UNAPCAEM Policy Brief

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

Issue No. 2, May – August 2012

Organic agriculture gains ground on mitigating climate change and improving food security: healthy food from healthy soil

While safe food may be the primary driver behind organic food, its production can be pro-poor and protects and sustains precious natural resources

Organic agriculture has a healthy and boutique image with organic foods costlier than conventionally produced foods. However, organic food and its production can make a clear contribution to food security, better public health and rural livelihoods, improved occupational safety and health, preserving natural resources, reversing environmental degradation and aiding in climate change mitigation. It is a full plate for a rapidly growing sector of the food industry yet a tiny enterprise as most countries devote less than 1 per cent of their cropland to organic farming1. China, as an example and based on 2005 statistics, had about 978,000 hectares of land dedicated to certified organic production or under certification, an amount second only to that in the United States2.

The United Nations Food and Agriculture Organization (FAO) defines organic agriculture as a holistic production management system that avoids use of synthetic (in-organic or chemical) 3 fertilizers 4 , pesticides and genetically modified organisms, minimizes pollution of air, soil and water, and optimizes the health and productivity of interdependent communities of plants, animals and people. The term "agriculture" is used in its wider sense to include crop/livestock systems, organic aquaculture and organic harvesting of non-timber forest products. Agricultural "products" include food, fibre and medicinal and cosmetic raw materials5. Organic agriculture includes the entire food supply chain, from production and handling, through quality control and certification, to marketing and trade. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.

The FAO definition notes that in the market place, the "organic" claim requires certification, and related products are distinguished by an organic label. Organic labels are obtained through third party certification and grower group guarantee systems, both of which provide valid verification of compliance with organic standards. Given the aforementioned detailed definition of organic agriculture, its rise in the public conscientious is not without debate.

For countries looking to address the critical issues listed above, adding organic agriculture to their basket of policy options can be a key step in advancing pro-poor, sustainable agriculture, such as allowing farmers with small land holdings to develop niche markets. Organic agriculture must also be part of the mix as food has rapidly risen up the global agenda, not only because of the 2008-2009 food crisis, but also in greater calls for safer food. Today much of what we eat is produced by a current industrial agricultural system that has maximized yields but threatens human health and degrades both land and sea.

[1] TIME 1/19/2010 -Getting Real About the High Price of Cheap Food

[2] Worldwatch Institute (2007), China's Organic Food Disappoints Consumers

[3] Inorganic fertilizer is often synthesized using the Haber-Bosch process, which produces ammonia as the end product. This ammonia is used as a feedstock for other nitrogen fertilizers, such as anhydrous ammonium nitrate and urea. These concentrated products may be diluted with water to form a concentrated liquid fertilizer. It is the Haber-Bosch process in which the term *fossil-fuel based fertilizer* comes from as coal (particularly in China) and natural gas are used in the process. – Both are finite energy sources.

[4] Organic fertilizers are made from materials derived from living things. Animal manures, compost, bonemeal and blood meal are organic fertilizers. Chemical fertilizers are manufactured from nonliving materials.

[5] FAO (2007), International Conference on Organic Agriculture and Food Security, 3-5 May 2007 FAO Italy: ftp://ftp.fao.org/paia/organicag/ofs/OFS-2007-5.pdf

Detailing Organic Agriculture

Organic agriculture, as a part of sustainable agriculture in developing countries, offers a unique combination of low external input technology, environmental conservation and input/output efficiency. Organic agriculture is often viewed in the context of sustainable agriculture as it pursues a similar agro-ecological 6 approach but with the guarantee system of organic standards and certification systems not found within the broader sustainable agriculture approach.

The International Federation of Organic Agriculture Movements (IFOAM) provides four ethical principles of organic agriculture (below)7. IFOAM offers a widely-recognized international certification template that can be found in the Asia and Pacific region, with many countries seeking/having IFOAM accreditation for their organic development centers.

According to IFOAM, organic agriculture should:

(1: Principle of Health) sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible, pointing out that the health of individuals and communities cannot be separated from the health of ecosystems, healthy soils produce healthy crops that foster the health of animals and people. The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. It should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

(2: Principle of ecology) should be based on living ecological systems and cycles, work with them, emulate them and help sustain them and states that production is to be based on ecological processes and recycling. Organic management must be adapted to local conditions, ecology, culture and scale. Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources.

(3: Principle of fairness) should build on relationships that ensure fairness with regard to the common environment and life opportunities, characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty.

(4: Principle of care) should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment. Organic agriculture is a living and dynamic system that responds to internal and external demands and conditions. Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being. Consequently, new technologies need to be assessed and existing methods reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken.

The above principles make up the foundation in which IFOAM certification is based and offer a glance of how adopting organic agriculture can benefit farmers, consumers and protect our dwindling natural resources. These principles feed into growing general public concerns over food quality and safety.

Yet principles aside, the costs of organic food also are a determining factor, particularly for budget minded consumers. Organic food is not cheap and there is debate as to whether it is any healthier than conventionally produced foods. This debate has gotten the attention of the pesticide and fertilizer industries that feel it is being unfairly demonized and counter that their products improve public health by mitigating our exposure to any number of health risks associated with pests. Also, the pesticide and fertilizer industries bring attention to concerns that organic agriculture is not capable of meeting the world's growing food needs due to low productivity per area.

[6] Agroecological restoration: Agroecological restoration is the practice of re-integrating natural systems into agriculture in order to maximize sustainability, ecosystem services, and biodiversity. This is one example of a way to apply the principles of agroecology to an agricultural system. http://en.wikipedia.org/wiki/Agroecological_restoration

[7] Complete text on IFOAM's four principles can be found at: IFOAM: The Principles of Organic Agriculture - http://www.ifoam.org/about_ifoam/principles/index.html

Adding to this debate, international institutions such as the FAO promote both organic agriculture on the one hand and Integrated Pest Management (IPM), which the pesticide industry backs, on the other. This brief presents all sides of the debate, sharing the realities of our current food system, and offers that organic agriculture can be a step in the transition to more sustainable agricultural practices and sustainable agricultural livelihoods. With more detailed information about organic agriculture, Asian and Pacific countries can then tailor organic agriculture policy to best address the varying local conditions found in the region.

The Organic Food Debate

Public perception is that organic food is safer and healthier. Yet, the UK's Food Standards Agency8 (FSA) made global headlines9 in the summer of 2009 announcing that organic food 'has no health benefits', with organic food no healthier than ordinary food. Experts pointed out that the overall, sweeping notion of organics' healthiness has overshadowed the reality that these foods still retain their other dietary and nutritional facts, and conclude that it is definitely a false notion that organic is healthier from a nutrient standpoint as organic and conventional foods contain the same amount of calories, nutrients, fats and sugars.

While public perception indicates that organic food is healthier for our bodies, the FSA research says not so. However, the research only focuses on nutrition and not safety concerns related to chemically tainted food. For its part the FSA research was conducted to address public concerns on the high cost of organic food – if conventional produced foods have the same nutritional value as organic foods – why pay more? The vast majority of global citizens don't, thus lending to organic foods having a boutique image.

The basic premise behind organic food and its production is that it is not treated with an intense array of fossil-fuel and chemical-based fertilizers, pesticides and herbicides, and in the case of pork, chicken and beef, animals are not injected with antibiotics and or growth hormones to fatten them. Organic foods are all natural and are maintained using natural fertilizers such as manure. Producing food without any of the above is costly due that we are still entrenched in an agricultural system that has yet to break away from the first green revolution that greatly increased yields and delivered food security to many countries but at an human health and additionally environmental price that we have only begun to assess.

To emphasize organic food's increasingly visible public image, the 2010 Winter Olympics was the first-ever Games to feature a distinctly organic flavor with the announcement that the Vancouver Organizing Committee for the 2010 Olympic and Paralympic Winter Games (VANOC) welcomed Hain Celestial Canada as the Official Supplier of natural and organic packaged grocery products for the 2010 Winter Games10. If there are no nutritional benefits to eating organic food, then why were athletes getting it on their plates? For the VANOC, the reason was to showcase healthy, sustainable living at the Vancouver 2010 Olympic and Paralympic Winter Games through natural and organic products that minimize environmental impact. Also, at the 2008 Beijing Olympics, one finds that the Chinese government took great strides to provide food for athletes and visitors to the Olympic grounds that was organic and used fewer chemicals to address concerns having to do with food safety and quality.

Organic food's global public perception masks the fact that the vast majority of us are conventionally produced food consumers, with our food grown with fossil-fuel based fertilizers and doused with pesticides. These chemical inputs have brought food security to many countries, and it is argued that they must continue to be part of the agricultural picture as our planet continues to add more and more mouths to feed.

The role of fertilizers and pesticides and their overuse

The use of chemicals is for defense against insects, as well as for fungi, weed control, and other pests such as rodents. Their place in the food industry primarily centers around their role in farming to encourage larger crops production and enhance visual appearance for our consumption. The fertilizer

[8] Food Standards Agency: http://www.food.gov.uk/
[9] BBC July 2009 Organic 'has no health benefits':

[10] Vancouver 2010 Official Olympics Site: Natural and organic foods fuel the taste for the Vancouver 2010 Olympic and Paralympic Winter Games. http://www.vancouver2010.com/olympic-news/n/news/natural-and-organic-foods-fuel-the-taste-for-the-vancouver-2010-olympic-and-paralympic-winter-games_53216hQ.html

and pesticide industries are large. The industry view is that fertilizers and pesticides are safe, with fertilizers increasing yields and pesticides reducing the risks of disease carried by any number of insects and other pests.

Responsible Industry for a Sound Environment (RISE) says that "pesticides allow us to continue to win major victories—victories that provide improved health for adults and children, assure safeguards against disease, promise more comfortable living and yield the most bountiful food supply man has ever known". RISE offers that pesticides can control and eliminate mosquitoes that carry such diseases as Dengue fever and West Nile virus and have been proven effective with minimal risks to humans, animals or the environment11.

RISE also notes that it is indiscriminate use of chemical inputs that harm humans and the environment. The FAO finds that such indiscriminate use of chemical inputs places agricultural production at risk. In particular, the overuse of pesticides is known to eliminate important ecosystem services resulting in secondary pest outbreaks, which could potentially jeopardize national and regional food security12. Intensive use of extremely and highly hazardous chemicals by small-holder farmers also continues to cause high incidence of farmer poisoning, covered ahead in this brief.

To counter excessive use of pesticides and other chemical inputs, the pesticide industry has aligned itself as part of the Integrated Pest Management (IPM) approach. FAO states that IPM is an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimize the use of pesticides. FAO promotes IPM as the preferred approach to crop protection and regards it as a pillar of both sustainable intensification of crop production and pesticide risk reduction13. IPM means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.

Those opposed to pesticides note that pests build-up an immunity to pesticides over time and it then requires a new more powerful pesticide to keep them in check. Much like pesticides, the over-use of antibiotics to reduce infections has followed a similar path as over use of such medicines has created more antibiotic resistant viruses. Also, it should be noted that pesticide use kills both pests and beneficial insects such as honey bees and lady bugs and harms other animals such as birds and bats that feed on insects. Nature was doing what pesticides have been promoted to do before their use came into being.

Pesticides, Food and Public Health

RISE acknowledges "minimal risks" to public health related to sustainable pesticide use as stated earlier. For example, the US National Organic Standards Board (NOSB) finds that root vegetables absorb herbicides, pesticides and fungicides that wind up in soil14. Potatoes are treated with fungicides during the growing season and then sprayed with herbicides to kill off the fibrous vines before harvesting. After harvested from the ground, the potatoes are treated yet again to prevent them from sprouting. Also, some potato growers have noted they would never eat the potatoes they sell, and that they have separate plots where they grow potatoes for themselves without all the chemicals15.

How about fruit? "An apple a day can keep the doctor away?". According to the Cornucopia Institute, apples may get bombarded with the most pesticides of any fruit that reaches the market. Apples are individually grafted (descended from a single tree) so that each variety maintains its distinctive flavor. As such, apples do not develop resistance to pests and are sprayed frequently. While the conventional apple industry maintains that these residues are not harmful, one should consider minimizing their exposure by avoiding the most

[11] RISE –Why Pesticides: http://www.pestfacts.org/content/why_pesticides.pdf
[12] FAO Regional Vegetable IPM Programme in South & Southeast Asia: http://www.vegetableipmasia.org/
[13] FAO, AGP - Integrated Pest Management, http://www.fao.org/agriculture/crops/core-themes/theme/pests/ipm/en/
[14] The Seven Foods Experts Won't Eat –Healthy Living on Shine: http://shine.yahoo.com/channel/health/the-7-foods-experts-wont-eat-547963/
[15] Ibid

doused produce, like apples, as farm workers have higher rates of many cancers16."

Farmed fish, such as salmon, have been identified as a health hazard. According to the Institute for Health and the Environment at the University of Albany, New York, nature didn't intend for salmon to be crammed into pens and fed soy, poultry litter and hydrolyzed chicken feathers. As a result, farmed salmon is lower in vitamin D and higher in contaminants, including carcinogens, PCBs 17 , brominated flame retardants and pesticides such as dioxin and DDT18. Such farmed salmon can only safely be eaten once every 5 months without increasing one's risk of cancer19.

The above examples are foods that are found at markets where persistent organic pollutants (POPs)20 have been banned and/or being phased out. The chemicals that are used above for potatoes and apples are the ones deemed safe by their respective farming industry. For farmed salmon, PCB's21 and DDT22 have long been banned in many countries but can remain intact in the environment for long periods given their long-range transport. In short, reducing the risks linked to pesticide use will be a long-term battle. Regionally, China banned DDT as of 2009. However, its long-term elimination has only begun. In Guangzhou, provincial authorities released a report that states that food safety risks are a public health concern with vegetables and tea being highly risky in terms of pesticide residue23. The report also noted that many banned pesticides are still in circulation, with farmers tempted to buy them, as they are much cheaper than legal pesticides.

Pesticides and fertilizer use: farmer safety and health

Finding chemicals in our food is one thing, exposure of those who apply them is another. Farmers are in harm's way as many countries subsidize in-organic fertilizer and pesticide use, thus contributing to farmers' poor health by making these products more affordable. In countries with limited oversight, the situation is much more severe, based on an FAO (2000) report24. In Cambodia for example, one can find in use highly hazardous products banned elsewhere in Asia. As classified by World Health Organization (WHO), 43 per cent of farmers in the country were using Ia (extremely hazardous) products and another 9 per cent Ib (highly hazardous). In total, 84 per cent used products from moderate to extremely hazardous to human health (Ia, Ib, II). Farmers were exposed to multiple doses on multiple occasions. Crops were sprayed up to 20 times per season with up to 5 different pesticides mixed together per tank per spray operation. Few used protective equipment resulting in likely heavy skin contamination to the hands (during mixing of the chemical concentrate) and legs and feet (during spraying). There was evidence that significant poisoning is occurring as 35 per cent reported vomiting - a sign reflecting moderate poisoning during or after spraying, with another 1 and 5 per

[16] Associated Press (2002), Hispanic farmworkers more likely to have cancer
March 18, 2002, http://ipm.osu.edu/trans/032_183.htm
[17] Polychlorinated Biphenyls are a class of synthetic organic chemicals.
[18] Dichloro-diphenyl-trichloroethane (DDT) continues to be the most produced and used persistent organic pollutant pesticide listed in the Stockholm Convention. The Conference of the Parties (COP) continues to allow the use of DDT for use in public health for disease vector control as recommended by and under the guidance of the World Health Organization (WHO).
[19] University of Albany (2004), 2004 The fish contamination study got broad media attention, with preliminary science also linking DDT to diabetes and obesity. There is also concern about the high level of antibiotics and pesticides used to treat these fish. When you eat farmed salmon, you get dosed with the same drugs and chemicals.
[20] The Stockholm Convention on Persistent Organic Pollutants is a global treaty to protect human health and the environment from chemicals that remain intact in the environment for long periods, become widely distributed geographically and accumulate in the fatty tissue of humans and wildlife. Exposure to Persistent Organic Pollutants (POPs) can lead serious health effects including certain cancers, birth defects, dysfunctional immune and reproductive systems, greater susceptibility to disease and even diminished intelligence. Given their long range transport, no one governing acting alone can protect is citizens or its environment from POPs. In response, the Stockholm Convention, which was adopted in 2001 and entered into force 2004, requires Parties to take measures to eliminate or reduce the release of POPs into the environment.
[21] PCB Overview:
http://chm.pops.int/Programmes/PCBs/Overview/tabid/273/language/en-US/Default.aspx
[22] DDT Overview:
http://chm.pops.int/Programmes/DDT/Overview/tabid/378/language/en-US/Default.aspx
[23] China Daily, 2-11-2010, Vegetable Tests Show Pesticides:
http://www.chinadaily.com.cn/china/2010-02/11/content_9459648.htm
[24] FAO (2000) Situation Analysis Farmers' Awareness and Perceptions Of the Effect of Pesticides
On Their Health, Prepared by Pan Sodav,, Mam Sitha,, Robert Nugent,, Helen Murphy, FAO COMMUNITY IPM PROGRAMME Field document April 2000,
http://www.toxictrail.org/Documents/Cambodia-SituationAnalysis.pdf

cent reported a serious episode (seizure and loss of consciousness, respectively)25.

Farmer occupational safety and health is no small matter, The FAO and International Labor Organization's (ILO) joint programme on Food, Agriculture and Decent Work finds that agriculture is one of the three most dangerous sectors in which to work, along with construction and mining. Out of 335,000 fatal workplace accidents that occur worldwide each year, some 170,000 of these involve agricultural workers 26 . Although technological change has reduced the physical hardship of agricultural work in some cases, it has also brought new risks related to the operation of sophisticated machinery and the intensive use of chemicals, often without appropriate safety and health measures, information and training.

Exposure to pesticides and other agrochemicals, as pesticide sales and use continue to climb over the years, constitutes one of the main occupational risks, with poisoning leading to illness or death. Other hazards are inherent in animal handling and contact with dangerous plants and biological agents and give rise to allergies, respiratory disorders, zoonotic infections and parasitic diseases. Exposure to agrichemicals poses an increasing health risk in agricultural work. In developing countries, workers and farmers face greater risks due to the use of toxic chemicals, which are banned or restricted in other countries. As the Cambodia example illustrates, farmers often do not have access to information on the risks associated to the use of chemicals and on the necessary precautions and correct dosage. FAO/ILO find that the total number of pesticide poisonings has been estimated between 2 and 5 million per year, of which 40,000 are fatal27.

Fertilizers, Pesticides and the Environment

In agro-ecosystems, mineral nitrogen in soils is the driver of crop productivity in many cases. Crop productivity has increased substantially through utilization of heavy inputs of soluble fertilizers, mainly nitrogen and synthetic pesticides. However, only 17 per cent of the 100 Mt N produced in 2005 was taken up by crops 28 . The remainder was somehow lost to the environment. Between 1960 and 2000, the efficiency of nitrogen use for cereal production decreased from 80 to 30 percent29. In China, Remin University's School of Agricultural Economics and Rural Development in collaboration with Greenpeace China has found that the country, the world's largest grain producer and top consumer of fertilizers, should reduce its reliance by as much as 50 per cent because excessive use has resulted in serious pollution30. Chemical fertilizers have helped China feed its population despite limited farmland, but excessive application has led to low farmland efficiency and serious pollution, according to the research report.

The Remin University/Greenpeace report found that farmers, particularly in northern China, used 40 per cent more fertilizers than crops needed, resulting in about 10 million tonnes of fertilizer every year being discharged into water, polluting China's rivers and lakes and making their way to the sea. Runoff of fertilizers from all countries in North-East Asia has now been identified in playing a role in boosting the growth of the microscopic plankton that booming jellyfish populations feed upon in the increasingly polluted seas in the region. Agricultural fertilizer and sewage runoff are spurring this plankton growth, and fish catches are declining. Increases in jellyfish are a warning sign that our oceans are stressed and unhealthy, as jellyfish have been reducing fish catches by 30 per cent in Japan. Jellyfish invasions cost the Japan fishing industry up to 30 billion yen (USD332 million) a year, and tens of thousands of fishermen have sought government compensation in Japan31.

The Remin University Report also found that China produced 24 per cent of the world's total grain output, but its use of fertilizer accounted for about 35 per cent of total global consumption. China's grain production has increased more than eight-fold from the 1960s, while use of nitrogen fertilizers had surged by 55 times. The report urged the government to reduce subsidies to fertilizer makers and called for more support for farmers who use animal waste.

---

[25] Ibid

[26] Food, Agriculture & Decent Work, ILO & FAO working together –Safety and Health: http://www.fao-ilo.org/fao-ilo-safety/0/?no_cache=1

[27] 2012 UNAPCAEM is establishing a network for testing of agricultural machinery (ANTAM) in part to address safety issues linked to overuse of pesticides: http://www.unapcaem.org/news_detail.asp?id=416

[28] FAO 2009, Low Greenhouse Gas Agriculture: Mitigation and adaptation potential of sustainable farming systems, p. 3,.

[29] Ibid, p. 3,.

[30] REUTERS 14-1-2010, China needs to cut use of chemical fertilizers; http://www.reuters.com/article/idUSTRE60D20T20100114

[31] China Daily, Jellyfish invasion: Fishermen net trouble. Updated: 2009-11-17 09:13

Additionally, China's Ministry of Environmental Protection for the first time released the country's pollution census (February 10, 2010) calculating agriculture's significant contributions of fertilizer and pesticide effluent adding to the country's current pollution woes. Agricultural waste contributes to more than 30 million tonnes of pollution a year with the government estimating that the country's rivers and lakes can only handle about 7.4 million tonnes a year of chemical oxygen demand32. The numbers demonstrate that agricultural waste is likely a more intractable problem than the many factories dumping effluent in to the country's waters.

As illustrated in the previous sections, in-organic fertilizers and pesticides are part of our agricultural production and food supply. Possible exposure via ingesting chemically-tainted foods is a public health concern, improper use and long-term exposure to in-organic fertilizers and pesticides a certain and significant occupational safety and health hazard, and overuse of such chemical inputs in agricultural production an alarming threat to our precious natural resources. Such use has also demonstrated that while we may be able to grow more food, the toxic run-off of chemical inputs negatively affects other food sectors such as the fishing industry.

Is organic agriculture the solution?

Organic agriculture is an important step in the transition to a more sustainable agricultural system. As a rural development strategy, organic farms provide more than 30 per cent more jobs per hectare than non-organic farms and, thus, create employment opportunities33. Agriculture is considered one of the most important livelihood strategies in India, with two thirds of the country's workforce depending on farming. While incomes in urban areas have risen, farm incomes in real terms have declined in many parts of India during the past decade34. Most farmers are small and marginal farmers cultivating areas of less than two hectares. It is these farmers that could benefit most from adopting organic agriculture as it is small farmers who produce much of what they eat and who are often too poor to purchase inputs. Increasing land fragmentation, diminishing natural assets, high costs for external farm inputs, indebtedness, and pesticide-related health issues are threats that impact many farming communities.

Farmers who have adopted organic agriculture in the Indian study noted enhanced natural assets, e.g. improved soil structure, improved water holding capacity and increased abundance of beneficial organisms35. Enhanced natural assets were said to allow production with less amounts of external inputs. The Indian experience also found that organic farming was said to be more in harmony with cultural values and contributed to the preservation and continuous development of indigenous knowledge, an important element of cultural assets.

Organic food and food security

FAO (2007) highlights that a significant feature of organic agriculture is its reliance on locally available production assets and, thus, its relative independence from crude oil availability and increasing input prices36 as demonstrated by the Indian example above. Working with natural processes increases cost effectiveness and resilience of food production. By managing biodiversity in time (rotations) and space (mixed cropping), organic farmers use their labor (the most readily available capital they have) and environmental services (e.g. predation, pollination, soil nutrient cycling) to intensify production sustainability37. These low cost farming practices reduce cash needs and,credit dependence thus enhancing farmer food security. Also, without the use of costly inputs such as fossil-fuel based pesticides, organic crops develop a natural defense mechanism in the form of chemicals called phenols. Phenols are found in the natural world, especially in the plant kingdom. In some cases phenols are present in vegetative foliage to discourage herbivory, a form of predation in which an organism consumes principally autotrophs38 such as plants, algae and

[32] New York Times (9-2-2010), China Report Shows More Pollution in Waterways; http://www.nytimes.com/2010/02/10/world/asia/10pollute.html

[33] FAO 2007, International Conference on Organic Agriculture and Food Security, 3-5 May 2007 FAO Italy: ftp://ftp.fao.org/paia/organicag/ofs/OFS-2007-5.pdf. p.13

[34] 16th IFOAM Organic World Congress, Modena, Italy, June 16-20, 2008 Archived at http://orgprints.org/view/projects/conference.html Organic agriculture and rural livelihoods in Karnataka, India Lukas, M.1 & Cahn, M.2, p.1

[35] Ibid, p.1.

[36] FAO 2007 ORGANIC AGRICULTURE AND FOOD SECURITY, by Nadia El-Hage Scialabba, p. 6. ftp://ftp.fao.org/paia/organicag/ofs/OFS-2007-5.pdf

[37] Ibid, p. 6

[38] An autotroph is an organism that produces complex organic compounds from simple inorganic molecules using energy from light (by photosynthesis) or inorganic chemical reactions. Autotrophs are fundamental to the food chains of all ecosystems in the world. They take energy from the

photosynthesizing bacteria. Phenols are antioxidants that some consider make organic fruits and vegetables better at protecting the body from cancers and heart disease.

Concerning rural livelihoods, areas where small holders lack capital (e.g. one third of the poor in Asia), organic agriculture breaks the vicious circle of indebtedness (due to external agricultural input purchases) which causes an alarming number of farmer suicides[39]. In contrast, organic agriculture offers small subsistence farmers the opportunity to develop niche organic produce with higher price for organically-produced crops that can increase their income. As such, organic agriculture is seen as pro-poor, resisting becoming locked into dependency on chemical fertilizer, pesticide and seed companies. It can keep rural populations on farms, enhancing their livelihoods and offer more resilience as an informal social safety net.

On land degradation, the IPCC Fourth Assessment Report addressing food security notes that organic agriculture reduces erosion caused by wind and water as well as by overgrazing at a rate of 10 million hectares annually, a crucial precondition for future food security[40]. And IFOAM finds that organic agriculture contributes to food security by increasing yields in low-input areas, and conserving bio-diversity and nature resources on the farm and in the surrounding area[41].

Organic agriculture and greenhouse gas emissions

According to an FAO 2009 report on Low Greenhouse Gas Agriculture [42], the minimum scenario for a conversion to organic farming from conventional farming would mitigate 40 per cent of the world's agriculture greenhouse gas emissions. The FAO 2009 report finds that when combining organic farming with reduced tillage techniques found in conservation agriculture [43], the sequestration rates on arable land could be easily increased to 500 kg C ha-1 yr-1. This optimum organic scenario would mitigate 4 gigatonne (Gt) CO2-eq. yr-1, or 65 per cent of the agricultural greenhouse gas emissions. Long-term comparison field trials in temperate climate zones have shown no slowing of sequestration for more than 30 years[44]. FAO further states that with a conversion to organic farming, another approximately 20 per cent of agricultural greenhouse emissions could be reduced by abandoning industrially produced nitrogen (fossil-fuel based) fertilizers as is practiced by organic farms, thus indicating that farming could become climate neutral.

Additionally, in terms of energy use, inputs in organic agriculture replace fossil fuel elements (e.g. highly soluble fertilizers, pesticides, machines) with lower impact, often locally accessed inputs and management skills. Higher labor input decreases expenses on purchased inputs by some 40 per cent but labor costs increase by 10 to15 per cent. The main benefit of organic systems is energy efficiency in natural resource use, and reduced irrigation requirements[45].

Organic Certification

environment in the form of sunlight or inorganic chemicals and use it to create energy-rich molecules such as carbohydrates. http://en.wikipedia.org/wiki/Autotroph

[39] Ibid, p.9.

[40] FAO 2009, Low Greenhouse Gas Agriculture: Mitigation and Adaptation Potential of Sustainable Farming Systems,p.12

[41] IFOAM: Organic agriculture and food security, http://www.ifoam.org/press/positions/Organic_Agriculture_and_Food_Security.html

[42] FAO 2009, Low Greenhouse Gas Agriculture: Mitigation and adaptation potential of sustainable farming systems, p11,.

[43] Conservation Agriculture (CA) is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment" (FAO 2008) . The first key principle in CA is practicing minimum mechanical soil disturbance which is essential to maintaining minerals within the soil, stopping erosion, and preventing water loss from occurring within the soil. The second key principle in CA is much like the first principle in dealing with protecting the soil. The principle of managing the top soil to create a permanent organic soil cover can allow for growth of organisms within the soil structure. This growth will break down the mulch that is left on the soil surface. The breaking down of this mulch will produce a high organic matter level which will act as a fertilizer for the soil surface. The third and final principle that is exercised by the FAO is the practice of crop rotation with more than two crop species. This process will not allow pests such as insects and weeds to be set into a rotation with specific crops. Rotational crops will act as a natural insecticide and herbicide against specific crops. - FAO 2008., *Agriculture and Consumer Protection Department, Conservation Agriculture. What is Conservation Agriculture?* Viewed March 2010, http://www.fao.org/ag/ca/1a.html

[44] Ibid, Modelling of sequestration potentials of a conversion from conventional to organic agriculture in Scandinavia gives a time span of 50 to 100 years.

[45] FAO 2007 ORGANIC AGRICULTURE AND FOOD SECURITY, by Nadia El-Hage Scialabba, p.5. ftp://ftp.fao.org/paia/organicag/ofs/OFS-2007-5.pdf

Increasingly, certification requirements and regulations are pointed to as the major obstacle to a continuous and rapid development of the organic sector, especially for producers in developing countries. Lack of cooperation and "harmony" is a central problem and lack of confidence and lack of mutual recognition are still major problems for the organic sector46. The organic market is confronted with hundreds of private sector and government standards, a rapidly increasing number of national regulations, two international standards for organic agriculture (Codex and IFOAM) and a number of accreditation systems. The Codex Alimentarius Commission (Codex) was created in 1963 by FAO and the World Health Organisation (WHO) to develop food standards, guidelines and related texts such as codes of practice under the Joint FAO/WHO Food Standards Programme. The main purposes of this programme are protecting health of the consumers, ensuring fair trade practices in the food trade, and promoting coordination of all food standards work undertaken by international governmental and non-governmental organizations. The IFOAM Organic Guarantee System assures organic integrity internationally. In the rapidly growing environment of marketing and trade of products claiming to be "organic", IFOAM provides a market guarantee of the integrity of organic claims. The Organic Guarantee System (OGS) unites the organic world through a common system of standards, verification, and market identity. It fosters equivalence among participating certifiers, paving the way for more orderly and reliable trade.

The IFOAM Organic Guarantee System enables organic certifiers to become "IFOAM Accredited" and for their certified operators to label products with the IFOAM Seal next to the logo of their IFOAM accredited certifier. Accreditation is based on the certifier's compliance with IFOAM norms. The IFOAM definition of certified organic products are those which have been produced, stored, processed, handled and marketed in accordance with precise technical specifications (standards) and certified as "organic" by a certification body. Once a certification body has verified conformity with organic standards, the product can be labeled as such. This label will differ depending on the certification body but can be taken as an assurance that the essential elements constituting an "organic" product have been met from the farm to the market.

[46] UNCTAD (2003), The Organic Guarantee System: The need and strategy for harmonisation and equivalence. Christina Westermayer and Bernward Geier (Eds.) p. 8. http://www.unctad.org/trade_env/ITF-organic/publications/HarmonizationBookwithoutcover.pdf

As the above illustrates, organic certification can sound daunting. Additionally, the lack of confidence and lack of mutual recognition are also major problems for the organic sector. For example, China's Organic Food Development Center under the country's Ministry of Environmental Protection and IFOAM accredited and founded in 1994, is the oldest and largest specialized organic research, inspection and certification organization and the only organic certifier in the country. To date its website only lists two certified operators both producing Asian pears while the country has become the dominant supplier of organic beans and seeds, such as pumpkin and sunflower seeds and kidney and black beans to EU countries.

The rest of China's organic food is certified by some 30 different domestic organizations authorized by the country's Certification and Accreditation Administration with varied results demonstrating the potential barriers related to transforming to organic agriculture. Among additional barriers are converting land that has been contaminated with heavy metals, fertilizers, and pesticides. For Example, most of the fertilizers used in China are phosphate-based chemicals that are highly toxic and have high heavy metal residues. China uses nearly 400 kilograms of fertilizers per hectare of land, far exceeding the threshold of 225 kilograms per hectare set by industrial countries, and such chemicals can remain for years in soils47.

In India, according to the Agricultural and Processed Food Products Export Development Authority (APEDA) under India's Ministry of Commerce & Industry, the country ranks 33rd in terms of total land under organic cultivation and 88th position for agriculture land under organic crops to total farming area. The cultivated land under certification is around 2.8 million hectares (2007-08). This includes 1 million hectares under cultivation with the rest under forest area (wild collection).

The Government of India has implemented the National Programme for Organic Production (NPOP) involving the accreditation programme for certification bodies, norms for organic production, and promotion of organic farming. The NPOP standards for production and accreditation system

[47] Worldwatch Institute, China's Organic Food Disappoints Consumers. by Ling Li on April 3, 2007., http://www.worldwatch.org/node/4998

have been recognized as equivalent to European Commission standards and as such, Indian organic products duly certified by the accredited certification bodies of India are accepted by the importing countries, with the country producing around 3,96,997 metric tonnes (MT) of certified organic products, eg. all varieties of food products -- basmati rice, pulses, honey, tea, spices, coffee, oil seeds, fruits, cereals, herbal medicines, cotton fiber, garments, and cosmetics. From 2007-2008, India exported a total volume of 37533 MT of organic items, with export realization around USD100.4 million, a growth increase of 30 per cent over the previous year. NPOP also notes that the county's organic products are mainly exported to EU, US, Australia, Canada, Japan, Switzerland, South Africa and the Middle East, with cotton leading all other organic products exported at 16,503 MT.

Organic agriculture conversion and loss of yields

According to an interview with Nobel Peace Prize laureate, Norman Borlaug 48 (on converting to organic agriculture), he said that, "even if one could use all the organic material that you have--the animal manures, the human waste, the plant residues--and get them back on the soil, you couldn't feed more than 4 billion people49". Borlaug adds that "if all agriculture were organic, you would have to increase cropland area dramatically, spreading out into marginal areas and cutting down millions of acres of forests". In short, we could not feed all the people that are on the planet today via organic agriculture.

According to a 2008 New York Times article: Shortages Threaten Farmers' Key Tool: Fertilizer, extensive use of chemical fertilizers was accompanied by improved plant varieties and greater mechanization, and from 1900 to 2000, worldwide food production jumped by 600 per cent. The NYT article notes that this increase was the fundamental reason world population was able to rise to about 6.7 billion (2008 population) from 1.7 billion in 1900. Also, the article quotes Vaclav Smil, a professor at the University of Manitoba, "…that without nitrogen fertilizer, there would be insufficient food for 40 per cent of the world's population, at least based on today's diets."

FAO notes that farmers experience some loss in yields after discarding synthetic inputs and converting their operations to organic production. Before restoration of full biological activity (growth in beneficial insect populations, nitrogen fixation from legumes), pest suppression and fertility problems are common50. It is also noted that it may take years to restore the ecosystem to the point where organic production is possible. An FAO (2009) report finds that a 100 per cent conversion to organic agriculture could decrease yields globally. The findings of this report also contend that this yield reduction could be 30 to 40 per cent in intensively-farmed regions under the best geo-climate conditions51.

However, the same FAO report also states that in the context of subsistence agriculture and in regions with periodic disruptions of water supply brought on by droughts or floods, organic agriculture is competitive to conventional agriculture and often superior with respect to yields, and in comparison to traditional subsistence farming, organic yields were 112 per cent higher due to crop rotation, legumes and closed circuits52. Given such erratic weather conditions, it should be noted that organic agriculture is adaptive in the face of climate change and serves as a mitigation strategy for climate change. Concerning Dr. Borlaug's comments, while the green revolution maximized yields and fed countless millions of people, it came at an undeniable cost to our planet. Currently, we are accelerating our unsustainable agricultural path.

The International Fertilizer Industry Association found that global consumption of fertilizer increased by an estimated 31 per cent from 1996 to 2008, driven by a 56 per cent increase in developing countries53. This, in turn, increased the cost of these chemical fertilizers and created a crisis in countries that subsidize fertilizer use for farmers such as India54. Demand for these fertilizers has the industry

[48] Nobelprize.org, Norman Borlaug, The Nobel Peace Prize 1970., - A central figure in the "green revolution"., http://nobelprize.org/nobel_prizes/peace/laureates/1970/borlaug-bio.html

[49] Reason.com, Norman Borlaug, Happy 95th Birthday!, Ronald Bailey | March 26, 2009., http://reason.com/blog/2009/03/26/norman-borlaug-happy-95th-birt

[50] FAO, Agriculture and consumer protection department, Organic farming, *Demand for organic products has created new export opportunities for the developing world.*, http://www.fao.org/ag/magazine/9901sp3.htm

[51] FAO 2009, Low Greenhouse Gas Agriculture: Mitigation and adaptation potential of sustainable farming systems, p11,.

[52] Ibid, p. 11.

[53] New York Times, April 30, 2008: Shortages Threaten Farmers' Key Tool: Fertilizer

[54] The soil for change, A sensible new policy for fertilizer

racing to build more factories in areas where natural gas, phosphorous and potassium are more readily available, such as the Middle East. This race for more chemical fertilizer does not bode well for current ocean dead zones that will likely see accelerated expansion, thus further disrupting complex undersea ecosystems, fragile food chains and the fishing industry.

Organic agriculture innovation

The above discussion highlights the urgency to seek sustainable agricultural solutions, including innovative organic agriculture. Currently, organic agriculture should not be viewed in terms of 100 per cent agriculture conversion but rather an area that should receive much more attention (research and development) as it is a sustainable component to reversing environmental degradation and can significantly contribute to climate change mitigation. As noted earlier in the brief, it is pro-poor, putting marginal farmers on the frontline in developing more sustainable agriculture that enhances rural livelihoods.

In terms of innovation that can produce more food without encroaching on more land and demanding increased chemical inputs, sustainable rice intensification (SRI) is one such viable solution. Younger and fewer rice seedlings transplanted with wider spacing, no continuous flooding and nourished by compost rather than chemical fertilizer generates much higher yield than conventionally-grown rice. SRI efficiently uses scarce land, labor, capital and water resources, protects soil and groundwater from chemical pollution, and is accessible to poor farmers55.

Organic agriculture can also play a role in reducing farmer dependency on fertilizer subsidies, that add considerable strain on fiscal government budgeting, by reducing excessive use of such fertilizers. A poverty reduction-food security strategy should be explored. Policy interventions for this group of farmers need to reduce conversion costs in the area of certification and promote use of organic fertilizers, such as animal manure and vermicompost 56 . Furthermore, natural pest mitigation technologies need to be shared and explored.

For example, on natural pest mitigation technology, the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) publication entitled Sustainable Agriculture and Food Security in Asia and the Pacific shares that farmers in Japan release ducklings in rice fields soon after they have planted rice seedlings, with the ducks eating insects and pests, such as the golden snail and the seedlings of weeds, and not eating the seedlings of rice which have too much silica57. This natural pest reduction strategy also addresses global warming as ducks in the rice paddies effectively reduce the emission of the greenhouse gas methane, which is produced when bacteria decomposes organic matter 58 . Ducks effectively suppress methane emission from rice paddies because of their constant paddling. Such good agricultural practices (GAP) need to be collected and promoted so that countries can tailor needs to meet local conditions. Often local knowledge is the solution.

Additionally, the United Nations Asian and Pacific Centre for Agricultural Engineering and Machinery (UNAPCAEM) can aid in organic agriculture innovation via its Asian and Pacific network for testing agricultural machinery (ANTAM) that is currently under establishment. This network is working toward developing region-wide safety standards and guidelines on the operation of agricultural machines and implements and can, if properly formulated, address not only operation of machinery but also the proper and appropriate use of inputs. Knap-sack sprayers, for example, should be sold with manuals in a country's local language, detailing how to use the sprayer and which

pricing
Business Standard / New Delhi February 22, 2010, 0:15 IST- "While farmers may object to higher urea prices, there would be more rational application of fertilizers which is good in itself, with subsidies encouraging excessive fertilizer use".

[55] APCAEM-ESCAP Policy Brief (2009). Advancing Agricultural Productivity in the Face of Increasing Water Insecurity: Innovating for the Future., p7.

[56] Journey to forever: vemicomposting., Vermicomposting uses earthworms to turn organic wastes into very high quality compost. Vermicompost consists mostly of worm casts (poop) plus some decayed organic matter. In ideal conditions worms can eat at least their own weight of organic matter in a day http://journeytoforever.org/compost_worm.html

[57] UNESCAP (2009), Sustainable Agriculture and Food Security in Asia and the Pacific, p. 89

[58] IRRI (2009), Philippines: Rice-duck farming can mitigate global warming – study- Chinese scientists such as Chengfang Li, Cougi Cao, Jingping Wang, Ming Zhan, Weiling Yuan and Shahrear Ahmad who did research on the *"Nitrous Oxide Emissions from Wetland Rice-Duck Cultivation System in Southern China"* found out that integrated rice-ducks farming will contribute to alleviating global warming. http://beta.irri.org/news/index.php/rice-news/philippines-rice-duck-farming-can-mitigate-global-warming-study.html

chemicals, including their dosages, should be used with what type of sprayer.

Country tailored organic agricultural programmes

Thailand: His Majesty King Bhumipol of Thailand who expressed great concern about the degrading environment caused by current chemical-based agriculture, launched a royal project for organic agriculture in 1993. The project included experiment and training at the Royal Chonburi Agricultural Youth Training Center and Royal Kao Hin Sorn Agricultural Research and Development Center and was considered the take-off point for organic rice farming in the country. Farmers involved in the project received training courses and started their own organic farms, with a total of 3,429 hectares of farmland under organic management in Thailand as of 200159. This programme with state support has allowed more farmers nationwide to switch from conventional farming to alternative organic farming. Today, such efforts have made Thailand the world's largest exporter of organic rice with organic producers committed to innovation, notably in the areas of crop fertility and pest control 60 . The government has also been helping farmers in finding domestic and foreign markets for their organic produce and has made organic farming a national agricultural strategy.

Today, a growing number of farms have converted to organic production with the sector enjoying increased government support and officially recognized organic farming practices and certification. Thai farmers in some regions of the country are getting equivalent or better rice yields than conventional producers, even secondary yields. The Khao Kwan and Hak Muang Nan Foundations and their associated farmer networks have developed a strong capacity in rice seed selection, breeding, improving and developing new varieties that perform well under organic farming methods 61 . Due to strong existing capacity and continued government support, the country receives many groups from other Asian countries looking for training in organic production, certification, processing, and marketing.

Bhutan: With 79 per cent of the Bhutanese population engaged in agriculture, particularly non-commercial farming, government policy has geared itself toward side-stepping chemical-based agriculture, with the country's vision to develop organic farming as a way of life and become fully organic by 202062. To do this, Bhutan's Ministry of Agriculture recently formulated the policy for organic farming in Bhutan in the form of a National Framework for Organic Farming (NFOFB 2007), outlining key approaches and strategies to promote organic farming in the country. Beyond promoting and developing organic farming, the government is looking to aid farmers in developing niche crops and markets and establishing organic communities and pilot activities in areas of high potential.

The current farming system, supported mostly by organic manures and indigenous practices, already is accessing the potential to increase production by adopting and enhancing organic farming technologies as the country has determined that organic farming best suits small farmers. Also, according to the NFOFB, livelihood strategies will include sustainable exploitation of non-wood forest products, increasing yields in marginalized areas via organic agriculture that has shown resilience to erratic weather events, biodiversity conservation, increased income through the development of niche markets of organic products, organic product diversification, and developing a sustainable food supply chain.

A landlocked, agrarian based economy, largely engaged in chemical-free production systems, Bhutan plans to market and brand itself via creating a "Clean Bhutan Image"63. Bhutan is known for its pristine environment and the natural beauty of its landscapes. Tourism is a huge revenue earner for the country, with the sector being further promoted through eco-tourism and agri-tourism. Such a framework could also serve as a template for other least developed and land-locked countries in the region.

---

[59] FFTC, Organic Farming for Sustainable Agriculture in Asia (2005). http://www.agnet.org/library/eb/558/

[60] Lucia Lorente, Thailand's Organic Sector Ready for a New Level
The International Newspaper for Organic Trade: Organic and Wellness News Fall 2008

[61] Ibid

[62] *Promoting organic farming in Bhutan: A review of policy, implementation and contraints* (August 2008). By Sangay Duba Programme Director RNRRC, Wangdue Mahesh Ghimiray Principal Research Officer RNRRC, Wangdue Tayan Raj Gurung Programme Director RNRRC., Wengkhar Council for RNR Research of Bhutan Ministry of Agriculture Royal Government of Bhutan. p.1.

[63] Bhutan Today, *The Organic Challenge*, February 25, 2010., http://www.bhutantoday.bt/?p=3008

Scaling-up: mechanizing organic agriculture

Improved post-harvest processes and mechanization are very much applicable in organic or natural farming, as are land preparation and adopting mechanization in making organic compost or fertilizer, particularly vermicompost64.

Organic farming is, in general, more labor intensive than conventional agriculture as it tends to add new operations to the farmer's everyday burden. Manuring, for example, is a complicated process that can include the collection, composting of the excrements and the spreading. Also, cultivation, cutting and incorporation of an extra crop between the rows or on a fallow field for green manure can be very taxing on a farmer and her/his equipment. In the tropics, fallow plots can easily grow within three years to vegetation measuring over three meters in height and impenetrably dense, explaining the difficulty of promoting this component of organic farming developing regions65.

Appropriate mechanization for reducing labor requirements is, therefore, a key issue for the future of organic farming, in industrialized countries as well as in developing countries. However, the development of adequate solutions for this challenge is still in its infancy. Some research and development has been done, for example, in equipment for soil-conserving tillage or mulching. A serious problem is the incomplete knowledge about the environmental impact of different mechanization systems.

In response to the above, FAO and UNAPCAEM in a collaborative effort have begun to assess the current status of agricultural mechanization among countries in the region, and to call upon Asia-Pacific countries to consider undertaking sustainable agricultural mechanization strategies (SAMS) as a tangible action toward enabling a more climate resilient and environmentally sustainable agricultural sector. Countries with a sustainable agricultural mechanization strategy in place can prepare an action plan to improve agricultural production, enhance food security and reduce post-harvest losses through proper policy measures, appropriate investments and interventions of an agricultural and/or technical nature. Also, developing a sustainable agricultural mechanization strategy would encourage member countries to take stock of their situation and analyze farmers' needs, institutional arrangements in the country and the availability of services to meet these needs. Thus, there are now international tools in place that can advance mechanized organic agriculture in the Asia and Pacific region.

Wrapping Up

For organic agriculture to take hold and address the full range of food security, better public health and rural livelihoods, improved farmer occupational safety and health, preserving natural resources, reversing environmental degradation, and aiding in climate change mitigation, one must "separate the wheat from the chaff", so to speak. This policy brief has attempted to share all sides of the organic agriculture debate and provide sufficient arguments to develop and defend organic agriculture policy.

As our current agricultural system of chemical inputs shows, we are accelerating harm to our planet's eco-systems, lands, rivers, lakes and seas. The planet functions as our cornucopia, but this horn of plenty now serves as our refuse basket as well. If we stay with the current system, we will reach a point where we create more tainted and poisoned waste than food. Our Earth is a finite resource having a finite carrying capacity with which we should not be experimenting.

If the first green revolution was an innovation, than we can also now have a truly sustainable "emerald, jade, olive, and lime colored revolution". Such sustainable innovations in organic agriculture already exist but others need to be found, shared and explored. The key to food growth is nitrogen, and natural nitrogen production needs more research and development, such as expanding and enhancing development of nitrogen-fixing plants, eg. peas, beans and other legumes66. Our own planet offers

64 Journey to forever: vemicomposting., Vermicomposting uses earthworms to turn organic wastes into very high quality compost. Vermicompost consists mostly of worm casts (poop) plus some decayed organic matter. In ideal conditions worms can eat at least their own weight of organic matter in a day http://journeytoforever.org/compost_worm.html

65 Manila Times, Organic farm mechanization., Saturday, 27 November 2010 00:00

66 These plants have a symbiotic relationship, working together with nitrogen fixing bacteria called Rhizobia (bacteria), to "fix" nitrogen. The Rhizobia chemically convert the nitrogen from the air to make it available for the plant, with this bacteria living in nodules in the plant's roots. In short, the plant can look after its own nitrogen needs and fertilizer is not required. Additionally, when the crop is harvested and the plant cut back to ground level, the root nodules should release all the valuable fixed nitrogen for following crops. Once

natural solutions, and we risk losing such solutions by damaging the natural environment. Organic agriculture at present is a viable step in developing resilient and healthy food supplies, producing food in marginal areas and enhancing rural livelihoods. Expanding its role in the future depends on research and development and its funding, so that the eventual conversion of our current chemical-based agricultural systems to those with organic characteristics can take place and continue to feed an increasing global population.

nodules form, the plant usually receives all of the nitrogen necessary for growth from that "fixed" by the bacteria. –From Tropical Permaculture, Nitrogen Fixing Bacteria – Rhizobia Growing Nitrogen Fixing Plants - The Beans and Peas Myth., http://www.tropicalpermaculture.com/nitrogen-fixing-bacteria.html

UNAPCAEM Policy Brief

(Issue No. 2, May – August 2012)

Organic agriculture gains ground on mitigating climate change and improving food security: healthy food from healthy soil

www.unapcaem.org

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

United Nations Asian and Pacific Centre for Agricultural Engineering and Machinery

This issue of the UNAPCAEM Policy Brief was prepared by Mr. Eric Roeder, Economic Affairs Officer, UNAPCAEM in Beijing, P.R China; and informally edited by Mr. LeRoy Hollenbeck, Head / Senior Economic Affairs Officer. For further information on this Policy Brief, please contact: Mr. Wei Zhen (weiz@unapcaem.org) or UNAPCAEM (info@unapcaem.org)