market, farmers can request a derogation to use non-chemically treated conventionally produced seeds or other material. To simplify this procedure and stimulate the use of organic seeds, the EU has set up a system with three categories (see: http://ec.europa.eu/agriculture/organic/eu-policy/seed-databases_en). Category 1 contains a list of crops for which it is considered that enough organic seeds and from enough suitable varieties are available on the market and for which no exemption to use conventional seeds will be allowed. Category 2 contains crops for which exemption is possible because, although organic propagating material is available, it is not available in sufficient quantities or for all cultivation methods. Farmers intending to use conventional seeds from crops in this category have to submit a request to obtain permission and provide arguments. Category 3 are crops for which no or hardly any organic seeds are available and a general exemption is granted for the use of non-chemically treated conventional seed. As seed production may vary from year to year, the division of crops over the three categories may also vary over time.

The costs of organic seeds can be 10% to more than 100% higher compared to that of their conventional counterparts. The main reason is the lower yield during production. Especially for crops as onion and cabbages, which require two growing seasons for seed production, losses during seed production can be considerable (Figure 1). Yield per plant is often less and upon lack of adequate control measures, diseased parental plants may have to be removed. With hybrid seed production weak growth of some inbred parental lines may make it impossible to produce seeds under organic conditions, which may limit the availability of such hybrid varieties. Unfortunately, the higher cost of organic seed has made it tempting to some organic farmers to choose varieties for which no organic seeds were available intending to get an exemption to use cheaper non-chemically treated conventional seeds.

Another drawback of organic seed production are the larger efforts needed to obtain high quality and healthy seeds. In the past decades commercial seed quality has, in general, come to very high standards regarding health and field emergence. With conventional production this is largely supported by the use of chemical pesticides and ability to regulate vegetative and reproductive growth by controlling nutrient levels. Under organic conditions chemical pesticides have to be replaced by natural crop protectants, which are often less effective, and it is more difficult to regulate plant development with the use of organic fertilizers that release the nutrients more slowly.

Challenges with organic seed quality

Economically sustainable crop production depends for a very large part on the quality of the propagation material. The genetic constitution of the seeds, tubers or other planting material determines the potential of the crop. Next to the importance of good farming practices, the ultimate yield relies very much on the quality of the inputs. Ideally the seeds should germinate fast, uniform, in a high frequency and produce well growing healthy seedlings, even under sub-optimal field conditions. This character of the seeds is often called seed vigour. For organic farmers seed vigour may be even more important, especially in competition with weeds. Because in temperate climates the mineralization of organic manure is relative slow, organic crop establishment will benefit from seedlings with a fast extending root system. Production of high vigour seeds is also more a challenge under organic conditions, since lower quality of the mother plant, related to nutrition or disease pressure, will result in reduced availability of nutrients and energy for the developing seeds. Also here there are lessons to be learned in producing high quality seeds under sustainable conditions.

Since many diseases can be transmitted through the seeds or vegetative propagules, it is of utmost importance to use healthy propagation material. Obtaining healthy seeds with a high vigour can sometimes be a real challenge under organic conditions. Whereas in organic crop production a low level of certain pests or some diseases can be acceptable, this is not the case with seed production. In conventional seed production chemical crop protectants are widely used, but for organic seed production alternative methods have to be developed. Most important is to prevent contamination with pathogens or the spreading of it. Increased knowledge in this field will aid seed producers in decreasing the use of pesticides also in conventional seed production. If contamination cannot be avoided, methods have to be developed for sorting out the infected seeds or for the application of seed sanitation treatments.

To tackle these challenges Dutch research institutes and seed companies are actively engaged in joined projects, financially supported by the Dutch government with the aim to stimulate the organic sector as a pioneer in sustainable crop production. Some examples of this research will be provided in the next paragraphs.

Critical control points in healthy seed production

To prevent contamination by pathogens that can be transmitted through the seeds and limit the costs in seed production, it is important to determine the critical control points. An example of a model studied in our research team, is the epidemiology of *Xanthomonas campestris pv. campestris* (Xcc) a bacterial disease that causes black rot with *Brassicacea* crops. This disease is considered as a major problem in organic cabbage production. If *Brassica* seed becomes internally infected, it often results in epidemics and high economic damage. No effective strategy is currently available to prevent seed infections and information is lacking how internal seed infections occur.

Two main sources for potential contamination routes were detected (Jan M. van der Wolf, Plant Research International, unpublished results). The first source was infection of basic seeds. Second, it was demonstrated that the bacterium can be transmitted by pollinating insects (flies) from infected sources via the stigma to the developing seeds. The bacterium can survive tor several days on the flies. Thorough health screening of the basic seeds and seed production under protected cultivation are advised as measures in the production of healthy cabbage seeds.

Seed sorting on maturity

During the maturation phase the seeds gain in stress tolerance and in general seeds obtain maximum quality around the moment of shedding. However, when seed producers should wait till natural shedding of the seeds, losses will be rather high. Moreover with many crops, like cabbage, the mother plants flower over a prolonged period of time and at harvest the plant bears seeds of different maturity. Consequently seeds are often harvested before maturation. It relies on the skills of the seed producer to dry the seeds slowly in order to finalize maturation, but not too slow because this will bear the risk of fungal growth. The most immature seeds are removed by sorting on size, but the near mature seeds do not differ in size or density. A method has been developed to sort the mature seeds from the near mature ones, based on residual chlorophyll levels in the seeds (Jalink *et al*., 1998). Normally chlorophyll is degraded during seed maturation, but when the seeds are harvested and dried prematurely the degradation is inhibited. Indeed when cabbage seeds are sorted on their level of chlorophyll fluorescence, less mature seeds are much more sensitive to storage. Interestingly, the frequency of seeds contaminated with *Alternaria* fungi is higher with seeds containing more chlorophyll compared to those showing very low levels of chlorophyll. Whether less mature seeds are more sensitive to the fungi or whether infection retards the chlorophyll degradation is not known.

Sensitivity to physical seed treatments

Physical seed sanitation is often applied with organic seeds. Hot or warm water and aerated steam are examples. Both crops and pathogens vary largely in their sensitivity towards these treatments. For the seed companies it is important to find a ‘window’ in which the pathogens are destroyed but the vitality of the seeds is not affected. Within a crop seed lots may differ in their sensitivity and some seed lots may not tolerate a crop specific standard protocol. At Plant Research International we have performed studies on factors that determine the sensitivity, using cabbage and carrot as models. This research was done in close collaboration with seed companies and other European research groups. Seed maturity turns out to be an important factor in the sensitivity (Groot *et al*., 2006). This was shown by treating sub samples from both cabbage and carrot seed lots sorted on their residual chlorophyll level, with hot water or aerated steam.

Another important factor increasing the seed sensitivity turned out to be the onset of germination processes prior to the harvest (Groot *et al*., 2008). Under humid conditions seeds may start germination while still attached to the mother plant, when progressing further, this is visible as pre-harvest sprouting (Figure 2).

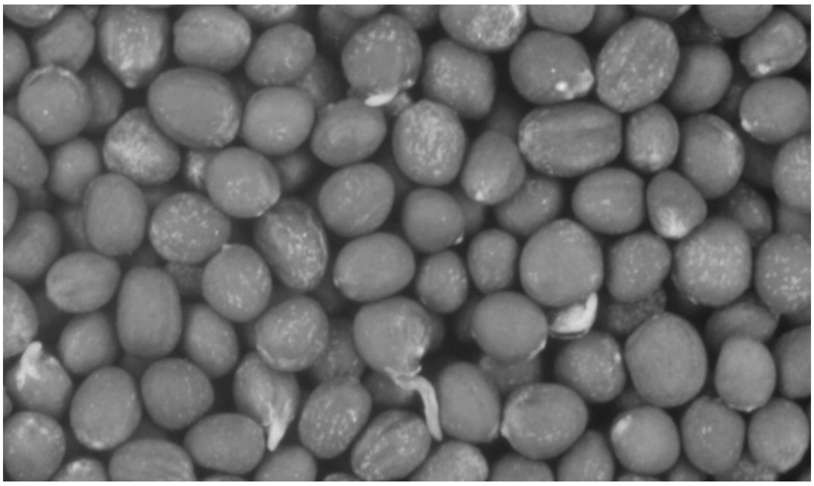

Figure 2. Visible and non-visible onset of germination in organic kohlrabi seeds, rendering the seeds more susceptible to physical sanitation treatments.

Seed sanitation with natural products

Next to physical sanitation treatments it is possible to treat organic seeds with natural components exhibiting antimicrobial activity. These include plant-derived products and antagonistic micro-organism. Of course also here the sensitivity of the seeds remains an important aspect in the development of sanitation treatments for specific crops and disease combinations.

Pseudomonas chlororaphis MA342 is an example of an antagonistic bacterium active against several seed borne pathogens (Johansson and Wright, 2003). In Europe commercial products (Cedemon® and Cerall®), based on this antagonist, are on the market for treatment of cereal seeds.

When developing new strategies for organic seed treatments it is important to consider that for commercial use the treatment should be allowed according to both the (inter)national regulations regarding crop protection agents and those of the organic standards. Natural acids such as acetic or lactic acid have a well known anti microbial activity and are being used in food preservation for thousands of years. However, these acids are presently not listed on the EU regulation on organic farming, as accepted in crop production or for treatment of plant material. Therefore, in the EU these acids cannot be applied for organic seed treatment. A general reluctance to increase the number of components allowed for organic crop protection hinders the use of many more natural products.

Essential oils, however, are listed in the EU regulation on organic farming practices and in The Netherlands and Germany the oils were also accepted as crop protectants. Both thyme and oregano oil showed to be potent inhibitors of several seed borne diseases (van der Wolf *et al.*, 2008). Presently seed companies are testing the efficiency of these oils for commercial seed treatments. Unfortunately new clouds have shown up on the horizon. In its aim to bring all national regulations on crop protection into one uniform EU-wide regulation, all components have to be registered at the EU level. Such a registration requires expensive toxicity tests. Since the use of essential oils as crop protectant cannot be patented it is not expected that anyone will pay for these tests. Therefore it is not clear if in the near future essential oil will still be allowed for treatment of organic seeds in the EU.

Seed vigour

As mentioned earlier, seed lots may differ in their sensitivity towards physical seed treatments. For logistic reasons it is not always possible to perform test treatments and analyze the sensitivity of the seeds by germination tests, which may take a week. At Plant Research International we developed a fast assay by analyzing the ethanol production in hot water treated seeds (J. Kodde and S.P.C. Groot, unpublished results). The assay is based on a method developed for vigour analysis of canola seeds with the use of a modified handheld breath analyzer (known for its use by police in traffic control) (Buckley *et al.*, 2003). Control seeds (only washing in tap water) do not produce ethanol. Seeds that show a decrease in germination capacity after 30 minutes of hot water treatment at 55 °C produce ethanol, which can be measured within 6 hours after the start of the assay.

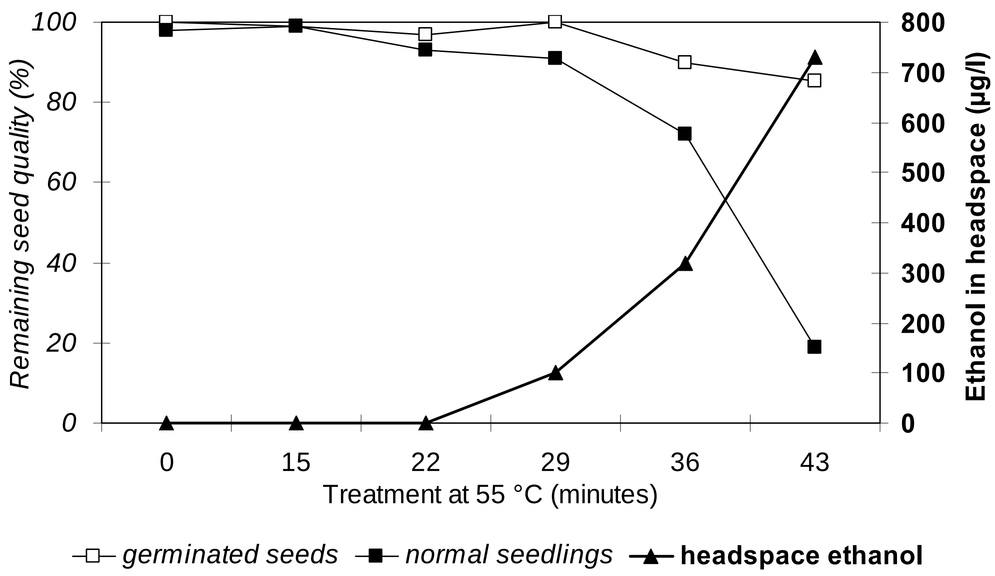

Figure 3. Germination behavior and ethanol production by hot water treated cabbage seeds. Dry seeds were incubated in hot water for various durations, cooled in tap water and re-dried. Germination behavior was tested subsequently at 20 °C and scored after 10 days. Ethanol production was measured after 23 hours incubation in closed vials at 20 °C with a seed moisture content (fresh weight basis) of 35%.

Conclusions

The use of organic propagation material is an essential part of the organic production chain. Stimulated by international regulations and an increasing demand from grower, the number of crops and varieties for which organic seeds or vegetative propagation material is available, is increasing. Inherent to the relative higher production costs, organic seeds are more expensive compared to conventionally produced seeds. Seed companies, supported by public research are actively engaged in optimizing seed production under organic conditions to increase seed health, quality and reduce the costs. Challenges are especially in the area of seed vigour and seed health. Increased understanding of the epidemiology of seed borne diseases, development of new techniques for seed sorting and seed sanitation treatments, will aid in increasing the quality of organic seeds. These techniques can also be applied to conventional seeds and help the conventional seed production to become also more sustainable and cost efficient as well.

Acknowledgements

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Integrated cultural programs for the production of cash crops in organic systems

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Abstract

Organic farmers borrow from all scientific fields, including both from the natural and social sciences, to optimize the production system on their farms. The science that aims to understand the underlying scientific principles that determine the sustainability, viability, and long-term productivity of organic systems is referred to as agroecology, or agricultural ecology. A basic tenet of organic farming is the need to learn from the thousands of years of agricultural experience gained by indigenous cultures, and to use this information as a starting point, considering both socioeconomic and ecophysiological factors, for the design of integrated organic systems that are closely adapted to the surrounding environment. Despite its popularity with consumers, with production on over 32 million hectares by over 600,000 farms worldwide, organic farming has not received full validation and accreditation from the academic agricultural establishment. However, this lack of recognition of organic farms as legitimate production systems, by agricultural scientists, has taken a steady turn-around over the past 30 years. Beginning with the publication of a manuscript entitled "Agroecology" in the early 1980s by UC Berkeley Professor Miguel Altieri, over the past two decades agroecologists and plant scientists have steadily continued to develop seminal research to establish the underlying scientific basis for the improvement of organic systems in the tropics. The use of habitat management techniques to better design organic systems, in time and space, has been referred to as Ecological Engineering. Scientific advances which are providing insight to better design integrated cultural organic systems include: New information on soil biology and its effect on crop growth; Systemic Induced Resistance in plants to resist pest and disease attack; the nascent field of Chemical Ecology, to unravel the role of 'info-chemicals' above- and below- ground level; Habitat management and the new discipline of agrobiodiversity to improve biological pest control and nutrient cycles; and ongoing improvements in crop breeding and germaplasm selection, such as the use of Marker Assisted Selection, for the identification and selection of crop varieties adapted to particular agroecosystems.

Keywords: Organic farmers, agroecology, biodiversity, germaplasm

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Introduction

Originated in the 1930s, organic farming has grown to become a worldwide agricultural grass root movement, devoted to the production of crops without relying on the use of synthetic chemicals. Organic farming is perhaps the first agricultural system that has become defined according to government and international defined production standards.

By 2007 organic farming was practiced in over 32.2 million hectares in over 141 countries, leading to global sales of over U.S. $46 billion (McKeown, 2009). Area under organic farming in tropical regions includes over 6.4 million hectares in Latin America, over 2.8 million hectares in Asia, and over 870,000 Hectares in Africa (McKeown, 2009). Because of its great popularity with affluent consumers increasingly major players in the food industry sector, such as Kraft, General Mills, Heinz, Kellog, and Wal Mart are also establishing a foothold in the organic industry (McKeown, 2009; Carey, 2009).

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A basic tenet of organic farming is the need to learn from the thousands of years of agricultural experience gained by indigenous cultures, and to use this information as a starting point, considering both socioeconomic and ecophysiological factors, for the design of integrated organic systems that are closely adapted to the surrounding environment.

Despite its popularity organic farming has not received full validation and accreditation from the academic agricultural establishment. However, this lack of recognition of organic farms as legitimate production systems, by agricultural scientists, has taken a steady turn-around over the past 30 years. Beginning with the publication of a manuscript entitled “Agroecology” in the early 1980s by UC Berkeley Professor Miguel Altieri, over the past two decades agroecologists and plant scientists have steadily continued to develop seminal research to establish the underlying scientific basis for the improvement of organic systems in the tropics.

The use of habitat management techniques to better design organic systems, in time and space, has been referred to as Ecological Engineering. Scientific advances which are providing insight to better design integrated cultural organic systems include: New information on soil biology and its effect on crop growth; Systemic Induced Resistance in plants to resist pest and disease attack; the nascent field of Chemical Ecology, to unravel the role of ‘info-chemicals’ above- and below- ground level; Habitat management and the new discipline of agrobiodiversity to improve biological pest control and nutrient cycles; and ongoing improvements in crop breeding and germaplasm selection, such as the use of Marker Assisted Selection, for the identification and selection of crop varieties adapted to particular agroecosystems.

Establishing the scientific basis of organic farming: Agroecology

Over the past 30 years a better picture has emerged within the field of agroecology to establish a better scientific basis for the design of sustainable, organic, or ecological farming systems. Even though considerable advances have been made, the field of agroecology is still in its infancy, as there is still much to be elucidated about the complex ecological interactions that exist in small diversified farms—interactions that facilitate improved internal nutrient cycles within the farm, as well as internal mechanisms of biological pest control.

In this paper I will highlight key areas of research where considerable advances have been made over the past 30 years, and will address additional issues to consider, as we seek to better define models used in the design of healthy horticultural ecological systems in the tropics.

Agroecology or agricultural ecology is the science that studies the sustainability of organic systems. Scientists from established agricultural research centers are increasingly recognizing the value of the agroecological approach to research production systems, and thus the merger of traditional agricultural research with agroecology (Miller, 2008).

In the tropics an aim of agroecology is to improve the efficient use of natural resources, to improve the livelihood of resource-poor farmers living in marginal lands (Altieri, 2002). In resource poor areas the goals of development programs may include to protect the natural resource base of the area, to increase the productivity of subsistence crops, and to promote the production of cash crops for either local or export-oriented niche markets, such as the production of organic crops.

As with any other production system, every production practice used in organic farming should be considered on its own merits, and evaluated based on both its potential positive and negative environmental impacts. For instance an index of nitrogen loss to food production ratios used in Norway showed potential higher relative N leaching losses in organic farms than in their conventional counterparts (Korsaeth, 2008). Similar risks of potential N leaching below the root zone were identified when very high rates of organic composts were used under organic farming conditions in Virginia, U.S.A., even though the above-ground runoff levels were always lower with the use of composts, compared to the use of synthetic fertilizers in conventional plots (Evanylo *et al*., 2008).

Socioeconomic factors

Consideration of the social, socioeconomic, and cultural aspects of the community is essential to the design of healthy agroecosystems. All production methods and technologies need to be developed from the bottom-up, to assure that they meet the economic and cultural needs of the family farm and of their community. Decades of experience from development work in developing regions have shown repeatedly that top-down approaches to research and agricultural development are doomed to failure. This means that all production programs will be location specific, not only because of the particular microclimatic and environmental conditions, but also because of the particular socioeconomic conditions in the community.

A key ingredient in the success of rural development programs is to invest in, and to build upon the social-capital of rural communities (Butler-Flora 2004; Reynolds *et al*., 2009). This first requires a proper characterization of the prevailing socioeconomic conditions (Giampietro, 1997).

Once the socioeconomic conditions have been taken into considerations, participatory research programs, following what has been termed a 'people-centered' approach (Castella *et al*., 1999), can be designed to improve cropping systems and community well being. The farming practices that are implemented should thus meet the socioeconomic needs of the community. This includes recognizing gender specific issues and not ignoring the traditional and integral role that woman play as part of the household and production system (Padmanabhan, 2007).

The value and significance of building on the social capital of a community was recently revealed by rural development surveys conducted in communities of China. The surveys showed that social resources and social capital were key determinants to successfully establish innovative programs that improved living standards in the community. Enabling social resources that led to community well-being included building enhanced social networks, channels of communication, and cooperative relationships (Jingzhong *et al*., 2009).

On a regional, national, and global scale, the market for organic products being produced by small rural communities will increase if there is increased realization of the economic, environmental and social value provided by small-farm based production systems (Ikerd, 2008). The market for organic products, from small farms, will also increase if more alternative marketing channels are developed, such as the popular fair-trade market for organic products (Bourlakis and Vizard, 2007).

It is increasingly being recognized that research on agroecosystems needs to build upon the knowledge obtained over thousands of years by indigenous cultures (Singh and Jardhari, 2002), such as the traditional rice farming systems of Asia (Bouman *et al*., 2007; Catling, 1992; De Datta, 1981). Agroecological approaches have been successfully utilized to improve traditional farming systems, such as the system of rice intensification, which has been reportedly adopted by over one million farmers (Broad, 2008).

Getting there, building a road map or agricultural development based on agroecology

To date most organic farming industries have been established based on grass-root initiatives led by individual farmers or farming communities. Increasingly programs to promote organic farming are becoming institutionalized, which may further facilitate the global growth of the organic industry.

Cuba has become one of the leading examples, where over a period of several decades, large sectors of the agriculture industry shifted towards the adoption of organic and agroecological production systems (Funes *et al*., 2002). Analyses of this national shift attribute much of its success to the institutionalization of support programs that supported research, education, extension, marketing and development programs for organic farming (Nelson *et al*., 2009).

The success experienced in Cuba in its national shift towards organic farming, and by other regions, on a smaller scale, highlights the importance of having a road map or institutional plan of action, to promote agricultural industries based on agroecology and organic principles. For instance, the value of establishing such roadmaps was shown in developmental work conducted as part of the Winterswijk case study in the Netherlands (de Graaf *et al*., 2009).

Establishment of ecological systems based on biodiversity, building natural resources, indicators of sustainability, and a landscape approach

The value of biodiversity is increasingly being recognized not only to increase the productivity and resilience of agroecosystems, but also for its close association with the general well-being of humans (Mooney *et al*., 2005). Biodiversity benefits includes the protection of wildlife, to provide ecological services such as pest control and improved nutrient cycling, and to provide indicators of agroecosystems health (Moonen and Barberi, 2008; Sukhdev, 2008). Biodiversity assists in the on-farm preservation of valuable germaplasm of traditional plants or useful crop varieties (Jarvis and Hodgkin, 2008; Jarvis *et al*., 2008), and provides other ecological services (Sukhdev, 2008). For instance, a study in Mexico found that a low-impact management system had a richer species density of pollinators, resulting in increased coffee fruit production, than high impact management systems (Vergara and Badano, 2009). Similarly in Kenya, proximity to natural habitats and the activity of native bee species was also found to improve pollination and fruit development in eggplant (Gemmill-Herren and Ochieng, 2008).

The promotion of biodiversity on the farm and at a landscape level is considered a key ingredient to promote internal ecological services to establish healthy agroecosystems in organic farming production systems. These services include healthy animal husbandry, nutrient management, and internal pest control mechanisms (Rämert *et al.*, 2005).

With the recognition of the contributions provided by landscape biodiversity, a new discipline termed "agrobiodiversity" intends to merge the field of biodiversity research with crop germaplasm development (Johal *et al*., 2008).

To assess the impact of particular production practices on farm biodiversity and on the overall 'health' of the agroecosystem, researchers are increasingly relying on the use of indicators of sustainability (Wei *et al*., 2009; Singh *et al*., 2009).

For instance, indicators of agricultural sustainability were used in Bangladesh to evaluate the ecological services provided by low-input productions systems as compared to those provided by more conventional systems (Rasul and Thapa, 2004). Examples of ecological indicators used to assess soil quality may include microbial biomass and diversity; in Spain these indicators were used to assess the effectiveness of several production practices on the soil quality and sustainability of olive orchards (Moreno *et al*., 2009).

The ultimate goal with the use of ecological indicators is to better design farming systems to improve crop productivity, household well-being, and ecological balance by what has been termed as "agroecosystem health" (Xu and Mage, 2001).

Increasingly to assess the sustainability of a community, analysis has to go beyond the farm level, and take a wider landscape approach. Such an analysis was used to assess the changes on a landscape level from the rapid changes in the rural transformation of the Yangtze Plain of China during the second half of the twentieth century (Wu *et al*., 2009). A better characterization of the regional landscape, allows farmers to develop management programs in the farm that match the agroclimatic conditions of the surrounding landscape, a strategy long promoted by biodynamic farmers (Vereijken *et al*., 1997). Conversely an analysis that goes beyond the farm level, allows the community to make management changes at a regional level, with the goal of establishing an 'ecologically sound' landscape (Beismann, 1997). A landscape approach towards sustainability further brings together the agroclimatic characteristics of the landscape with the socioeconomic conditions of the community (Beismann, 1997).

Soil quality and its contribution toward crop health

Today, there is a greater consensus in the scientific community on the importance of soil quality, and on the value of organic matter to increase crop growth and performance. In concert with a principal tenet of the organic movement, there is increased agreement among scientists that a healthy soil is fundamental to the health of the entire cropping system. A healthy soil, rich in organic matter, is sought to maintain a steady nutrient pool in the rhizosphere, to sustain a rich microbial activity that will suppress soil-borne pests, promote crop growth, and to optimize water dynamics in the rhizosphere.

Considerable advances have been made to elucidate the importance of soil biology and quality, including the role played by soil microorganisms for pest suppression (Boneman and Becker, 2007; Weller *et al*., 2002), soil biology (Hatfield and Stewart,1994), and to enable key soil ecological interactions (Brussard and Ferrera-Cerrato, 1997; Paoletti *et al*., 1993) that contribute towards crop health and productivity.

We now have a better understanding about how beneficial rhizosphere bacteria and fungi release compounds that promote crop growth. Similarly some rhizobacteria are effective for suppression of soil-borne diseases (Biesseling, *et al*., 2009).

Research is also increasing our understanding of the value played by components of the soil matrix such as humic acid (Yildirim, 2007), and glomalin (Nichols and Wright, 2005), to promote crop growth and tolerance to stressful growing conditions. In addition, some products that are typically used as nutrient amendments may provide other benefits to the crop, such as increased heat tolerance, with the application of seaweed extracts (Zhang and Ervin, 2008). In addition, long-term surveys are increasingly showing a correlation between high soil organic matter levels, agroecosystem stability, and yields (Pan *et al*., 2009).

Furthermore, in tropical areas such as Thailand (Aumtong *et al*., 2009) and Malaysia (Tanaka *et al*. 2009), soils are being characterized to better make associations between best management practices, soil quality, microbial activity, and crop productivity. For instance, surveys conducted in northern Thailand have found the important contributions made by arbuscular mycorrhizal (VAM) associations with local agroforestry and cash crop species, towards improving fertility and crop growth. The survey found especially high levels of mycorrhizal populations associated with the tree Pada (*Macaranga denticula*), leading to increased phosphorus availability for the associated rice crops. As an indication of the soil biodiversity in the area, both Pada and food crops in the area were associated with 29 beneficial mycorrhizal species belonging to 6 genera (Yimyam *et al*., 2008).

The effects of organic amendments to improve soil quality and to reach yields that are similar to those obtained with conventional fertilizers has been observed in several areas, from long-term research experiments (Riley, 2007; Bi *et al*., 2009). For instance, compost amendments improved crop productivity in low-input marginal lands of West Africa (Ouedraogo, 2001).

The value of rotations towards increased soil quality, such as improved aggregate formation and structural stability, is increasingly being recognized (Sandoval *et al*., 2007).

However, as agricultural research focuses more on the use of alternative nutrient management practices, researchers will need to revisit the research paradigms established at major agricultural research centers when their work was based on the use of synthetic fertilizers; new research paradigms may need to be developed for nutritional and soil quality research based on agroecological principles (Drinkwater and Snapp, 2007).

For instance, an agroecological approach towards nutrient management needs to place a greater focus toward improving nutrient cycles within the farm to improve nitrogen availability (Kawashima, 2001), carbon conservation (Koizume, 2001), and to gain a better understanding on the role of microbial activity on nutrient cycles (Paoletti *et al*., 1993; Smith, 1994); rather than focusing on maximum yields alone.

Pest management, new IPM paradigm, ecological engineering, chemical ecology, systemic induced resistance

Integrated Pest Management (IPM) is a pest management program conceived over the past 40 years to try to decrease the dependence on the high use of agrochemicals in the farm. While by definition, the use of pesticides within IPM is a control method of last resort, the reality is that most IPM programs to date have been centered on the use of pesticides for the management of key pests in the farm. However, new efforts have been made over the past decade to further redefine pest control paradigms, with the goal of establishing management programs that do without, or minimize the use of synthetic pesticides (Gallaher *et al*., 2005; Herren *et al.*, 2005; Williamson, 2005). For instance, in Thailand, after a collapse of the industry due to excessive pesticide use, a shift occurred towards the adoption of more sustainable IPM protocols for the production of cotton (Castella *et al*., 1999).

To optimize pest management programs in organic farms, it is increasingly recognized that it is necessary to establish programs on a landscape level, to minimize the movement of pests from farm to farm (Schmidt *et al*., 2004).

Habitat management consist of manipulating the vegetational diversity of the agroecosystem in time and space to optimize biological processes that will lead to improved nutrient cycles, and to promote internal mechanisms of biological pest control in the farm. A greater understanding of the underlying mechanisms that result from the effective use of habitat management, will lead to more productive rotational systems, and to improved intercropping and agroforestry systems.

Habitat manipulation, as a method to enhance field biodiversity, is considered to be a valuable tool for pest management. Examples of habitat management include intercropping, cover crops, rotations, field borders or the establishment of windbreaks (Nicholls and Altieri, 2004). Habitat management is considered a valuable tool in pest management because it provides mechanisms for increasing vegetational biodiversity, which enhances pest biocontrol through a variety of mechanisms (Paoletti, 2001).

More recently, in their effort to better study and design field biodiversity, agroecologists have borrowed a term used earlier by environmentalists and ecologists: Ecological Engineering. Our level of understanding of the many mechanisms and interactions that occur in the agroecosystem is now allowing scientists to start placing the pieces of the puzzle together, in our effort to design a productive and healthy agroecosystem.

Some examples of management tools that are being incorporated as part of the process of ecological engineering include: habitat management techniques to promote vegetational diversity, the use of polycultures, planting arrangements and canopy architecture, composts, organic fertilizers, cover crops, insectivorous plants, windbreaks and border rows, agroforestry systems, germaplasm selection, and the use of products that may elicit systemic induced resistance in plants, among many others.

The concept of ecological engineering proposes that habitat management techniques offer potential valuable tools for the management of pests in the agroecosystem. However the effective implementation of ecological engineering requires an understanding of pest life cycle, pest biology, and possible methods of population control or methods to manage dispersal and reproduction patterns, via the implementation of viable techniques of habitat manipulation (Gurr *et al*., 2004; Pretty, 2005; Rickerl and Francis, 2004; Shiyoma and Koisume, 2001).

Another relatively new research direction within the umbrella field of ecological engineering, is the new discipline of **chemical ecology**, which endeavors to unravel the chemical interactions or communications that exist in the farm between living organisms (Hines and Zahn, 2009). A better understanding of the 'info-chemicals' and chemical signaling interactions that occurs among plants (Vet and Dicke, 1992; Callaway and Mahall, 2007), between plants and pests, and between plants and beneficial organisms (Lincoln, 2006), may provide insight on how to better design habitat management programs on the farm (Jander and Howe, 2008; Goyret *et al*. 2008; Meinwald and Eisner, 2008; Schaller, 2008).

Practical examples to the implementation of chemical ecology on the farm include the use of wildflower strips in organic farms to manage caterpillar pests, which resulted in variable and differential results depending on pest and beneficial species (Pfiffner *et al*., 2009); altering N inputs to manipulate pest x beneficials dynamics, which also resulted in variable results (Chen and Ruberson, 2008); the emission of volatiles in corn to attract beneficial nematodes for management of the Western corn rootworm, *Diabrotica virgifera* (Rasman *et al*., 2005); the planting of chives to repel Green peach aphid (*Myzus persicae*) populations in intercropped sweet pepper plantings; volatiles and extracts from chives to repel aphids (Amarawardana *et al*., 2007); and the use of repellant volatiles in potato to deter pest oviposition (Karslsson *et al*., 2009).

Another relatively new area in the field of pest management is the field of systemic induced resistance (or systemic acquired resistance) in which plants develop temporary immune defense responses to pest attack (Bedarnek and Osborun, 2009; Durrant and Dong, 2004; van Loon *et al*., 2006; Vallad and Goodman, 2004). Systemic induced resistance has been described for pathogens in over 30 species and for resistance against insects in over 100 species, with resistance reported for fungi, bacteria, nematode, insect, and viral diseases. In the rhizosphere, 16 growth-promoting bacteria have been identified to promote systemic induced resistance. Systemic induced resistance can be elicited by pest attack or by products such as compost extracts, oxalic acid from spinach or rhubarb extracts, and chitin. One example, a compound produced by sweet potato as an elicitor of plant defense, is described by Harrison and colleagues (2008).

New products are constantly being evaluated for their use in disease management in organic farms. For instance a formulation of grapefruit seed extracts has shown promise for the management of powdery mildew in cucumbers (Toppe *et al*., 2007).

The research areas described above indicate that there is considerable potential in terms of habitat manipulation techniques, with the selection of appropriate varieties, and with the identification of new products, to identify strategies for the management of pests and diseases under organic production systems.

Conclusions

Over the past 30 years, significant advances have been made in the field of agroecology, which have provided a scientific basis for the successful establishment of integrated organic production systems. While a bulk of the research has been conducted in temperate areas, significant advances and practical on-farm work has also taken place in tropical areas; with Cuba being a prime example of organic programs being implemented at a national level. In some ways, the science of organic or ecological farming, is catching up with the farmers or practitioners of organic farming, who for many decades have now promoted key production strategies such as the need to build soil fertility (or the 'life' of the soil), the need to promote field biodiversity in time and space, and the need to promote healthy plant growth so that the plants would be better able to resist pest and disease attack. Science has recently begun to corroborate that many of the presuppositions from the early practitioners, were valid.

Indeed, researchers are increasingly now confirming the ecological value of increasing soil fertility or the 'life of the soil'; through the field of chemical ecology and ecological engineering researchers are confirming the many tropismatic interactions and the value of field and landscape biodiversity to manage pests and diseases; and researchers, through work in the area of systemic induced resistance, are confirming that healthy plants may, in some instances, have the ability to resist pests and disease attack.

However, considerable more work and research is required to help organic farmers deal with the myriad of production challenges faced on a daily basis, to help manage pests, to improve resource utilization, to optimize production efficiency, and to improve the postharvest quality and marketability of their products.

Some key areas where research efforts are needed include: mechanization at all levels of production (especially for small-farms); fertility strategies to meet all nutrient demands (especially N and P); breeding work to develop crop varieties adapted to the fertility status of organic farms; soil biology and calibration work to better characterize the fertility, and biological life of soils, under organic farming conditions; no-till, minimum till, and field cultivation strategies; further research on the design of polyculture and rotational systems; research on the postharvest management and quality of organic crops; and research at the household, community, and region level on the socioeconomic effects and variables that are pertinent to the creation of vibrant, economically viable, food-secure, and socially just rural communities.

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Organic agriculture improves soil quality and seedling health

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Abstract

Since 1981, the Rodale Farming Systems Trial (RFST), with over 28 years of monitored field legacy, has compared organic (ORG) and conventional (CON) cropping systems featuring maize and soybean. In 2008, uniform seed emergence tests were performed to test the effect of soil differentiated from consistent agricultural system application on seedling health. Super sweet corn was selected as health indicator plants based on their susceptibility to *Pythium* damping off. Agronomic history had a legacy effect on soil organic matter (SOM) levels, soil respiration, SOM lability as well as seed germination and emergence. The RFST utilized a split plot design featuring large plots with 8 replications for each farming system. Seed germination and emergence tests provided a standard evaluation platform to assess the comparative influence and importance of 1) soil quality legacy, organic or conventional, 2) seed genetic background (varieties), 2) fungicide seed treatment, 3) the interaction of these factors and the effect of stress environments for seedling evaluation, Iowa cold test. Super Sweet corn varieties were: Sweet Chorus, HMX6538, Sweet Ice, Reflection, Renaissance, Revelation and Sweet Rhythm. Seed treatment consisted of either standard maxim fungicide or non-treated control. Germinations were conducted either in soil with cold treatment (stress test) or on warm cellulose pads without soil, non-stress environment. The cold stress was performed by planting into the differentiated field soil types (org and con) and exposing the experimental units to cold, 10 °C for 7 days in moist soil, prior to warm germination at 25 °C in soil. After a decade of soil organic management, soil respiration was increased over 130%. After more than 2 decades, soil organic carbon gained approximately 1% annually from base level of about 2.0% soil organic carbon (SOC) to 2.6% in top 15 cm profile. Soil nitrogen was increased under organic management by about half that rate (from 0.30 to 0.33%). Conventional corn and soybean system showed no changes in these parameters. Sweet corn cold tests indicated seedling health levels were associated with soil quality changes from long term management practices or legacy. Increased soil organic matter content was associated with a reduced incidence and severity of damping off. In cold tests, organically managed soils showed higher ($P = 0.0001$) seedling emergence (32%) than that found under conventional soil (15%). The yield of dent corn in uniform tests correlated well with the content of chemically labile organic matter content, increase in total carbon and nitrogen, respiration of the microbial community. Besides soil management system, cold emergence was also significantly influenced by varietal background of the sweet corn seed tested ($P= 0.01$). Cold emergence among varieties varied significantly from less than 5% to almost 70%. Six of seven varieties of corn had significantly higher cold emergence under organic compared to conventional soil legacy. Soil by variety reaction was significant ($P = 0.05$). In warm cellulose pad germination emergence rates were higher 73 to 95% compared to less than 30% cold tests. Cellulose warm germination was lower on fungicide treated seed 72.9 than for non-treated seed 95.6%. Soil cold test germination was more effective in differentiating system legacy. System legacy associated well with soil organic matter active levels of organic matter turnover measured by respiration and lability under oxidative treatment. Soil organic matter and microbial activity appear to play a role in optimizing plant seedling response particularly under stress cold germination.

Keywords: Organic agriculture, soil quality, cold stress, organic matter

Introduction

Oomycete fungi are known to cause damping off, early seedling death and root rot (McGee 1988). Members of genus *Pythium* are commonly cited as major cause of this disease. Over 9 species (*Pythium graminicola*, *P. irregulare*, *P. debaryanum*, *P. ultinum*, P. *paracandrum*, *P. splendens*, *P. vexans*, *P. rostratum*, *P. arrhenomanes* and *P. species*) are reported on maize *Zea mays* (McGee, 1988).

Pathogenicity of *Pythium* isolates vary widely in their ability to impact dent field corn inbreeds and hybrids (Arthur Hooker, 1956). In addition reaction corn genotypes vary widely in their disease reactions under artificial inoculation.

Oospores of fungal pathogens germinate and produce flagellated spores which are motile. These spores direct their movement soluble nutrients in tender seed, seedling and roots of mature plants which have been damaged. Keen (1974) identified seed exudation as an important trigger of *Pythium* damping off disease cascade.

In maize, *Pythium* damping off is particularly severe under when wet and cool environments predominate (Johann *et al*., 1928). Sweet corn varieties particularly super sweet corns are particularly susceptible (Erwin and Cameron, 1957). Mechanical damage of seed (Koehler 1959) stimulates exudation of plant material. Exudates provide a nutritional base which forms a base for pathogenesis to occur. This is particularly stimulated under cool wet environment which stimulate disease development (Mckeen and Macdonald, 1976).

The Iowa Cold Test has been widely used as a seed health test for corn. This test depends on natural populations of soil borne *Pythium* (Garzonio and Larsen, 1981) and standard application stress environment produced by suboptimal temperature for seed germination. Although *Pythium* is particularly severe in the cool wet environment, Roldan (1932) found that 25 to 35% of corn seedling stands reduction in field corn in the Philippines under warm tropical conditions. Hampton and Buckholtz (1959) showed that 37% of all corn roots were colonized by *P. irregulare* in mature corn plant roots. Imbibing seeds under cool condition is known to stimulate seed exudation.

According to Petersen *et al.* (1986) *Pythium* is the principle reason why almost all corn seed is treated with fungicide. Metalaxyl fungicide is the more common active ingredient used in commercially treated corn seed. Its activity is mostly specific toward oomyceteous Pythiaceous fungi particularly the members of the genus *Pythium* (McGee, 1988).

Since 1981, the Rodale Institute has been differentiating experimental field plots based on organic and conventional practices for producing corn and soybean crops. Winter cover crops have been identified as a key support strategy for our organic production systems. Besides cover crops, manure and compost are used to support organic systems. Cover crops, compost and manure are effective tools for increasing soil organic matter. Our Farming Systems long term trial shows that soil organic matter levels have improved approximately 30% since 1981 or about 1% improvement relative to each year of organic treatment legacy.

In our nonorganic conventional corn and soybean control system we have seen no significant increase in organic matter in conventional corn and soybean trial plots over the same timeframe under the same field conditions. Soil organic matter management is the central focus of organic agricultural practice.

Soil organic matter is well known to support a wide variety of soil microorganisms. It appears that it can both provide residence sites and nutritional support for a wide array of microorganisms. The hidden kingdom of soil microorganisms is complicated in that most species of this diverse array of micro-organisms have never been cultured in the laboratory or their taxonomy and ecological functioning is not known in any profound scientific detail. This limited knowledge base represents both an enormous black box and a significant opportunity for major discoveries.

As an example of potential value soil micro-organisms these have been the source of the majority of antibiotics presently in use. This treasure house of potential plant health aids suggests enormous potential benefits for continuing to explore soil micro-organism. We particularly are in the dark in relation how soil health inter-related with plant health representing a significant and untapped opportunity. This potential may be under-appreciated and under-recognized compared to more visible terrain such as the aboveground plant kingdom based on the sheer difficulty of working with unseen realms. Because of the infancy of the field and the technical difficulties, we see great potential value based on developing more complete knowledge in this area.

Plant disease is one way that invisible life forms become visible. Through epidemic disease outbreaks microscopic pathogens become visible in the form of diseases they cause on crop plants of interest. These diseases reduce crop productivity and profitability of farming operations endangering human well being. Much less appreciated than disease is the positive pro-biotic effects of beneficial micro-flora associated with plants and the soil in which they grow.

While some soil and seed microorganisms are very well known for their ability to cause plant disease, a majority of these unseen life forms are either beneficial or harmless. Yet the vast majority of our work does not enter the realm of natural promotion of health through the soil but rather of soil pathogens as they attack our crops. This represents a glass half empty approach to our opportunities. We believe we need to start looking more intently at both the Health and Disease sides of the performance coin.

Plant pathogens commonly cause epidemics that result in reduced seedling stands and compromised plant vigor. This reaction has a detrimental effect not only on plant health, but also reduces both biological productivity and economic returns of crop plants. *Pythium* species that are Oomyceteous fungi are excellent examples of economically important plant pathogens. They are well known as principle biological agents causing damping off of seedlings of a wide array of plant species. Parasitism by soil micro organisms can lead to premature death of young plants in the condition commonly called damping off. One of the most important groups of fungi causing this malady is species of the genus *Pythium*. The so called Pythiaceous fungal family represents an array of species that are leading causes of damping off and root rot. These fungal species are also commonly referred to as water molds.

Active and diverse beneficial microbial communities are known to increase in some high organic matter content environments.

Many researchers point to soil organic matter for its ability to stimulate natural biological control of root rot fungi. Beneficial communities of soil micro-organisms are helpful in providing biological control of seedling and root pathogens. Most soil borne pathogens are compromised in their survivability and pathogenic potential when beneficial soil microorganisms are robust in their presence and activity. When soil condition controls soil borne pathogens the phenomenon is called soil suppression. Soil conditions favoring active and diverse microbial communities appear to not only favor pathogen suppression but also favor high plant productivity and plant health.

Many pathogens live parasitically while most soil micro organisms live as a beneficial micro-flora community reside in and feeds off soil organic matter. Soil microorganisms play an essential role in recycling nonliving substrates and allowing these materials to re-circulate their nutrients and energy in new plant life and back and forth in the soil. Many non-parasitic soil micro-organisms have been proven effective in reducing disease and promoting healthy plant response. In particular *Pythium* species are known for their sensitivity to and control by non-parasitic soil micro-flora.

Young seedlings represent a critical life stage. In the seedling stage, plants are often most susceptible to pathological influences. This combination of influences can provide a perfect storm leading to their early death. These issues are especially important in the critical initial stages of plant development because young seedlings are be very tender and succulent and therefore extremely perishable.

Pythiaceous fungi can be favored in water super-saturated soil environments. Stress induced by low oxygen induces increased damping off. Not only do the fungi need copious amounts of water for development but also in water saturated environments seed exudation is enhanced. These combinations of factors pre-condition seedlings to be more attacked by these fungi. In addition to low oxygen stresses such as cold suboptimum germinating temperature and mechanic damage to seed can stimulate a release of seed nutrients into the soil environment around the seed stimulating damping off and root rot.

Under stress nutrients leak out of the seed in this condition of sudden nutrient release, water molds in the soil become activated. Seed nutrient released at germination trigger the activation of parasitic soil fungus growth, development, and movement. As soil fungi proliferate, their growth results in the invasion of the seedling tissues. Mechanical, enzymatic and toxic actions provide mechanisms which can lead to compromised metabolism and disrupted structure. These mechanisms in turn lead in some cases to premature death and decreased performance. On a histological level macerating enzymes and toxins are associated with soft rots associated with these diseases.

Nutrients leaked from seeds can provide the nutritional base that initiates a syndrome that eventually leads to host plant death or its compromised growth and vigor and consequential economic losses from reduced plant productivity. Conditions of high soil water saturation and cold soils are particularly challenging to optimum seed germination. In addition to cold water saturated soils, mechanical damage of the seeds and varieties that have compromised seed metabolism such as super sweet corn varieties are compromised in relation to their emergence and performance. Based on their genetic background they are particularly prone to damping off. This perfect storm of pathology can make damping off a severe economic constraint for commercial farmers for the major food crops of North America and around the World.

Sweet corn among major seed crops is particularly susceptible to damping off. Among sweet corn super sweet corn varieties are maximally susceptible to damping off damage. Reduction of corn stands challenges the ability to optimize primary plant productivity of sweet corn stand compromising both crop production and economic returns. Sweet corn particularly super sweet provide optimized condition for assessing treatments for their effects on damping off and seed health.

Fungicides such as Maxim registered by Syngenta are widely used in commercial sweet corn and dent corn production. These are employed in an attempt to mitigate damage from fungal damping off. According seed treating commercial giant Syngenta, over 90% of commercial dent corn seed treated. These treatments are most often applied to the seed in small doses. Micro-doses moderate the well known detrimental effects of the toxic treatment materials. Seed treatments are known for their benefits and their health of the environmental side effects and risks.

In this research we focus on the use of long term soil organic matter differentiation from farming systems and the comparative potential of soil, host plant genetics, and standard fungicide treatment for their ability to stimulate management of damping off from *Pythium*. In our model, cold test germination using super sweet corn varieties is used based on its sensitivity to precisely measuring these effects.

Our results point to key importance of enhanced biological action related to increased soil organic matter to improved plant health. This is measured and evidenced by reduced severity and incidence of damping off and higher stand establishment and high yield potentials.

We believe the benefits of soil organic matter and enhanced soil biology appear to be under appreciated, understood and estimated. This is particularly apparent when we understand emphasis and adoption of chemical seed treatments without emphasis on soil quality and organic matter in most modern agriculture production systems. While chemical seed treatment did not improve either warm germination on cellulose pads or cold germination in soil in our tests, soil quality did. We believe that probiotic and environmental factors are cause of this and they have great potential compared to improve under antibiotic chemical type of approach for plant health promotion.

Materials and Methods

Site Conditions and Experimental Design

From 1981 through 2008, field investigations were conducted at The Rodale Institute Farming Systems Trial® in Kutztown, Pennsylvania on 6.1 ha. The soil is a moderately well drained Comly shaly silt loam. The land slopes ranged between 1 % and 5 %. The growing season has 180 frost-free days, average temperature is 12.4 °C and average rainfall is 1105 mm per year.

The experimental design included three cropping systems (main plots); each of them replicated eight times. These systems detailed below included manure-based organic, legume-based organic and conventional systems. The main plots were 18 x 92 m, and these were split into three 6 x 92 m subplots, which allowed for same crop comparisons in any one year. The main plots were separated with a 1.5 m grass strip to minimize cross movement of soil, fertilizers and pesticides. The subplots were large enough so that farm-scale equipment could be used for operations and harvesting. The rotation scheme is shown in Figure 1. In each system, N inputs were only added to the maize (*Zea mays* L.) crop at equivalent available rates for the crop. These inputs included: steer manure and legume plow-down in the organic-manure system; legume plow-down (red clover (*Trifolium pratense* L.) or hairy vetch (*Vicia villosa*) L.) in the organic-legume system and ammoniated fertilizer in the conventional system.

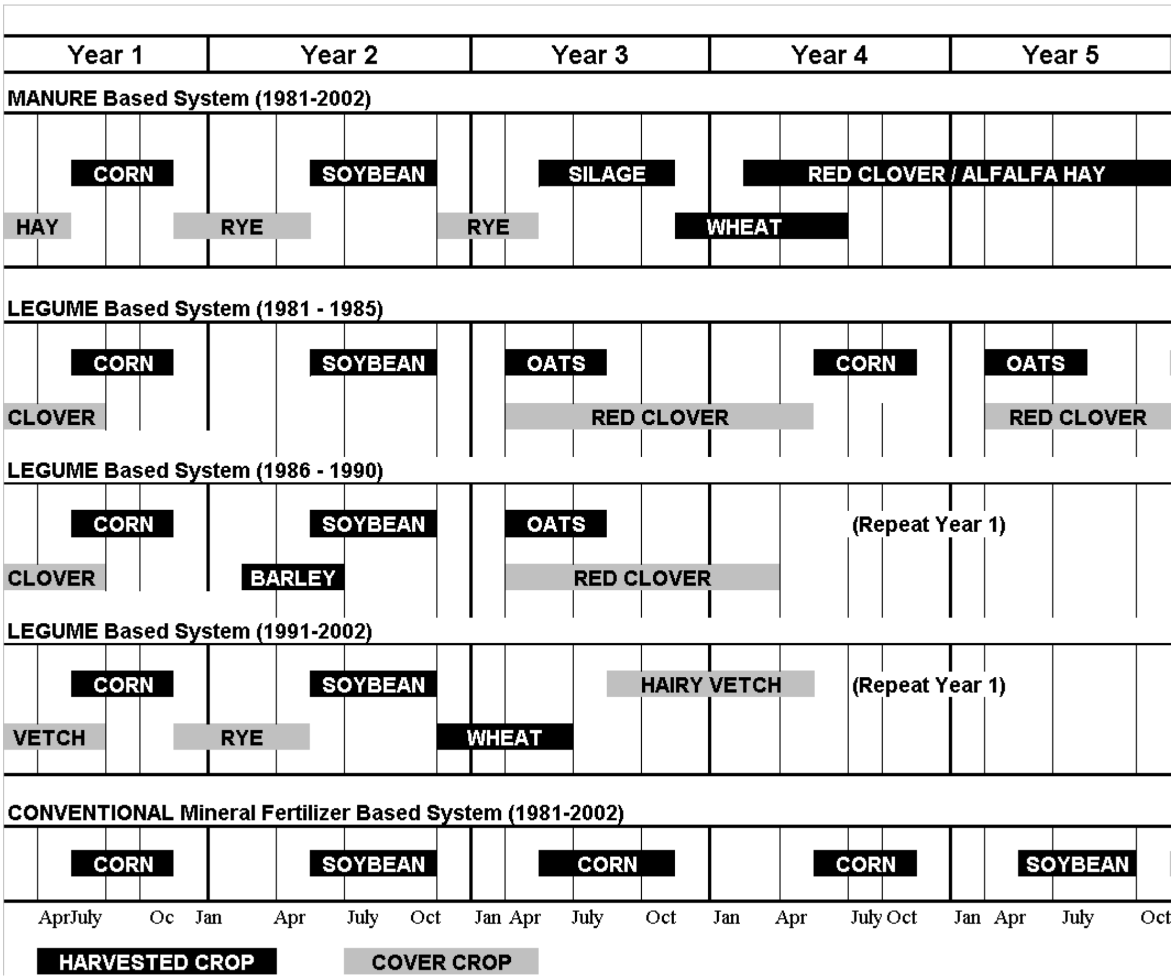

Figure. 1. Rotations employed in The Rodale Institute Farming Systems Trial®.

Organic, manure-based, simulated organic dairy farm: This system simulates a mixed livestock farm operation. Grain crops are grown for animal feed. This operation is typical of a diversified Mid-

Atlantic grain-dairy farm. The rotation includes maize, soybeans (*Glycine max* L. Merr.), maize silage, wheat (*Triticum aestivum* L.) and red-clover/alfalfa (*Medicago sativa* L.) hay plus a rye (*Secale cerale* L.) cover crop before maize silage and soybeans. Aged cattle manure (2-3 months old) serves as the N source and was applied at a rate of 5.6 t/ha (dry), 2 out of every 5 years, immediately before plowing the soil for maize. Additional N was supplied by the plow-down of legume-hay crops. The total N applied per hectare with the combined sources was about 40 kg per year (or 198 kg·ha^{-1} for any given year with a maize crop). The system uses no herbicides, relying instead weed management is based on mechanical cultivation and weed-suppressing crop rotations.

Organic, legume-based, cash grain: This system represents a mixed grain operation without livestock. It produces a cash grain crop every year, but it uses no commercial synthetic fertilizers, relying instead on N-fixing green manure crops as the primary source of N. The initial 5-year crop rotation in the legume-based system was modified twice to improve the rotation. The final rotation includes hairy vetch (winter cover crop used as a green manure), maize, rye (winter cover crop), soybeans, and winter wheat. The total N added per hectare per year to this system averaged 49 kg (or 140 kg·ha^{-1} for any given year with a maize crop). Weed control practices were similar in both organic systems with no herbicide applied in either organic system.

Conventional grain rotation (synthetic fertilizer and herbicide-based): This system simulates a cash grain farming operation. It uses a simple 5-year crop rotation of maize, maize, soybeans, maize, and soybeans. This system is the most common conventional operation in the Midwest (over 40 million hectares are in this production system in North America) (USDA, 2003). Fertilizer and pesticide applications for maize and soybeans followed Pennsylvania State University Cooperative Extension recommendations.

Table 1. Cultural practices used in the Rodale Institute Farming Systems Trial.

Cultural practices	Manure	Legume	Conventional
Crops	maize, soybeans, small grains, hay cover crop: rye	maize, soybeans, small grains cover crops: rye & vetch	maize, soybeans no cover crop
Nitrogen Input	40 kg ha^{-1} yr^{-1} manure + legume hay (198 kg N ha^{-1} on maize)	49 kg ha^{-1} yr^{-1} legume cover crop (140 kg N ha^{-1} on maize)	88 kg ha^{-1} yr^{-1} mineral fertilizer (146 kg N ha^{-1} on maize)
Ground Cover	living: 73% dead: 20% bare: 7%	living: 70% dead: 22% bare: 8%	living: 42% dead: 50% bare: 8%
Primary Tillage	moldboard plow 0.8/yr (4 times/5 yr rotation)	moldboard plow 1.3/yr (4 times/3 yr rotation)	moldboard/chisel plow 1.0/yr (5 times/5 yr rotation)
Weed Control	rotary hoeing cultivation, rotation	rotary hoeing cultivation, rotation	herbicides
Insect Control	rotation	rotation	insecticides for maize only in 1986-89, 1993

Data collection and analytical methods

Total soil C and N were determined by combustion using a Fisons NA1500 Elemental Analyzer and soil water content was determined gravimetrically on sieved soil (2 mm). Statistical analyses were performed with the General Linear Model Univariate procedure and Duncan's Multiple Range Test (SPSS software version 12.0).

Soil tested for its effect on corn seed damping off and emergence was selected from the Organic Manure or Simulated Dairy Farming Treatment compared to Conventional corn and soybean soil. Results of a range of tests between the two organic treatments generally show no significant differences among them for indicators of interest such as organic matter, nitrogen and biological activity but a significant difference between the two organic treatments and conventional farming systems.

Seed germination and emergence tests provided a standard methodology to assess the comparative influence and importance of 1) soil quality, 2) varietal genetic background, 3) fungicide seed treatment potential and 4) the interaction of these factors on seedling health.

Seven Sweet corn seed varieties were used: 1) Sweet Chorus, 2) HMX6538, 3) Sweet Ice, 4) Reflection, 5) Renaissance, 6) Revelation and 7) Sweet Rhythm. All the sweet corn varieties were products of commercial seed development program of Harris Moran Seed Company Yuma, Arizona.

Seed treatment included: i) treated with maxim fungicide, fludioxonil and mefenoxam, at standard rates or ii) non-treated control. Treatments were applied commercially for seed supplied by Harris Moran Seed Company Modesto California. According to Syngenta seed treatment fungicide is applied to more than 90% of hybrid corn seed in United States. Maxim XL is a registered trademark of Syngenta the active ingredients kill a variety of fungi. The combined chemicals provide action against diverse fungi including *Pythium*, *Penicillium*, *Fusarium*, and *Aspergillus* species.

Germination was determined either in: i) soil under cold pre-treatment (stress test) or ii) on cellulose pads without soil, non-stress environment, ie. warm germination at 25°C. The Iowa cold stress test soil either came from either: i) organic simulated dairy (organic) or ii) conventional corn and soybean row crop system (conventional). The Iowa cold test was effected by exposing soil which is seeded into pre-germination incubation at 10°C for 7 days in moist soil, prior to warm germination at 25°C in soil in the greenhouse.

Each treatment combination consisted for 4 replications 12 seed each. Seedling emergence counts were performed at weekly intervals for 3 weeks. Emergence rates were analyzed for their variance, factor influences, and potential for factor interactions.

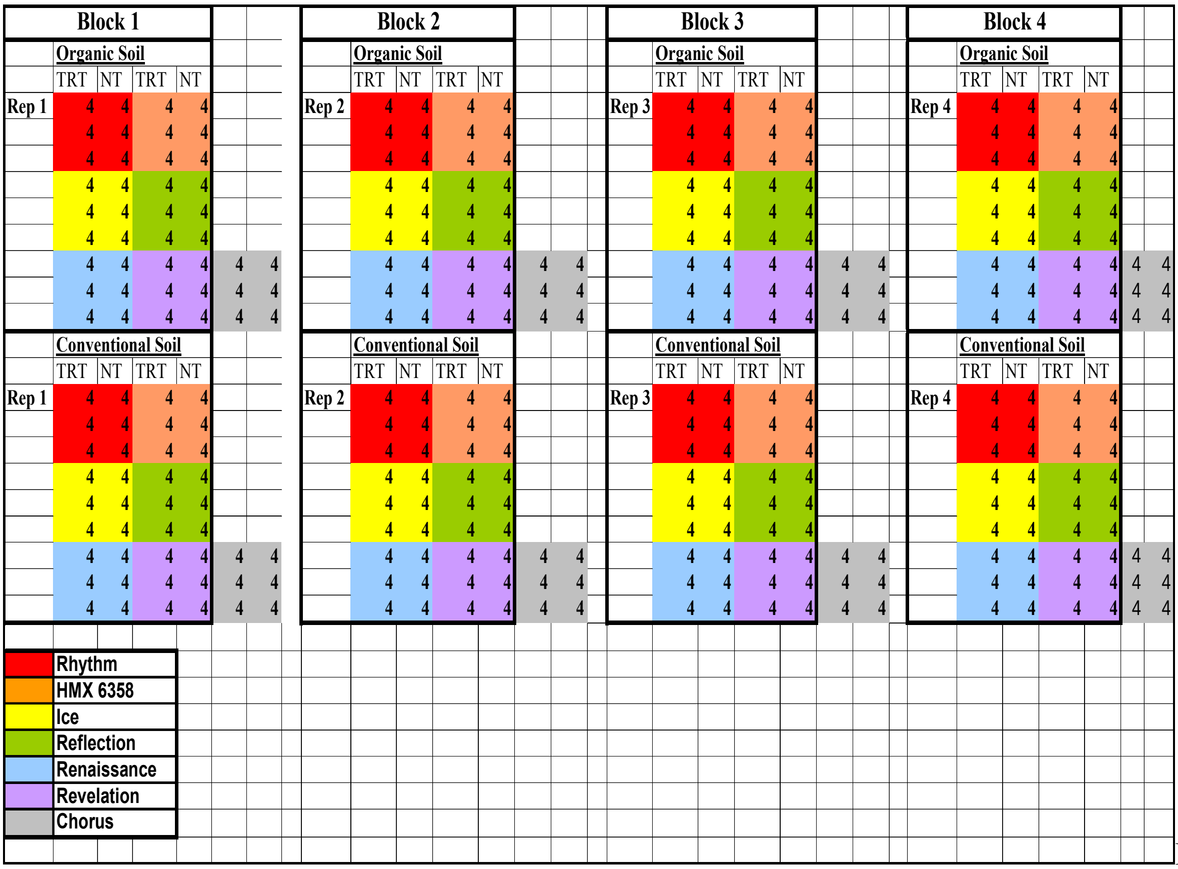

Figure 2. Schematic drawing of the cold germination and emergence trial of super sweet corn varieties in organic and conventional differentiated soils from Rodale Institute Farming Systems Trial.

Results

Soil

Soil C and N: In 1981, soil C levels between the systems were not different (p = 0.05). However in 2002, soil C levels in the organic-legume (2.4 %) and organic-manure systems (2.5 %) were significantly higher than in the conventional system (2.0 %) (Fig. 3). The two organic systems retained more of that C in the soil, resulting in an annual soil C increase of 981 and 574 kg ha-1 in the organic-manure and organic-legume systems; whereas, the conventional system showed a 293 kg ha-1 gain (Table 2).

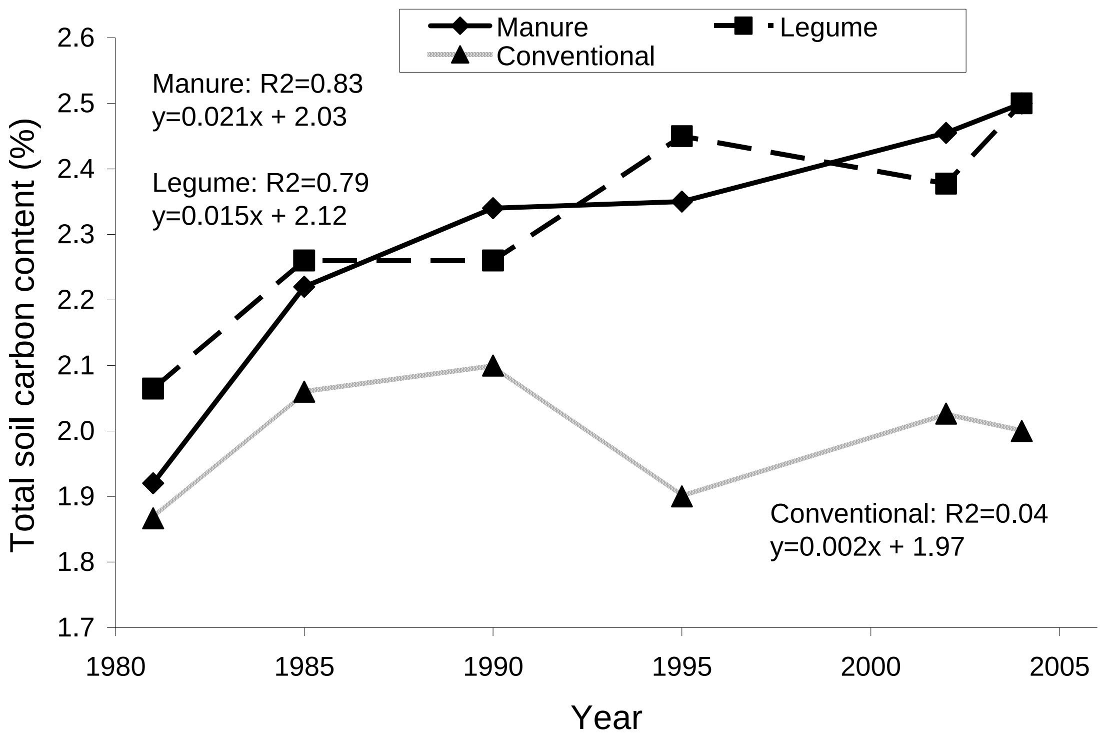

Figure 3. Rise in soil Carbon with time with linear regression equations for soil from organic and conventional systems in the Rodale Institute Farming Systems Trial 1981 to 2005.

Table 2. Soil C and N accumulation in kg ha-1 year-1 between 1981 and 2002. Different letters indicate statistically significant differences for that element (p = 0.05).

	Carbon	Nitrogen
Manure	981 b	86 b
Legume	574 b	41 b
Conventional	293 a	-2 a

Soil N levels were measured in 1981 and 2002 in the organic-manure, organic-legume and conventional systems (Fig. 3). Initially, the three systems had similar percentages of soil N of approximately 0.31%. By 2002, the conventional system (0.31%) remained unchanged while the organic-manure (0.35%) and organic-legume (0.33%) systems had increased significantly (Table 2).

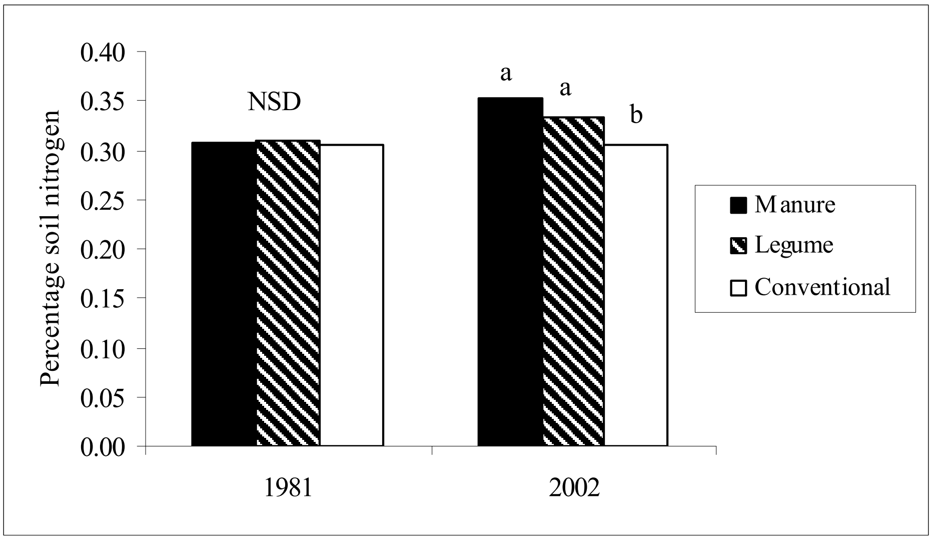

Figure. 4. The percentage soil N in 1981 and 2002, for the three systems. Bars with different letters indicate statistically significant differences, while NSD indicates no significant difference (p = 0.05).

Table 3. Uniform testing of corn hybrid yield and chemically labile organic matter show that 25 years of organic and conventional practice influence corn yield potential and active soil organic matter both of which increase under organic system management

Systems of Management	**Labile Soil Organic Matter Content**	**Maize Grain Yield (kg/ha)**
Organic Animal System with Manure	590 A	11,900 A
Organic Cash Grain Cover Crops no Manure	530 AB	11,000 AB
Conventional Corn and Soybean Rotation Fertilizers and Pesticides based on PSU	450 B	9,600 B

Among the means those not sharing a common upper case letter are significantly different. There was a direct relationship between the content of labile organic matter and high yield of corn in a favorable production year in uniform trialing. The average National Corn yield during this period is approximately 9,000 kg/ha showing the ability to increased soil organic matter to increase yield potential under a favorable production environment.

Soil Biology

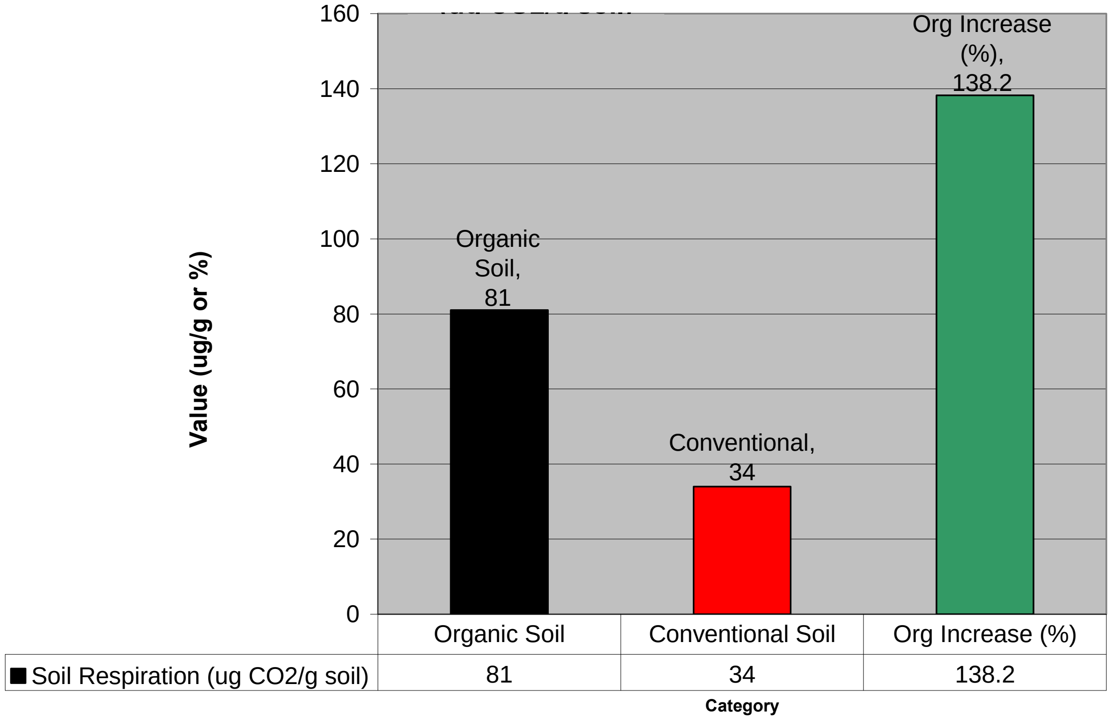

Figure 5. Influence of organic management on soil respiration (µgCO_2 / g soil).

The respiration of soil results from Harris *et al*. 1994 and Wander *et al*. 1994 Rodale Institute Farming Systems Trial.

Wander *et al*. (1994) and Harris *et al*. (1994) demonstrated that 10 years after initiation of the trial soil respiration was significantly higher in the two organic systems compared to the conventional system: For example, soil respiration in corn plots was 81 µgCO_2 per gram of soil in the organic-legume system versus 34 µgCO_2 per gram of soil in the conventional system. Higher microbial populations and activities explain the higher respiration or metabolism rates found in organic soils than in the conventional system soils (Lavelle and Spain, 2001).

Table 4. Cold test emergence of organic and conventional soil for 7 varieties of super sweet corn varieties.

Agricultural System			
Variety Name	Organic	Conventional	Statistical Significance
Sweet Chorus	5	2	*
Renaissance	22	14	*
Reflection	25	29	Not Stat. Sign.
HMX6358	35	15	*
Sweet Ice	39	18	*
Sweet Rhythm	46	4	*
Revelation	53	21	*

Table 5. Warm germination on cellulose pads and warm temperature 25 °C.

Variety Name	Maxim Fungicide	Nontreated	Statistical Sign.
Sweet Chorus	100	100	Not Stat. Sign.
Renaissance	40	70	*
Reflection	80	100	Not Stat. Sign.
HMX6358	90	100	Not. Stat. Sign.
Sweet Ice	90	100	Not Stat. Sign.
Sweet Rhythm	40	100	*
Revelation	70	100	*
Overall Mean	72.9	95.6	*

Table 6. Super sweet corn cold germination results factors of significance and their interactions.

Factor	Statistical Significance Level
Organic or Conventional Soil	****
Difference Among 7 Cultivars	**
Fungicide Treated or Not	NS
Soil by Cultivar	*
Soil by Fungicide	NS
Soil by Cultivar by Fungicide	NS

NS denotes no statistically significant difference P = 0.05.

* = Statistically Significance at P = 0.05

** = Statistically Significant at P = 0.01

**** = Statistically Significant at P = 0.001

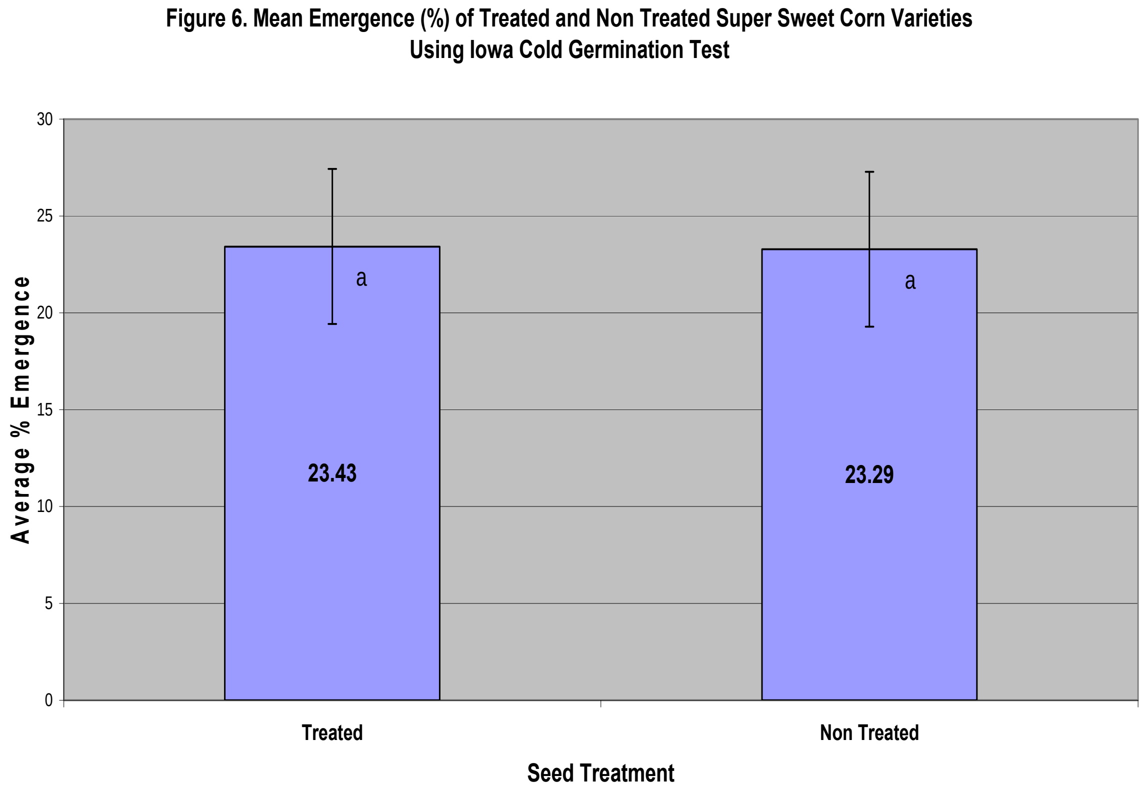

Figure 7. Influence of standard Maxim fungicide seed treatment on the emergence of super sweet corn varieties incubated in cold 10 °C for 7 days prior to warm germination in soil using Iowa Stand Corn Cold test for detecting *Pythium* susceptibility under a controlled stress environment.

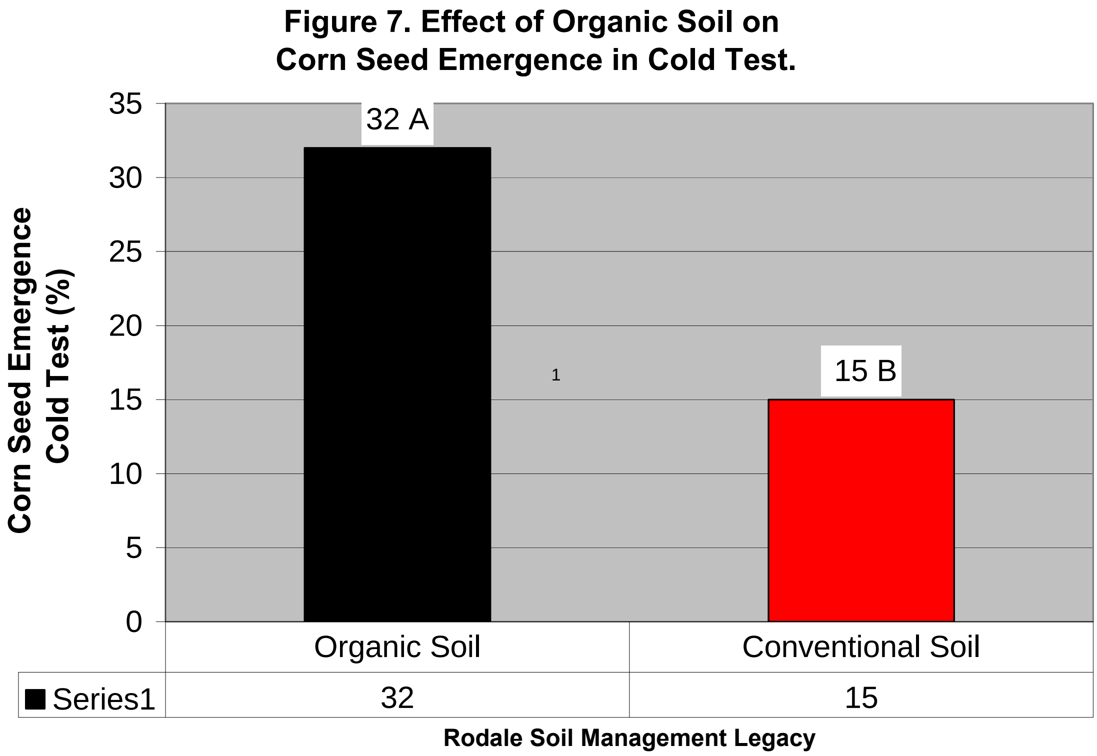

Figure 8. The effect of soil organic management legacy on corn seed emergence using super sweet corn under the Iowa cold test procedure designed to differentiate seedling based on reaction to Pythium under a natural inoculation and controlled stress.

Discussion

In the 1970's Robert and Ardath Rodale established a 300 acre farm to demonstrate the viability of organic agriculture as a solution to many of the problems related to energy and environment issues related with high input agriculture dependent of synthetic pesticides and fertilizers. In 1981 Rodale joined forces with US Department of Agriculture following President Carter's concerns if organic agriculture could offer a viable tools and ability for reducing energy and environmental issues related to our food system. For over 6000 years organic methods have been utilized to make agriculture sustainable. Organic farming methods do this by conserving soil, water, energy, and biological resources. There are many of the benefits of organic farming that have been identified and supported by our long term studies at the Rodale Institute that originally initiated with collaboration of US Department of Agriculture Research Service. These benefits point back to improvement in soil Carbon content and quality.

Proven long term benefits of organic agriculture include: 1) soil organic matter (soil C) and N can be raised substantially providing multiple benefits to the overall sustainability of these farming systems. 2) Overall organically managed crop yields on a per hectare basis can equal those from conventional agriculture. 3) During drought years, high soil organic matter under organically managed systems helps conserve soil and water resources stabilizing yields of maize and soybean. 4) During overly wet conditions, high soil C content under organic management conserves soil N, leading to higher yield and protein levels in organic systems than the conventional system. 5) The crop rotations and cover cropping typical of organic agriculture reduce soil erosion. 6) When done properly, recycling of livestock wastes can reduce pollution and at the same time accrue soil C on organic cropland. 7) Abundant biomass both above and below ground (soil organic matter) also increased biodiversity which helps in the biological control of pests and increases crop pollination by insects. 8) The organic farming technologies leading to C sequestration include diverse rotations, cover cropping, and manure/compost utilization. Their use and benefits are not restricted to organic farmers and may be adopted by conventional agriculture to make their operations more sustainable and ecologically sound. 9) Organic farming is a proven method of reducing greenhouse gases as well as having multiple benefits for a wide range of other environmental concerns (Lotter *et al*. 2002, Pimentel *et al*. 2005, Teasdale *et al.* 2007).

A growing scientific literature supports the fundamental importance and potential of using organic amendments and soil organic matter to help suppress of soil-borne diseases and optimize plant health. Soil organic matter has capacity to contribute to highly competitive crop yield and quality. However, in some conventional mainstream agriculture arenas this is not always appreciated. The Rodale Farming Systems trial provides a unique platform for better understanding fundamental questions such as how to the long term application of organic practices affect key natural resources such as soil. Levels of soil organic matter are clearly differentiated in this trial based on consistent management over decades. With this differentiation it serves as an excellent foundation for better studying and understanding the nature of soil conditions and quality to health itself.

Soil Carbon importance resides not only in its chemical and biological stimulus but also its ability to transform the physical nature and structure of soil itself. In regards to physical improved increased stable aggregation of soil particles leads to greater percolation and retention of water. Soil nitrogen is while understood for its relation to high yield potential and environmental issues. While soluble chemical Nitrogen has major issues with its susceptibility to both leaching and volatilization, some forms of organic nitrogen can be less directly mobile and easily lost through leaching and de-nitrification. Soil Nitrogen retention allows for better season-long provision toward crop development. It also can help avoid nitrate fluctuations that can be harmful to water sources. In high rainfall years, not only is leaching less but because aeration is superior when soil carbon increases, volatilization by de-nitrification can be reduced potentially. All of these changes may have potential to increase health, quality, nutrition, stability and productivity of our crops.

Soil Quality

For millennia, Chinese, Korean, and Japanese peasants have been able to maintain excellent stable high yield by use of organic sources of amendment and intensive multiple cropping (Kelman and Cook 1977 and Shen 1997. King (1911) a former chief soil division of the US Department of agriculture watched in the last part of the 19^{th} and first part of 20th centuries while the once fertile prairies and fields became impoverished leading to the famous dust bowl.

Upon his retirement, King travelled throughout China, Korea, and Japan to discover how the Asiatic peasant populations were able to defy the declining productivity with continuous field culture noted time and time again in North America. How could the traditional Asian field culture maintain itself in high productivity after more than 4,000 years of continuous production. This was the key question King asked.

King understood that this was done without an ounce of fertilizer application. His conclusion was that chemical fertilizer was not the answer to sustained agricultural productivity. He was well aware that copious fertilizer application was not producing sustainable production in his experience in North America. He was well acquainted as a soil scientist with the use of copious amounts of fertilizer.

In his poignant memoir he concludes that soil organic matter from recaptured resources through recycling of all types of organic matter was the key to traditional Asian systems and their sustainability and success.

Davis *et al*. (2001) found factors such as soil organic matter, organic nitrogen content were highly associated with higher potato tuber yields and reduced levels of diseases. Cook (1990) has argued that modern agricultural systems have lost track of soil's natural ability to suppress diseases, improve health and crop productivity.

Soil organic Carbon or closely allied soil organic matter provides a foundation for organic agriculture. Certified organic agriculture is based on observe a practice code. Genetically modified organisms, human sewage, use of irradiation, and synthetic chemicals are examples of restricted practices under National Organic Standards. These standards arose from Congressional authorization in the early 1990's which became formalized as authorized USDA labeling in 2002. In addition to restricted practice observance, certified organic farmers must follow a system of practice establishment, practice monitoring record keeping and third party verification. Farm plans are required that outline the practices in relation to key areas such as soil conservation and improvement, crop rotation, and maintenance and promotion of biological diversity. Certification for organic agriculture is based more on process emphasis than performance requirements by its nature.

In this trial after 22 years of different management, soil Carbon was significantly higher in both the organic-manure and organic-legume systems than in the conventional system. Since 1981 the Carbon content of soil has risen 0.75 to 1.00 percent per annum in the organic systems (Fig. 2). Because organic manure and legume systems show similar improvements in soil Carbon, it is believed that rotation and cover cropping outweigh the importance of manure addition for achieving this soil C gains. The conventional maize-soybean rotation showed no rise in soil C content under the same experimental conditions. Over the course of the trial, soil C and N in soil samples occur at about a 7 to 1 ratio. While soil C in the organic systems increased up to 30% in 25 years, the increase in soil N was about 15%. This means, for every 2% increase in soil C we saw about 1% rise in soil N.

The motto of the Rodale Institute Healthy Soil = Healthy Food = Healthy People is a state emphasizing the interaction of soil quality to food quality and diet quality to the health of people. Although we do not have it in our official motto we see healthy Planet as a perquisite our societies in a general sense While the findings of soil carbon and nitrogen sequestration are increasingly recognized for their growing impact on the key issues of global greenhouse gas issues and their management, the ability to understand the complication interactions of health to soil quality has much less recognized and understood the overwhelming majority of all soil micro-organisms to this day have never been either isolated, classified and studied. Nevertheless, R. J. Cook (1986) stressed the premiere importance of root health in order to stimulate high crop yield. Root health starts in the soil and is a function of the biological life within it.

About 80% of all plant pathogens are fungal. For promoting crop health managing root disease appears a key area for starting a pro-health program. In 1953 Dobbs and Hinson had shown that most fungal propagules cannot germinate in natural soil. Lockwood (1986) concentrated his career studying this phenomenon called fungistasis in depth. He has pinpointed a combination of lack of soluble nutrients and antibiosis as the principle factors that naturally suppress germination of a wide variety of fungal pathogens. Ho and Ko (1986) and Elad and Chet (1987) stressed the role of low nutrient availability as a key factor for inhibiting the development of microbes in soil and growth media and in relation of Pythium damping off control by bacteria, respectively. Toyota *et al.* (1996) stressed the activity and diversity of soil microbes was key to fungistasis of Fusarium wilt pathogen.

Kao and Ko (1983 and 1986) studying the natural suppression of *Pythium splendens* showed the critical nature of nutrients and microbial probiosis to counteracting disease. *Pythium splendens* causes a devastating root rot disease in Papaya in Hawaii. A series of well run replicated studies determined that sporangial germination was inhibited in natural Soil in the South Kohala coast of the big Island of Hawaii. The application of heat sterilization of the soil was able to over ride the natural inhibition of sporangial germination leading to severe root rot of papaya in originally suppressive soil conditions. Disease suppression was not prevalent when soils were low in Calcium and/or when microbial activity in the soil was low. As such the nature of the health response appears grounded in both competition, antibiosis and nutritional optimization. .

Hoitink and Boehm (1999) would specifically developed composts for promoting plant health and suppressing plant disease Along with Chen *et al*. (1988) found general promotion of health and suppression of root disease were associated with microbial activity. They measured microbial activity using the biological conversion of fluroscein diacetate into red colored fluorescein. This red colored biological conversion can be exactly measured in laboratory tests with precision using colorimetric methods. Zhang *et al.* (1998) was able to show that compost which was disease suppressive also could trigger induced systemic resistance to disease. This revolutionary finding places biological environment as a key initiator of plant immune like response.

Harman and his collaborators at Cornell University (1978 and 1988) have identified biological control organisms and mechanisms more specifically. Fungal pathogens can be controlled specifically by parasitism of the parasite so called hyperparasitism. This specific approach is somewhat different than the suppressive compost approach used Ohio State initially. Species of *Trichoderma* fungi are quite effective as hyperparasites of both *Pythium* and *Rhizoctonia* two very diverse and important root rot pathogens. Induced systemic resistance was also triggered by *Trichoderma* biocontrol fungus. Hadar and Harman (1983) found that the bacteria Enterobacter cloacae had ability to degrade linoleic acid from cotton seed. Linoleic acid can stimulate opportunistic development Pythium spp. Without the food base for this opportunistic development the enzymes and toxins of Pythium fungus cannot stimulate the damping off disease cascade. We would like to highlight how nutritional and antibiotic and/or competitive factors seem to work together to achieve high levels of disease control and plant health.

Fluorescent Pseudomonad bacteria has well represented in their ability to biologically control a range of root pathogens. Besides their abilities to produce potent antibiotics specific proteins produced by the biocontrol organisms are now identified sequester scarce iron not allowing pathogenic members to flourish when scarce iron is available in the environment.

The Rodale work which shows the ability of biologically based control of seedling damping off under severe stress conditions gives a strong support to the effectiveness of a general suppression related to stimulating favourable environment for microbial probiosis through organic matter management. This effect was more conclusive in stress environments that seed treatment with fungicide. Probiosis related to soil improvement has beneficial effects not always fully appreciated or implemented. Despite its enormous potential and powerful results organic agriculture is applied by a small minority of present day farmers in North America and the World.

We see great potential to improve the productivity and quality of our crops produced and the natural resources themselves by using organic philosophy. Traditional art and experience are increasingly being verified by hard state of art science and technology. We like to think that both high technology and biologically bases systems as not mutually exclusive but rather complementary opportunities to get the best of both worlds.

Regardless of wonders of modern science and technology are more immediate opportunities are in the dynamic change of philosophy to a more generalized approach that emphasizes health in general sense than from specific silver bullet approaches disease control. Indeed there is growing realization that pro-biosis may be more effective and useful than antibiosis.

As we see it organic standards appear to have validity in approaching these issues and might be supplemented with performance standards as part of best of both worlds approach to promote better crop health.

The use of stress environments and long term differentiation of soil parameters provide a very useful foundation for differentiating factors for their influence on disease and health challenges. These studies continue to support the strong inter-relationship of soil and plant health as a function of underlying biological activities which organic matter plays a key role. This foundation concept may deserve increased and continuing engagement and interest in our society, research and education institutions.

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The business of organic agriculture in China

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Abstract

The situations of a typical organic operator for the market sharing, quality management system and profit in Shandong Province of China are presented in this paper. The people's awareness on organic food and the marketing circumstance in Nanjing City of China have been investigated and analyzed. From the results of the above investigation, it can be concluded that organic agriculture contributes greatly in; a) improving the share of international market; b) optimizing the management system of production, and c) ensuring the profit of the operator. Moreover, consumers choose organic food because of their belief in the health benefits and safety of the products. It is suggested that the domestic organic food market should be further developed in order to reduce price, increase the varieties and share of organic food market share. More effort should be concentrated in publicity for consumers' knowledge and awareness of organic food. Meanwhile, a holistic supervision and integrated management of organic food shall be carried in order to further protect consumers' interests.

Keywords: Organic food, food safety, consumer

Introduction

With the unique natural advantages and the historical origins of agriculture, organic industry is booming steadily in China. China is ranked the 5th in the world in terms of organic farmland acreage. In the meanwhile, China is one of the world's major suppliers of organic produce. The development potential of domestic organic market in China has been growing up during the past 15 years along with the increase of people's living standards. More and more consumers prefer to healthy food and sustainable agriculture for our next generation with facing the emerging problems. With respect to the food safety, its scope is not only limited to the benefit to human health, but also including the influence on the operators, agriculture and market.

Contributions to the operator —TTAF Co., Ltd case

Gaining the market

Tai'an Taishan Asia Food (TTAF) Co., Ltd was organically certified by Organic Food Development and Certification Center of China (OFDC, a national organic certifier in China) in 1997 firstly. From then on, it gained other international organic certification in the following years, such as OCIA (1998), JONA (2000), ICS (2001) and BRC (2005). The development of organic production helped the operator overcome the 'green barriers to trade' and become one of the leading companies of organic production, processing and exporter in China.

Chinese People's Daily (July 13, 2006) reported that the implement of "The Japanese Positive List System" observably decreased the export amount of agricultural products of China. Fortunately, this company has not been influenced by this action, and the export amount actually increased 20% comparing to the same period last year. The data showed that the development of organic agriculture can not only contribute to break the trade barriers, but also gain the chance to occupy the market for organic food.

Gaining the economic profit

Economic profit is one of the most important interests to farmers. In this case, it was calculated that the farmers' income in Tai'an region could reach at the highest of 915.7% when they cooperated with TTAF Co., Ltd, for organic production in comparing with their conventional agricultural production (Table 1-2) . Mutual benefits to the company and farmers were achieved.

Table 1. Annual net income of farmers from conventional agriculture

	Annual input (Yuan/mu)				**Annual income** (Yuan/mu)	Net income (Yuan/mu)
	Fertilizer and pesticide	water	seeds	labor		
Wheat	280	100	80	80	650	110
Corn	200	50	30	-	520	240
Total	**480**	**150**	**110**	**160**	**1170**	**350**

Table 2. Annual net income of farmers from organic agriculture

	Annual input (Yuan/mu)				**Annual income** (Yuan/mu)	Net income (Yuan/mu)
	Organic /biological manure	water	seeds	labor		
Sword bean	292	100	25	270	2400	1713
Green manure		50				-50
Broccoli	378	50	80	-	2400	1892
Total	**670**	**305**		**270**	**4800**	**3555**

10 years ago, only conventional corn-wheat were planted there, and no one knew what was "organic food". Now, if you visit one farmer in that region by chance, he can tell you some knowledge about

organic agriculture. Because the fact showed that organic vegetable planting can acquire more profit than conventional planting.

Gaining the good management system

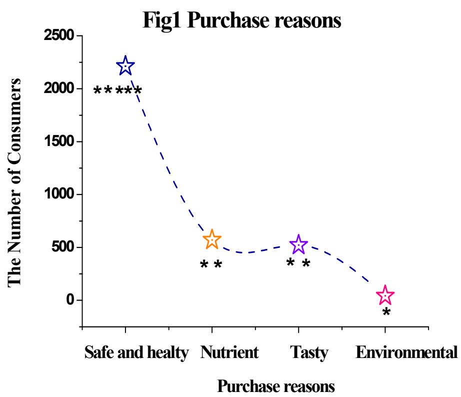
Organic integrity is most important to the operators. They should be aware of all the points in the process of planting, storing, handling and transforming horticultural crops where accidental contamination might occur. A good and active management measure was set up. From one lot number (such as F01P1OSPN050411), we can trace the products in the processing plant and the producing plot. Then, organic integrity can be insured. And then, it found the studied company has their own laboratory and cooperate in harmony with experts of local known agricultural university for many years. The farm management and cultivation mode were often optimized to adapt the new situation.

Contributions to the consumers--Gaining the health idea

Food safety

The demand for organic foods is constantly increasing mainly due to consumers' perception that they are healthier and safer than conventional foods. Rembialkowska (1999) found the most of examined health-quality factors were better for organic potatoes. With regard to other food hazards, such as natural chemicals, microbial pathogens and mycotoxins, no clear conclusions can be drawn, although several interesting points can be highlighted. While, people prefer to think the organic food is healthier and safer, because the certified farms adopt proper agricultural practices and management. Organic farming can be seen as an approach to agriculture where the aim is to create integrated, humane, environmentally and economically sustainable agricultural production systems (Thamsborg, 2001). Principles like nutrient recycling, prevention rather than treatment and the precautionary principle are included in aims and standards.

Consumer attitudes towards organic food



Totally 3500 customers were surveyed randomly in Nanjing downtown towards organic food in Nanjing. 90% organic buyers purchase organic products mainly in consideration of organic food safety and reliability. The results are obviously showing that people’s behavior and attitude towards organic food is relating much more to the health issue than other reasons in Nanjing of China so far.

The marketing of organic food in major supermarkets in Nanjing

High price

10 brands of hypermarkets in Nanjing city were investigated in 2008, including 6 international ones (Metro, Wal-Mart, Lok buy, Lotus, Auchan and Carrefour) and 4 domestic ones (PARKnSHOP, Lianhua, Hualian and Suguo). The average price of organic food is 1.5~3 times higher than that of

conventional food (Table 3) . Contrarily, the price premium was no more than 100% in many developed countries. Then, the premium prices were beyond the expectation of the ordinary consumers, and the willingness for organic consumption is not strong, which could be ascribed to the low consumption in China. We think that product value increase is firstly based on the added labor, technique and marketing cost. It is believed that the price of organic food will go down to stability with the organic markets trending to maturity.

Small market share

As the in-coming bulk of products of the major supermarkets in Nanjing, share of organic food is less 0.1%. However it already reaches 4-5% in European developed countries, such as Germany, Austria, Denmark etc. Although this disparity accounts for the weak organic market in China, it implies the huge domestic market opportunities and potential.

Limited Varieties

Compared to the conventional food in the supermarkets, the varieties of organic food are far from enough to meet the catering demands. Some supermarkets only deal with organic vegetables and organic cereal. Though rich varieties of products certified in China, we didn't find dedicated area to sell organic food. The fundamental reasons for supply deficiency of organic products are small market share and limited variety for sale. Additionally, organic processing put strict requirements on the processing flow, minor ingredients and aids, which hinder the development of further processed products. Thus the product diversity could not be enriched.

Conclusions

With investigating the company, the consumers and the supermarkets, it shows that the organic agriculture contribute greatly on a) improving the share of international market; b) optimizing the management system and c) ensuring the profit of the operator. At the same time, the consumers gained the health food. While, the internal market need further developing for higher price, small market share and very limited varieties.

How to develop organic standards that is best suited for Thailand and developing economies

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Abstract

Organic Agriculture Certification Thailand (ACT) was founded by the Alternative Agriculture Network (AAN). The main purpose of establishing ACT was to help certify the authentic alternative farmers and their chemical-free products and thus increase the reliability of the products, while there are several business groups marketing their self-claimed products by labeling as "hygienic food" or "non-toxic food". That has made the products appear as if they were organic and consequently mislead consumers. The standards of ACT were developed from the grass roots, but it is always with an eye on international equivalence. They remain practical for Thai farmers at the same time as meeting international market requirements. ACT is registered as a Foundation in Thailand and its logo (a design based upon ears of paddy rice) is a protected mark. ACT has recently focused attention on providing services to small-holder producers. In 2001 ACT launched an inspection and certification system for special projects with internal control systems operating fully in line with IFOAM (International Federation of Organic Agriculture Movement) norms on smallholder certification. In November 1999, ACT applied for IFOAM Accreditation Programme. On 15th February 2002, ACT received IFOAM Accreditation contract with the International Organic Accreditation Service (IOAS), the accreditation body responsible for implementing the IFOAM Accreditation Programme. ACT is the first IFOAM Accredited certification body in Asia. Current focus is in Thailand, but ACT are now providing inspection services with local inspectors throughout Southeast Asia on contract to other certification bodies.

Keywords: Organic Agriculture Certification, chemical-free products, standards, small-holder

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Since 1961, Thailand's National Economic and Social Development Plans have continually played a very powerful role in changing the attitudes and practices of Thai small farmers on their farms for market economy. Most farms have changed from integrated farming to mono cropping which needs more chemical fertilizers, plant regulators, and pesticides. These agricultural chemicals have subsequently not only caused increasing severe health problems of the people exposed to them but also induced large scale environmental degradation. In addition, many kinds of exported agricultural products were rejected during the 1990s. As a result, the responsible government organization launched a policy and measures on safe food from agricultural products in recent years by randomly testing the products; however, the test could not cover all products and thus continue consistent implementation. Without a good certification system, the consumers have been more confused with the self-claimed products i.e. “safe food”, “hygienic food”, “pesticide free product” and “organic product” and their reliability.

Organic Certification and Standards

Organic Agriculture Certification Thailand (ACT) was founded by the Alternative Agriculture Network (AAN). Initially the so-called Alternative Agriculture Certification Thailand operated in the field of 'alternative agriculture' but in 1998 it revised its focus to organic farming and changed its name to 'Organic Agriculture Certification Thailand'. The main purpose of establishing ACT was to help certify the authentic alternative farmers and their chemical-free products and thus increase the reliability of the products, while there are several business groups marketing their self-claimed products by labeling as “hygienic food” or “non-toxic food”. That has made the products appeared as if they were organic and consequently mislead consumers.

The standards of ACT were developed from the grass roots, but it always with an eye on international equivalence. They remain practical for Thai farmers at the same time as meeting international market requirements. Through a membership structure, ACT ensures participation of stakeholders. A General Assembly meets to approve standards and elect a Governing Board who is in charge of policy. An Executive Board supervises the day to day work of a secretariat led by a General Manager.

ACT is registered as a Foundation in Thailand and its logo (a design based upon ears of paddy rice) is a protected mark. Certification decisions are made by Organic Certification Committee.

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ACT is an independent certification body. Its members include producer organizations, consumer groups, NGOs, environmentalists, and academics. ACT's standards include crop, wild product harvest, processing/handling, input and aquaculture, but not organic mushroom. Although rice is a main product from ACT operators, a wide range of sub-tropical fruits and out of season vegetables are now available along with an interesting range of wild herbs. Although much of the product is exported, there is a growing domestic market. The ACT certified organic operators in only 22 of 75 provinces of Thailand and in limited areas in Viet Nam and Laos. ACT has certified 110 organic operators (only small producers) with an area of 1,490 rais in 1997 and 52 operators (617 producers) with 14,694 rais in 2002. As of January 2007, there are 62 certified operators (1,326 producers) as shown in Table 1. At present, ACT certification covers some 5,207 hectares in Thailand, comprising around 3,968 hectares of Organic areas and 1,239 hectares of conversion areas as shown in Table 2.

Table 1. ACT Certified Operators during 1997 to 2007

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Producers	110	45	85	157	36	39	42	30	39	42	42
Grower Groups (members)	-	-	-	-	4 (285)	8 (578)	11 (671)	16 (1,415)	26 (1,109)	11 (671)	11 (671)
Processors	-	4	3	3	7	3	3	3	9	9	10
Wild Product	-	-	-	-	2	2	2	2	2	2	2
Input	-	-	-	-	-	-	-	5	6	6	5
Total	110	49	88	160	49	52	58	56	77	75	62

Source: ACT Office, 2008

Table 2. ACT Certified Operators as of June 2009

	No of Operators	Organic Areas in hectares (Rai)	Conversion Areas in hectares (Rai)	Total Areas in hectares (Rai)
Producers	29	619 (3,866)	113 (707)	732 (4,572)
Grower Groups (members)	19 (1,308)	3,349 (20,928)	1,126 (7,038)	4,475 (27,965)
Processors	13	-	-	3
Input	4	-	-	-
Total	65	3,968 (24,794)	1,239 (7,745)	5,207 (32,537)

Source: ACT Office, 2009

Production and producers

Thai organic agriculture is still at an infant stage although there is some sign that the movement may be on the take-off stage. The development so far is largely in the hand of farmers and private sector while government supports are lacking behind. Its development has capitalized on the economy's strengths by focusing on organic rice and vegetable production. The majority of organic producers are family farms organized under grower group programme or organic projects.

The predominant organic agriculture in Thailand is crops, especially rice, vegetables and fruits. A couple of wild products like honey and herb tea operators exist. There is one organic shrimp production certified. No organic livestock production exists yet.

There are several producer groups that presently produce organic rice, majority of which are the jasmine rice. Two producers are in Chiang Rai, one in Surin, three in Yasothorn and another in Khon Kaen. This organic rice is sold by 2 main traders, namely the Capital Rice Co. Ltd., and Green Net Cooperative. Most of the rice is exported (mainly to European markets) and only small quantity is sold locally.

Vegetable production is the second most important organic crops. They are fresh vegetables and baby corn. Majority of fresh vegetables is sold in Thailand while baby corns are mostly exported.

An estimate of 13,900 hectares of farmland is presently now under organic management. This represented around 0.1 % of the total farmlands as shown in Table 3.

Table 3. Organic crop production areas year 2004

Crop	Land area (ha)
Rice	8,350
Field crops	1,258
Vegetables and herbs	2,125
Fruits	2,044
Others	123
TOTAL	13,900

Source: Green Net / Earth Net Foundation 2005

Thai organic producers are largely family farms with average land holding less than 5 hectares. Majority of these farms are organized as grower group. There is a couple of plantation farm operated by private company.

Movement

Because Thai organic agriculture is still at early stage there are only a few key actors involved in Thai organic movement. There are however numbers of producer groups and traders that claim to produce or handle organic products but there is no independent body to verify its claim.

Table 4. Key actors and their role in organic agriculture development in Thailand

	Key Actors	Roles
Producers& producer organization	Either individual farm or organized as producer groups, e.g. -Nature Care Society, Yasothorn -Mae Ta Sustainable Agriculture Cooperative -Plook Rak Farm (Love Cultivating Farm) -Rangsit Farm	Crop producers
NGOs	Various non-government organizations under the Alternative Agriculture Network (AAN), key players include: -Sustainable Agriculture Foundation Thailand -Sustainable Agriculture Pilot Project -Earth Net Foundation -Surin Farmer Support	Providing support services for organic conversion and internal control system
Certification body	Organic Agriculture Certification Thailand (ACT)- the first and the only Thai certification body	Thai certification body providing organic certification services
	Foreign certification bodies: -Bioagricert (Italian) -Soil Association (UK) -BCS (Germany) , etc.	Foreign certification bodies certifying organic farms in Thailand
Trader	-Capital Rice Co. Ltd. -River Kwae International Food Industry Co Ltd. -Green Net Cooperative -Swift Co Ltd.	Almost all certified organic products are exported, only few products are sold domestically.
Government	National Bureau of Agricultural Commodity and Food Standards (ACFS)	Implementing and enforcing national agricultural and food standards as well as accreditation
	Department of Agriculture (DOA)	Established "The Organic Crop Institute" and approved the logo of organic produce “Organic Thailand”
	Department of Agricultural Extension (DOAE)	Support organic farming activities

Policies

The 8th National Economic and Social Development Plan (1997-2001) is the first institutional framework at national level that clearly describes about sustainable agriculture, including organic farming.

The 8th plan also sets an ambitious target of converting 20% of arable land to sustainable agriculture. The incorporation of sustainable agriculture in the 8th Plan was part of the result of policy advocacy by NGOs and farmer movements.

Despite the favorable policy environment, Thai Ministry of Agriculture and Cooperative failed to translate the Plan into any concrete activity. It was not until the Assembly of the Poor held a massive rally and forces the government to finance the Sustainable Agriculture Pilot Project with over 30,000 farming families involved.

The main concrete efforts of government agencies have been to develop organic standards and certification programme. The Department of Agriculture and the Thailand Institute of Scientific and Technological Research had developed organic crop standards since 2001 and National Bureau of Agricultural Commodity and Food Standards (ACFS) have developed a national organic agriculture criterion in 2002.

Only the Department of Export Promotion had put up a trade promotion projects known as "Pilot Project on the Export of Organic Farm Products". The Project was initiated in 1999 with the main objective of promoting organic production and export of rice, banana, pineapple, asparagus and baby corn. The Project has a total budget of 10 million baht and aims to develop practical experiences in organic farming and to establish an inspection and certification system. The DEP financed the DOA and Thailand Institute of Scientific and Technological Research to develop the National Organic Standard Guideline for Crop Production. It also finances private companies to put up organic food exhibition in Thailand as well as overseas.

Besides the initiatives mentioned above, there is a couple of organic agriculture projects initiated by local government agencies. All of these initiatives are supporting composting, no-straw burning and usage of organic fertilizers (instead of chemical fertilizers) but none of them have gone as far as applying for organic certification.

No pricing policy is available for organic farming.

Challenges

ACT is committed to support organic agriculture, a farming system in harmony of ecology without the use of synthetic chemicals and artificial fertilizers. This they achieve by enhancing consumer confidence through the development of standards and the provision of inspection and certification services.

The goals of ACT were set as follow: to build producer and consumer confidence, both in Thailand and foreign countries, in the ACT organic inspection and certification system which is equivalent to international standards; to raise awareness among consumers, producers, handlers/processors and traders as to the environment impact of their actions; to introduce organic production methods to farmers in the developing countries through international standards and certification services and to increase access to world organic markets.

Therefore, ACT would like to strengthen its capacity to support more small farmers who are interested to apply for organic standards, to build up producers and consumers' confidence in ACT inspection and certification system, as well as to raise awareness of positive impact to the environment.

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Developing organic brand through building trust and quality-sharing Zenxin experience

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Abstract

As the organic food market is the fastest growing segment in the food industry, many farmers and wholesalers have started searching for ways to market and brand their organic products. This presentation will share Zenxin Agri-Organic Food's experience in developing Zenxin brand's organic fresh produce in Malaysia and Singapore region, through the building of trust amongst consumers as well as offering quality organic fresh produce through its certified organic operations. Zenxin Organic's experience will be categorised in three aspects: Firstly, focusing on building a brand of organic produce through self-operating organic shops, supermarkets and dealers as well as organic farm opening for public visits, building trust through Zenxin's tasty products, hygiene standards, and presentable packaging, and lastly, challenges in managing the whole organic supply chain.

Keywords: Organic food market, brand of organic produce, organic supply chain

Introduction

The purpose of the study is to give an overview about developing the ZENXIN brand of organic fresh produce in Malaysia and Singapore region, based on the experience of Zenxin Agri-Organic Food.

Presently, most of the recognized brands in the organic fresh produce market are foreign brands, namely Earthbound, Taylor's, etc. Organic consumers tend to perceive the organic produce certified by USDA or EU Organic as more trustworthy. A locally-renowned brand of organic fresh produce in the region has yet to be established.

Current Climate of the Organic Food Industry in Malaysia and Singapore

Market structure

The organic food industry has always been acknowledged as the fastest growing segment of the food industry in Malaysia and Singapore, which shares the similar climate as the rest of the world. However, in our point of view, the organic food market is still considered a niche market, because the sales contribution of organic fresh produce stands below 5% of the overall fresh produce sales in

Malaysia and Singapore, based on our experience. In Malaysia, a majority of the organic customers are Chinese, Mandarin educated, Chinese, English educated (Gan, 2007), and some foreign expatriates. Likewise, Singapore has similar consumers' profiles as Malaysia. The main advocates of organic food are adults (age from early 30s), from medium to high disposable income groups.

The key consumers who opt for organic food are mothers with newborn babies, cancer patients, health-conscious individuals and environmentalists. This group of customers forms the early adopters of organic food who buy organic food regularly (once a week), and they tend to give good recommendations to friends and family about organic food, as well as portray a good image of organic food to the media. Organic consumers usually obtain organic fresh produce from supermarkets, organic shops, health food chain stores, vegetarian stores and minimarkets. The regulars usually purchase basketfuls of organic fresh produce and they also penetrate the organic counters or organic shops at least once a week.

Zenxin has seen a steady growth on the consumption of organic food and an increased customer's base in recent years. A study by NTUC Fair Price Singapore (the largest supermarket chain in Singapore) (Chin, 2008) showed that although 4 in 10 customers are buying organic food in supermarkets, only 12 percent of them are regular buyers. This study echoed our view that organic food is still a niche market in the region.

Influential factors which contribute to organic consumers' purchase decision

Zenxin believes that the most influential factor in the consumers' purchase decisions is pricing. Prices of organic produce are still about 100% higher than conventional fresh produce, because conventional fresh produce are produced relatively cheaply as opposed to organic produce from other regions around the world. Hence, it is believed that the prices of organic fresh produce will stay relatively high at this level for a certain period. Zenxin believes that for the society to adopt the habit of organic food consumption, pricing will continue to play an important role.

In addition to pricing, trust is another crucial factor in promoting the sales of organic fresh produce. In view of organic fresh produce being promoted by the media as superior in terms of nutrition, pesticide levels and are beneficial to the environment, many self-claimed organic food producers started mushrooming in organic shops and wet markets. Retail personnel find that the term "organic" and "natural" are the best sales pitches to sell their products and start obtaining fresh produce from self-claimed organic farmers. Hence, this chain of events influences normal farmers to start turning to organic farming ways and claim their produce as organic.

On the other hand, a similar situation happens in another major retail channel – the supermarkets. To stay on par with the supermarkets that carry organic produce, other supermarket buyers start looking for organic produce without much knowledge about the requirements of organic farms, organic handling and organic certification. This situation remains for a long period of time and we have seen the gradual change when they collect more knowledge about organic food from other buyers who have experience in dealing with organic fresh produce suppliers. We believe that supermarkets will begin to set quality assurance requirements to suppliers who will like to distribute organic products in their supermarket outlets

This confusing situation has resulted in the loss of confidence among consumers towards local organic produce which cause them to prefer imported organic produce, which are deemed more trustworthy. The situation is made worse by the usage of misleading labels such as “compost grown”, “natural”, “using Japanese microbiology techniques”, “company function: supply and import organic produce”, local authority logos and certificates of attending organic courses – which are some gimmicks used to mislead consumers. This has further worsened the trust among consumers towards local organic produce.

Besides pricing and trust issues, food scares such as the poisoned China dumplings, bird flu, pesticides concern, environmental concerns and health considerations, are also the influential factors to the sales of organic food in the region of Malaysia and Singapore.

Building an organic food company

Zenxin Agri-Organic Food Sdn Bhd was established in 2001, is one of the largest organic vegetables and fruits producers in the region of Malaysia and Singapore with sales channels comprising of 7 retail shops, 1 recreation park, more than 100 supermarkets and more than 100 dealers. Since the establishment of the company, Zenxin has always focused on producing organic fresh produce consistently. Since it was established, Zenxin Organic always remains true to its mission – to strive to bring the best quality of organic fresh produce to consumers in the most trustworthy manner.

In 2001, Zenxin started producing organic fertilizers, and growing organic produce in northern Malaysia, which is 700km away from its headquarters. The process was tough because there was a huge distance between the farm and the retail store in Johor and the initial investment was enormous. Moreover, there were a small number of people who appreciated the value of organic produce. When the produce was in good harvest, the company had a hard time selling off excess organic produce which grew in the farm through its limited retail channels. The excess produce was always discarded. Conversely, the farm had not enough supply during the rainy seasons to support the retail stores sales, which specialize only in selling organic fresh produce. Supply volatility was a big threat to the company’s performance.

In 2004, the company ventured into more organic farmlands which are closer to its headquarters in Johor even though it was bearing a huge loss. It had strengthened the company supply capability with less supply volatility and more variety of organic fruits and vegetables. Zenxin opened accounts with supermarkets such as Jusco and Giant in Malaysia and started to distribute Zenxin brand organic fresh produce through this sales channel, which made the products publicly recognized. Although the company sees a strong growth in supermarkets business, the company was not able to obtain enough profits from the big retail channel due to high margins given to supermarkets. Low awareness among the public towards organic produce in the region also made it harder for the company to market organic produce at higher prices. Conversely, the situation encouraged us to grow more organic vegetables and fruits to supply more supermarkets’ outlets in order to lower the fixed operating costs of the company. This decision had awarded Zenxin an advantage of being a one-stop supplier with the best selections of organic fresh produce in the economy.

In 2006, the founder of Zenxin realized that the awareness and trust levels were still low towards organic products and decided to open its largest organic farm in Kluang, Johor, Malaysia as a recreation park to showcase to the public on the methods of organic farming. The park admission and the guided tour are free of charge to the public in order to educate people about the benefits of organic food. The park drew thousands of visitors from both Malaysia and Singapore every month and boosted the confidence amongst consumers towards Zenxin Organic's organic produce. During the same year, Zenxin also embarked on the certification route by inviting NASAA, Australia, to certify the farms of Zenxin. The company felt that organic certification would not only bring more marketing advantages into the organization, but at the same time, gains a third party to monitor the operations and ensure the company is following the stringent guidelines to meet international organic standards.

In 2009, the company had its broad sales network covering the whole peninsular Malaysia and Singapore. The whole operation of the company, from the compost-making facilities, organic farms, to organic packing houses had gone through the organic conversion period and was certified fully organic by NASAA. The profile of being one of the top selling brands of vegetables and fruits in the regional supermarkets has shot Zenxin's popularity to another level, which attracted the attention of many suppliers and buyers around the world.

Building trust and building a brand-marketing experience

Since its establishment, improving the quality of vegetables in terms of appearance, cleanliness, good taste and good shelf life has always been the top priority of the company. Zenxin believes that organic vegetables should be more presentable and to appear healthy as opposed to many farmers who still claimed that organic vegetables and fruits are supposed to look naturally unattractive and filled with holes. Zenxin realized when normal consumers pay higher prices for organic vegetables; they prefer quality-looking vegetables and tend to judge the vegetables by their appearance at first sight. Zenxin reacted by adapting itself to the conventional mindset but continue to educate consumers about how organic produce was grown. Consistent quality is the key to maintain and improve the sales of Zenxin brand's organic produce.

Zenxin always inculcates the idea of treating the organic market as a niche market to all levels of its employees – from the top management to the supermarket promoters. Everybody in the company must try its best to keep every single customer satisfied with Zenxin brand's organic produce. The company cannot afford to disappoint its customers because the circle of organic food consumers is small and word spread quickly in this niche market. The strategy worked well in maintaining the service standards and keeping regular customers who penetrate the retail stores or supermarkets' counters at least once a week.

The company believed that Zenxin brand's organic produce is a kind of psychologically high-involvement products, which always draw the attention of organic consumers, who study labels and understand the organic food companies carefully before purchasing. In fulfilling the need for more information about organic produce, Zenxin started a marketing program in 2006 with the slogan: "Your Reliable Organically Grown Produce". The company started displaying more informative signboards, shelf talkers and brochures on the counters displaying Zenxin brand's organic vegetables. The message on the display media is always about Zenxin Organic Farm, Zenxin's vegetables, the importance of organic certification and more. The display media recite the same message in line with promoting trust towards Zenxin brand's organic vegetables.

On the other hand, the company also emphasized research on labeling and packaging. Clear, informative, story-telling label and presentable packaging are all important to the brand's image and also product sales. Moreover, better labeling will also make the products stand out from other self-claimed organic produce which do not indicate organic certifications, story about its farms, original source of the produce or even lacking company name and address.

The most important milestone in the whole marketing campaign is opening Zenxin's largest organic farm – Zenxin Organic Park - as a recreation park to the public. Zenxin Organic Park is the first open-to-public organic farm in Malaysia, combining educational and recreational purposes. The visitors can choose to explore the farm on their own, or take guided park tours with the in-house tour guides. They can witness the way organic farmers in Zenxin grow vegetables organically, which builds ultimate trust about Zenxin brand's organic vegetables.

Conclusions

Zenxin believes that organic food will continue to be the fastest growing segment of the food industry and the competition within the industry will remain intense in the next decade. As long as the prices stay high, more local farmers will look into growing organic produce, and more fruit and vegetable wholesalers will pay to develop organic brands. There will be more local and foreign brands of organic produce appearing in the market, which will force the prices of organic produce to be competitive and relatively cheaper.

Based on Zenxin's experience, building the brand name and upholding the quality of products are the success factors for an organic food company. Having a recognized brand allows consumers to identify the company easily as well as develop a preference for the mentioned brand. Also, organic certification will become a passport for organic companies to access the international market and also to ensure trust amongst consumers.

Keeping the regular customers has always been Zenxin's priority. The company will continue its promotion efforts in keeping the regular customers satisfied. To persuade further goal, the company starts looking into non-traditional markets such as the Malay and Indian market in the region of Singapore and Malaysia.

In terms of operations, Zenxin will continue to invest in building traceability and transparency of its operations to ensure customers obtain genuine organic produce and facilitate future certification process. Zenxin will continue to research and learn from successful organic companies such as Wholefoods Market and Earthbound, as well as great example such as Japanese Gourmet Fruits and Vegetables, so that the company can continue to grow and become an established brand in Asia.

Lastly, for Zenxin, promoting an organic lifestyle is not merely about consuming organic food. It is a way of life which in line with promoting a better well-being of individual, enjoyment of life's simple pleasures by consuming fresh, unadulterated, and naturally grown food.

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