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Feeding the Planet, Energy for Life

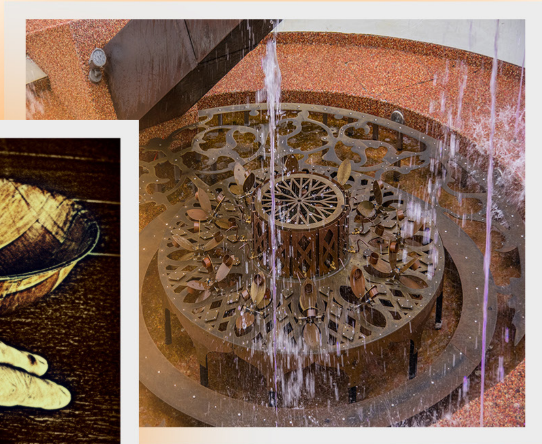

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Table of Contents

Cover Photo

Nutritional Movement, 2015. THE MILAN CHARTER at *http://nutritionalmovement.com/wp-content/uploads/2015/05/carta-di-milano-cop.jpeg*.

Take Back Your Health Conference 2015 Los Angeles, Fruit Basket at *https://www.flickr.com/photos/130855607@N05/16596216868/*

nebojsa mladjenovic,2009. Hunger at *https://www.flickr.com/photos/mladjenovic_n/3402535662/*

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Editorial

"Feeding the Planet, Energy for Life": the innovative thematic approach of Expo Milano 2015"


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2. Country Relations Officer

MILANO 2015
NUTRIRE IL PIANETA ENERGIA PER LA VITA
NOURRIR LA PLANETE ENERGIE POUR LA VIE
FEEDING THE PLANET ENERGY FOR LIFE

"Everything is the theme. The theme is everything". This declaration, presented in Expo Milano 2015 Participants' Guide, enshrines the spirit of an Expo that aimed at proposing a new model for Universal Expositions in the 21st century, through an innovative thematic approach pervading every aspects of the Expo, from the physical structures of the Exhibition Spaces to the multifaceted experience offered to visitors by both the Participants and the Organizer. From these very premises, since the times of the bid to host the World Expo in 2015, the theme "Feeding the Planet, Energy for Life" and its centrality in the approach proposed by the Italian candidacy engaged all Countries, convincing them that this project could be realized in Italy for its particularly profound link with nutrition, and at the same time offering such a wide range of possible interpretations and declinations to be embraced by every Participant.

The first step towards the development of this thematic approach has been the publication of a series of documents designed to provide participants in Expo Milano 2015 with guidance in their own interpretation of the aspects of the theme they intended to present as part of their participation in the Universal Exposition. Among these documents, special mention should be made of the Theme Guide and the Sustainable Solutions Guidelines. The Theme Guide, is a document preliminary to the Participation and presents a detailed description of the theme of Expo Milano 2015, starting from a question which is at the heart of the concept of this Exposition : "is it possible to ensure sufficient, good, healthy and sustainable food for all mankind?". Through thinking on sustainable behaviors to feed the mankind and the planet Earth itself, Expo Milano 2015 presented itself as a place where all Countries of the World and the various international community's stakeholders can come together around the same table to enhance their dialogue and active collaboration in addressing the main challenges that must be faced by humanity. The areas which have been identified to represent the main theme of Expo Milano 2015 range from architecture and technology to performance content and food services. With reference to architecture, the Sustainable Solutions Guidelines were published in 2013 with the purpose to share knowledge

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on best solutions and practices and to provide guidance to designers with the aim of improving the performance of temporary buildings and Exhibition Spaces in Expo Milano 2015 by reducing the consumption of energy, water and materials, and by preventing potential environmental impacts. Along with architecture, in the physical determination of the Exhibition Spaces, the interrelated concepts of technology and sustainability have always been considered as fundamental for both the Organizer and the Participants in the design and creation of their own spaces.

The general structure of the Expo 2015 Site itself has been designed to be permeated by the theme in a harmonious way. First of all, because the Expo Site was conceived as an ecosystem and created around the concept of a landscape in which human needs are in harmony with nature. Secondly, because the Organizer and the Participants have strived their best efforts to ensure internal coherence around the main theme of the Universal Exposition, by harmonizing several different scientific, cultural and entertainment proposals made available on the Expo Site. In light of this, the "Vie d'Acqua" project – the hydric system encircling the Expo Site – not only contributes to the creation of a landscape of natural beauty in Milan (recalling Leonardo's navigable canals of Milan), but it is also a real component of the theme evoking environmental sustainability: as a matter of facts, the Canal of Expo Milano 2015 collects rainwater in a wet park and return clean irrigation water to the surrounding countryside, utilize a system of water phyto-purification, and creates differentiated micro-climates for visitors' comfort. The Thematic Areas – such as Pavilion Zero, the Biodiversity Park and the Future Food District – have perhaps been the places where the theme as unifying code of communication was developed most. Just to give an idea, Pavilion Zero, developed in collaboration with the United Nations, has been the first area visited by the majority of visitors when entering the Expo Site, and it had the role to stimulate their curiosity about the themes of the Exposition. It was also the visitors' first contact with the Best Practices, which are selected innovative solutions developed in specific contexts to the challenges posed by feeding the planet. Moreover, the theme has been made the unifying thread crossing the entire Expo Site also through the nine Thematic Clusters, a key innovation of Expo Milano 2015, consisting of Exhibition Spaces grouping within the same architectural project a number of Countries sharing a representative theme, like a thematic identity (Agriculture and Nutrition in Arid Zones, Bio-Mediterraneum, Islands, Sea and Food) or a food chain (Rice, Cocoa, Coffee, Fruits and Legumes, Cereals and Tubers, the World of Spices). The Thematic Cluster model is not only an innovative way to overcome the limited space bound, but it adds also considerable value to the participation of the Countries, both overcoming the concept of the Joint Pavilions, which in previous Expos gathered Countries according to exclusively geographical criteria, and helping the extensive diffusion of the theme.

Starting from the programmatic documents and the master plan of the Expo 2015 Site, the theme of Expo Milano 2015 was finally made live and vibrant during the six months of the Event, through a rich program of events, conferences and seminars focused on the importance of "Feeding the Planet, Energy for Life". Among them, it is particularly worth mentioning the Thematic Days that have been celebrated throughout the Event, such as the Bread Day, celebrated on July 19th 2015 to show the fundamental value of this basic food and bring together all Participants at Expo Milano 2015 in a symbolic moment that for many friends also marked the end of Ramadan. Another unique opportunity for reflection and dialogue on the important theme of Expo Milano 2015 was represented by the international event "It begins with me: how the world can end hunger in our lifetime", held on September 6th in the Expo Site. This event, co-organized by the Governments of Italy and Ireland in collaboration with the World Food Program, consisted of a public discussion aimed at increasing awareness on food-related emergencies and the global effort necessary to face them, which involved the highest level institutional representatives of Ireland and Italy, including the Prime Minister of the Italian Republic, the Irish Minister of Agriculture, Food and the Marine and the Executive Director of World Food Programme. A crucial event for Expo Milano 2015, moreover, has been "The After Expo: the Legacy of Milan 2015", held on October 10th as culmination of the reflections that arose on the occasion of the event "The Ideas of Expo" of February 7th. Thanks to the inclusive and participatory model of the working tables, which gathered not only representatives from the Countries taking part in the Universal Exposition but also the leading players involved in different ways in Expo 2015 and its theme, this initiative offered the opportunity to take a closer look at the global challenges linked to the Expo 2015 theme, from the battle against food waste to the goal of Zero Hunger by 2030, from support for family farming to boosting research and innovation, and from the safeguarding of biodiversity to food and wine culture. The importance of this event lies essentially in the fact that it was a unique occasion to share everything that has been developed during previous years and months on the theme of Expo Milano 2015, trying to find responses and solutions, but also paving the way for new challenges presented in the Milan Charter and which will be included in the post-Expo 2015 activities.

The Milan Charter has been conceived as the cultural legacy of Expo Milano 2015, representing another fundamental innovation relatively to Expo Milano 2015 and its theme. As a matter of fact, in the months preceding the beginning of this major international Event, an intense debate involving the scientific community, civil society organization and several institutions' contributions on the theme of Expo Milano 2015 led to the drafting of the Milan Charter, a participatory and shared document that calls on every citizen, association, company and institution to assume their responsibility in ensuring that future generations can enjoy the right to food. In particular, the Milan Charter addresses four major issues: what economic and production models can ensure sustainable development in economic and social areas? Which of the different types of existing agriculture are able to produce sufficient quantities of healthy food without damaging water resources and biodiversity? What are the best practices and technologies to reduce inequalities within cities, where the majority of the human population is concentrated? How can we think about food not only as a mere source of nutrition, but also as something that provides a socio-cultural identity? As conclusive moment of this process, and at the same time as the beginning of its new life, the Milan Charter was handed over to the United Nations Secretary-General on October 16th 2015 in the culmination of the celebrations for the 2015 World Food Day, which this year were significantly held in the premises of the Expo 2015 Site.

This is how the Expo 2015 theme has permeated each component and aspect of this global Event and has become a fundamental part of its legacy, which aims to be not only a material legacy characterized by innovative architecture or new monuments, but most of all a conceptual one, encouraging everyone to take on the challenge of the achievement of the important and tangible goals of feeding the planet and mankind in a sustainable way.

We are glad to contribute this editorial to Volume 4 Issue 1 of the "Future of Food: Journal on Food, Agriculture and Society", on the theme of "Feeding the Planet, Energy for Life". The selected research papers presented in this volume will provide innovative insights of the thematic area with research-based experiences in regional and global perspectives. Furthermore, this edition is enriched with a documentary that was produced by the Future of Food Journal to bring a critical review on Expo 2015. The book and film review section bring the description and an evaluation of actual publication on the thematic area.

Our special thanks go to Ms. Oksana Smirnova, Mr. Jacopo Luigi Stecchini and all persons interviewed who made possible our special documentary on Expo 2015.

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Local food security initiatives: systemic limitations in Vancouver, Canada

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Cropping conditions, Economics, Food security, Land use, Urban gardening

Abstract

This paper approaches the topic of urban/community gardening not through the lens of urban theory per se but in light of basic farming realities such as growing season and land availability. Food security comprises availability and affordability. In the context of North American and Western European societies, only food affordability normally merits public discourse. In practice, governments have little or no means to change food affordability, in view of prevailing capitalistic free-market structures. In the current wave of popular exuberance, civic politicians and others have promoted the belief that community gardening could be the pathway to produce affordable food. The formidable obstacles to this pursuit include the availability of (low-cost) land within the highly-densified city limit, insufficient ambient temperature and water supply during the growing season and the contemporary structure of society. Overcoming these fundamental hurdles carries significant negative environmental and economic consequences.

Introduction

Food security relates to both food availability and food affordability (Pinstrup-Andersen, 2009). In North America and Western Europe, the issue of food availability has essentially been resolved by increasingly efficient international transportation networks. Food affordability is, however, an intractable problem which is tied closely to the structure of the prevailing free-market capitalistic system (Kneafsey et al., 2012). Low-income citizens are routinely exploited, resulting in their having access to low-cost foods at low quality and/or higher quality foods at exorbitantly high pricing.

In North America and Western Europe, many civic politicians and a growing minority of urban populations have come to believe that fresher and safer food could be produced locally at comparable or lower costs (see, for example, City of Vancouver, 2011a; City of Vancouver, 2011b). For Vancouver city politicians, the promotion of food security from local production is considered to be risk-free. The obvious truth is that no citizen would ever be against the increased availability of less expensive foods. But is this food security proposition meaningful? The economic and technical fundamentals are weak. For example, there is little or no consideration of the impact of corporate structure of food supply and distribution on food security (see, for example, Hallsworth & Wong, 2015b). After all, the sole purpose of a modern corporation[1] is to maximize prof-

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it for its shareholders (Wong & Hallsworth, 2013). There is no other legal mandate (Friedman, 1970). It follows that food security is of no topical concern to the corporation controlling food supply and distribution to the urban masses. The exception would of course be if participation in building food security from local production will result in substantially higher profit for the corporation. Furthermore, vital technical issues such as land availability (priced under any political ideology), geophysical conditions and labour supply have largely been unaddressed in the relevant literature (see, for example, Colasanti & Hamm, 2010; Jenkins et al., 2015).

Interest in local food production, notably of vegetables and fruits, has increased substantially in North America during the past decade (Onken & Bernard, 2010) even as macro-economic pressures push commercial operations in the opposite direction (Sacks, 2010). The geographic definition of "local" in local food production is still being contested (Feagan, 2007; Hand & Martinez, 2010). There appears to be considerable elasticity in geographically focused definitions. For example, in Canada, Smith and MacKinnon (2007) have popularized the 100-mile diet as being "local". This distance limit appears to be largely arbitrary and expediently fit the local geography (see for example, Byker et al., 2010). Conversely, 'local' can simply mean that the product has not crossed a national border. Using that definition, in Sweden for example, "local" might cover produce from Skåne (e.g., Kristianstad, 56.03 ºN-14.16 ºN in the south) sold in Pajala kommun (67.18 ºN-23.37 ºE in the north), a distance of over 1,500 km (Jeswani, 2009). In reality, vegetables delivered from example neighbouring Tornio (65.85 ºN-24.15 ºE, in Finland) would certainly be more "local", at a distance of about 160 km. For national-boundary reasons, Finnish produce sold in Sweden might not be considered to be "local". It may be noted that Swedish and Finnish populations are culturally very similar in this North Baltic region.

From a broader perspective of human geography, "local" does not necessarily mean purity in, among other things, community spirit (see, for example, DuPuis & Goodman, 2005). Similarly, "local" does not always mean lower carbon footprints (see, for example, Wong & Hallsworth, 2012). Will the prices of "local" goods be lower? The pursuit of maximum profit is the only guidepost. In other words, a local producer (or merchant) would strive to sell "local" products at whatever price the market will bear (Wong & Hallsworth, 2016). There is no higher motive or driving force. This philosophical viewpoint of community spirit and social justice might be just wishful thinking to afford equality and social justice to a community at large. Self-interest in a cash economy will always remain paramount.

The definition of "urban" is itself also highly debatable. Urban (used as a noun) might be best defined to be an agglomeration of human dwellings in a relatively small area, for example a location of high human population density, which is opposite to "rural", wherein human dwellings are widely dispersed. But there is no threshold parameter to qualify an agglomeration of dwellings to be urban and not rural, vice versa. The definition "peri-urban" originated in France as a description of the area between a city and its countryside (see, for example, Lambert, 2011). *Banlieue* (suburban) is also used routinely in France to designate the area between urban (*ville-centre*) and peri-urban. But in many instances, these designations are meaningless. For example, the city of Timmins, Ontario in Canada (48.5 °N, 81.3 °W) has a registered area of 2,979 km^2 (Statistics Canada, 2015). The actual inhabited area of Timmins is estimated[2] to be only about 15 km^2 for its ~43,000 inhabitants. The "peri-urban" area where many active gold-copper mines are located was annexed several decades ago for taxation reasons. In this example, what is considered urban (or city) is merely a political boundary that could be changed at will. Does a "peri-urban" space exist if there was no agricultural countryside (as in the French context), just forested or mountainous wilderness?

Notwithstanding the continued interest in the promotion of urban gardening in developed northern-latitude countries (see, for example, Jenkins et al., 2015), the perplexing issue is whether prevailing physical and societal circumstances could actually support such a model for food supply in an urban setting. This study was aimed to examine the realities and limitations of producing fresh vegetables locally, in the context of contemporary North America. In particular, the issues of physical, social and cultural constraints will be addressed. Vancouver was chosen as the example because it is located in the mildest climatic zone of Canada. Staple cropping and large-scale meat production are usually already excluded from the discourse because of the relatively large land base and specific processing facilities required. In this paper, "urban agriculture" or "urban farming" is synonymous with "urban cropping".

Methods

This study relies on the analysis of available public-domain publications, for example scientific/ agricultural journal papers, government reports and newspaper articles which are pertinent to the particular case studied. All documents analyzed were cited appropriately in the text. No field research or interviews were undertaken as they were not deemed to be relevant to this case study. The interview approach was deemed to be highly problematic in view of the considerable heterogeneity of, among other things, the ethnicity, age structure, immigration status and employment income of the population. For example, mid-income young professionals living in small (example 75-m^2) apartments of high-rise buildings would intuitively have a very different interest in local food supply from low-income immigrants living in crowded single detached dwellings. There is an extreme paucity of citable literature on Vancouver-specific agricultural practices. After all, large scale food cropping ceased to be practiced within Vancouver city limit more than 50 years ago. Anticipated logistical needs for the re-introduction of large-scale cropping in Vancouver had to be reconstructed from available meteorological and other ancillary infrastructure data.

Accordingly, this paper also contains no new discussion of urban theories as the crucial issue of interest is not how or why cities have grown to be unsustainable in many forms. Instead, only the practical science behind food production and supply is considered. It is conceded however that multiple conflicts inevitably would arise over satisfactory allocation of scare resources for sustenance versus profit (including excess profit). The interested reader is directed to an extensive discourse on underlying "urban" issues including sustainability and conflict over space (see, for example, Soja, 2000; Mayer, 2012; Brenner, 2014; Brenner & Schmidt, 2014; Catterall, 2014; Soja & Kanai, 2014; Peck & Theodore, 2015). Moreover, this paper does not discuss the societal aspects of local food production which are well debated elsewhere.

The scope of the present paper is deliberately restricted narrowly to the subject of the formidable practical barriers to achieving local food security in the dense clustering of human dwellings that is contemporary Vancouver, Canada.

Reality of food security

There is essentially no food availability crisis in present-day North American and Western European societies to warrant urban food cropping. Advances in refrigeration technology and transportation logistics since 1950s have largely eliminated the principal logistical restraints on delivering fresh food supply to large cities (see, for example, Hallsworth & Wong, 2012). The issue of food affordability is recognized to be real only for low income families; this problem could only be solved by substantial changes in the hegemonic economic system of oligopolistic corporate control of food supply and distribution, market exploitation of well-meaning citizens, increasing income inequality, etc. (see, Hallsworth & Wong, 2015b).

Throughout North America and Western Europe, food supply for cities is now controlled by a few large corporations. For reasons of profit maximization, produce might be procured from distant farms from virtually anywhere in the world. The key success factors include cheap labour, warm climate, good water supply, intensive monoculture and low environmental protection standards. The rising market dominance of food production and distribution by large corporations has also limited already scant opportunities for small scale production in the fringe area of urban centres. Moreover, the freedom of choice of consumers has steadily been eroded by the profit-maximization interest of large corporations (Hallsworth & Wong, 2015). It is generally recognized that the sole legally-mandated objective of every corporation is the pursuit of profit (see, for example, Wong & Hallsworth, 2013). The equilibrium price of goods is simply what the contemporary market will bear. Shelf-edge pricing[3] in grocery stores has essentially nothing to do with food grown, locally or not, in an urban or peri-urban setting (see, for example, Hallsworth & Wong, 2015a). Typically, a middle-income[4] family with *x* income can purchase a food item at y price. Regrettably, all too often, a family with less than *x* income cannot afford *y*-priced food. In the hegemonic discourse of the currently-dominant neoliberal regime, the deprived family has clearly failed to "work harder" to achieve *x* income. This is reminiscent of the Irish potato famine exacerbated by the neoliberal economic policy of the English colonial government in the mid-1800s. Food remained available but only if one only had the money to purchase it. A lack of adequately-paid work for the starving Irish people (Woodham-Smith, 1962) was the "problem". Consequently, millions of poor people perished from what was, at root, avoidable starvation. Resolution of the present food affordability problem will be achieved only by a substantial re-structuring of the customary free-market regime. After all, the sole purpose of a modern business entity is the pursuit of profit by all means available (see, for example, Friedman, 1970). It is generally recognized that free-marketing pricing means what the market will bear. Measures such as government control of prices and profit margins contradict the principles of free-market economics. Such a task of reforming free-market economics, - if attempted at all by governments at any level - would be very daunting.

It follows that food security (especially affordability) provides an essentially frivolous driving force for the promotion of urban agriculture, in the context of modern-day North American and Western European societies. For example, dairy products are consumed routinely by a large segment of contemporary population of North America and Western Europe. But dairy cows would need to be fed with on-purpose barley grain crop (or purchased forage crops which are grown elsewhere) or to be raised in open pastures. Neither of which is practicable in Vancouver. The exuberance expressed by most civic politicians, some academics and various advocacy groups in the endorsement of cropped food production (i.e. production of grains, vegetables, tree fruits and roots) in an urban environment would thus appear to be somewhat irrational. It would equally appear that many politicians do not have a clear understanding about the practicalities of urban agriculture.

Systemic limitations of local food production

The intractable fundamental issues of urban cropping in Vancouver are very simple and should be obvious. There does not appear to be any logic in attempting to construct a "theoretical framework" or any other complex urban theories, to justify urban cropping as a practical means to supply foods to citizens in a large city. There are three very basic barriers hindering the realization of urban agriculture as means to provide food security.

Land base

Historic land use

In Pre-Contact days[5], the entire lower reaches of the Fraser River were heavily forested. The *Coast Salish* aboriginal people had inhabited this region in widely dispersed hamlets for millennia. There was considerable spatial separation between hunting, fishing and berry-gathering sites. See Galois (1997, pp. 112-114) for an example description of the seasonal movements of the pre-Contact *Tsimshian* people. Self-sufficiency in food supply was maintained from the harvesting and gathering from the natural environment (see, for example, McMillan, 1988, pp. 201-209; McMillan & Yellowhorn, 2004, pp. 190-232). Harvested foods were preserved routinely by the indigenous people for use during the winter months. Trade in foodstuffs (with distant communities) was largely limited as the transportation routes were difficult. Moreover other coastal or inland aboriginal communities were largely self-sufficient. Various site-specific food delicacies such as oolichan (Pacific smelt; *Thaleichthys pacificus*), and oolichan grease were traded periodically (see, for example, Green, 2008). Food security (in terms of seasonal availability of indigenous supply) was largely maintained in equilibrium (Robinson, 1996). In effect, the lower reaches of the Fraser River (i.e. present-day Metro Vancouver and Fraser Valley) which are densely forested never had planned crop cultivation on a large-scale for reason of food self-sufficiency. The land had no monetary value. By tradition, it was, in effect, a common. The development of Vancouver (as a European settlement) began in the 1850s with the discovery of gold by European prospectors in the upper reaches of the Fraser River (Kloppenburg et al., 1977). The completion of the transcontinental railway in 1887 facilitated the mass influx of European settlers into the region from present-day Eastern Canada. Land was subsequently expropriated by the Crown (in the right of the Colonial government

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of the day) for distribution to loyal (white) subjects of the British Empire (see, for example, Cardinal, 1969). The deliberate policy of the government was race-based colonization by alienation of the indigenous people from the land (see, for example, Perry, 2001, Chapter 5). The indigenous inhabitants (i.e. the aboriginal people) were herded to live in miniscule reservations. Monetization and *bétonisation*[6] of the common land then began in earnest as much of the intact virgin forest was liquidated entirely.

Present land use

There is no possibility for the city of Vancouver to expand its land base. It is hemmed in by the seas and mountains, and by other established adjoining cities. As shown in Figure 1, the geographical constraints of Vancouver eliminate any possibility of "peri-urban" land allocation for urban-agriculture purposes. In reality, there is no such "peri-urban" space. Unlike recently de-industralized American cities such as Detroit (Colasanti & Hamm, 2010; Rudolf, 2010; Crouch, 2011), there was only 1% vacant land recorded in Vancouver in 2006. See Table 1. In 2014, the amount of vacant land was even less. In essence, there is insufficient urban land to provide even just staples for the "massive" population in Vancouver. In the example of medieval England, it has been estimated that one person would require about 0.8 hectare of wheat crop for sustenance (Hallsworth & Wong, 2015a). Over the centuries, improved grain crop yield has largely been offset the increased per capita consumption of staples in modern-day England as elsewhere. It is an inescapable fact is that cities have become too large by design or by accident. They long ago lost any capacity to provide a within-city land-use base for any cropped food production that might result in self-sufficiency of the citizenry. It follows that food sovereignty becomes a moot issue if staple cropping could not be realized.

Civic government intervention

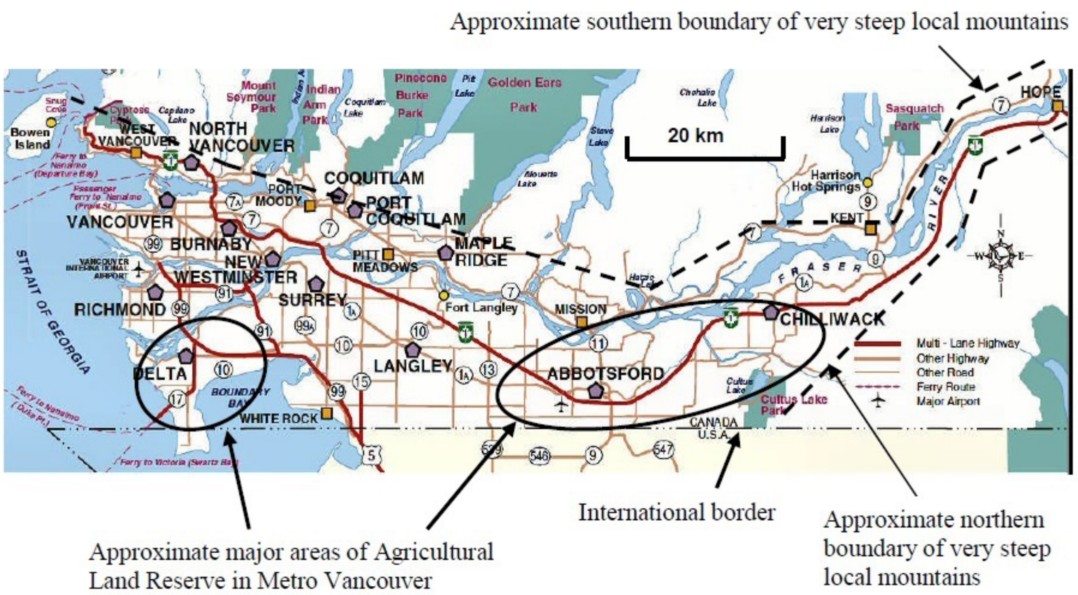
There are several City government directives to promote and regulate urban gardens (syn., community gardens) on a micro-scale (City of Vancouver, 2011a). Using highly-masked publicly available data from the City of Vancouver, Wong and Hallsworth (2016) have estimated the total area of city-recognized and –supported community gardens to be about 40,000 m^2. This figure corresponds to an allotment of about 0.07 m^2 per city inhabitant. It is unlikely that this land allocation could sustain any one person. The underlying problem is of course the acute shortage of "unused land" in the city of Vancouver.

The application of local tax incentives for the promotion of urban gardening for commercial-sale purposes is not practicable. In Canada, sales taxes are collected and retained solely by provincial and federal governments. It may be noted that provincial sales tax is only applied to foods processed at the point of sale. The principal revenue sources for Vancouver city government are property taxes, licensing fees, water usage fees, garbage collection fees, and fines for infraction of various city by-laws. Despite the professed interest of civic politicians to promote "urban gardening for food security", there is no political reason to provide any tax concessions (within its remit) to commercial urban farmers.

Food production scenario

In the matter of food security, production of staples would be the obvious first priority. If all land (i.e. 11,467 hectares in total) within the city limit of Vancouver was converted to wheat cropping, the expected output would be about 26,000 tonnes, at the reported 2011-2012 yield of 3.03 tonnes per hectare (Agriculture and Agri-Food Canada, 2012), and corrected for typical ~25% lower organic cropping yield (de Ponti et al., 2012). The use of herbicides and pesticides for community gardening is prohibited by the City of Vancouver (2014). And if the average Canadian consumption of wheat (i.e. ~225 kg per person per year) was applied, this amount of wheat produced would have sustained only about 116,000 persons. The population of Vancouver in 2011 was already more than 600,000. Moreover, in this food self-sufficiency scenario, the citizens of Vancouver would have to relocate elsewhere as all the land within the City of Vancouver would be appropriated for wheat cropping. If the example sustenance data of medieval England from above was used, the total land area within the city boundaries of Vancouver could only support less than 15,000 persons. This outcome leads to the only conclusion that there is absolutely no possibility of self-sufficiency in the production of cropped staple foodstuffs.

From another perspective, for an example 10 m x 10 m (presently viewed as large[7]) yard of a detached



Population pattern of contiguous "large" communities

West Vancouver Pop. 42,694* Density 489/km^2	North Vancouver Pop. 84,412* Density 4,074/km^2	Port Moody Pop. 32,975 Density 1,274/km^2	Coquitlam Pop. 126,840 Density 1.037/km^2	
Vancouver Pop. 603,502 Density 5,249/km^2	Burnaby Pop. 223,218 Density 2,464/km^2	Pitt Meadows Pop. 17,736 Density 205/km^2	Port Coquitlam Pop. 55,958 Density 1,918/km^2	
New Westminster Pop. 65,976 Density 4,222/km^2	Langley Pop. 104,177* Density 338/km^2	Maple Ridge Pop. 76,052 Density 285/km^2	Mission Pop. 36,426 Density 161/km^2	Kent Pop. 5,664 Density 34/km^2
Richmond Pop. 190,473 Density 1,474/km^2	Surrey Pop. 468,251 Density 1,480/km^2	Abbotsford Pop. 133,497 Density 356/km^2	Chilliwack Pop.77,936 Density 298/km^2	Hope Pop. 5,969 Density 145/km^2
Delta Pop. 99,863 Density 554/km^2	White Rock Pop. 19,339 Density 3,774/km^2			

* municipality or incorporated city with adjoining municipal district

Source: adapted from BC Ministry of Transportation map; Statistics Canada, 2015

Figure 1: Geographical constraints of Vancouver

mum yield of wheat (cropped organically) would be about 23 kg wheat as whole-grain flour, assuming ideal growing conditions (i.e., adequate sunlight, temperature and water) and zero loss in grain milling. Note that the typical yield of milling to flour is 74% (Canadian Grain Commission, 2011). On the basis of the UK average consumption of bread[8] (Flour Advisory Bureau, 2013) of 4 slices (20 slices per 800-gram loaf) per day per person, the amount of wheat grown in the example front yard would suffice the bread consumption of a 2-person household for about 72 days. It may also be noted that more 30% of the Vancouver population are of non-European ethnicity (Statistics Canada, 2008); they do not necessary consume ordinary bread in their daily diet. Nor is rice cropping technically feasible in Vancouver.

What then is the true economic perspective for food cropping? The average price of bare land inside the Vancouver city limit hasgrown to be very high during the past four decades. By 2012, the average Van couver housing price became the highest in Canada (Anon., 2012). A publicly-available document has revealed that in January, 2010, the disused Shell gas

ISSN-Internet 2197-411x OLCL 862804632

Table 1: Selected statistics on population and land use

Vancouver city (49.15°N 123.10°W) land area, km²	**114.67**			
	2001*		2006#	
City population (Statistics Canada, 2013)	~546,000		~578,000	
Apparent density, persons per km²	4,761		5,041	
Land use (within city limit)	km²	% of total	km²	% of total
Single family dwellings	37.67	32	28.49	24
Multiple family dwellings (including duplex, rowhouse, apartment and mixed apartment and commercial)	10.13	9	24.68	21
Commercial	4.47	4	3.82	3
Industrial, utilities and port	6.77	6	5.61	5
Parks or public services (including social or public service, school, cultural or recreational, park and other open space, exhibition grounds and golf course plus 193 hectares of 2 lakes inside the city limit)	21.34	18	22.16	19
Vacant	2.50	2	1.10	1
Streets, lanes, sidewalks	33.72	29	30.74	26
Others	---	---	---	---
Total (the total is larger than the cited land base as this figure includes the two lakes within city limit)	116.60	100	116.60	100

* latest available data source from http://vancouver.ca/commsvcs/planning/stats/landuse/index.htm
\# latest available data source from http://www.metrovancouver.org/about/publications/ Publications/KeyFacts-LandusebyMunicipality-2006.pdf

single-family dwelling in East Vancouver, the maxi oline filling station site located at 4000 Main Street in the central east side of Vancouver was sold for C$3.875 million[9] on an as-is basis, including the incurred cost of building removal but excluding the cost of environmental remediation of the site. At the lot size of 1,618.2 m², the value of the *bare land* value is calculated to be C$2,395 per m². The site was subsequently re-zoned and a typical 4-story apartment with ground-floor retail shops stands at this site today. Using the methodology of Davis and Palumbo (2008), the land share[10] of the original (gasoline-filling station) property is estimated to be about 94%. This example also illustrates that the price of the land, and not the building cost of the property, is the principal causal element of the present housing crisis in Vancouver. It is thus evident that there is no economic possibility for the implementation of any urban food cropping activities.

Even land in the "peri-urban" area of Vancouver is still much too expensive to undertake urban agriculture for achieving food security. For example, farmland in the Fraser Valley[11] is valued between C$9.88 per m² to C$14.83 per m² (Anon., 2013). This range of pricing dictates that only very high-return commercial crops such as blueberries and strawberries should be grown (Anon., 2008). In the case of blueberries, the gross revenue[12] would be about C$7.40 per m². The economic return of other field crops would be substantially less. With such a large differential in land price between housing and farming, there is considerable pressure from farm land owners to repeal the designation of Agricultural Land Reserve for housing development (Anon., 2008). It is a matter of simple land-use economics.

Although many "urban agriculturalists" are still debating the possibility of diet change[13] to fit the "landscape", the fundamental foods for the present-day Vancouver city dwellers remain staples such as wheat (for bread) or rice, and fresh vegetables. Even if formidable society-wide dietary changes could be realized, large scale production of staples and vegetables to sustain the large population of Vancouver remains extremely problematic. In an ideal-

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ized situation in which the unsatisfactory neoliberal economic structure was destroyed instantly and the price of land in Vancouver was re-set magically to zero, there is still no possibility to convert existing housing land to agricultural land. As discussed earlier, in a clearly meaningless scenario, the city would have to be de-populated by nearly 85% to release land for realizing this scheme of growing sufficient food for the self-sufficiency of the remaining 15%. In a parliamentary democracy[14] , who would decide which segment of the population would have to be "expelled" and where would be surplus population be re-located? Axiomatically, there are no feasible circumstances that could realize increased deployment of land for agriculture within Vancouver city limit. For Vancouver, this synthesized conflict of land use, or in other words habitation versus food production, is essentially intractable.

The contest over scarce land and its use under the framework of neoliberalism (see, for example, Harvey & Chatterjee, 1974; Harvey, 2003; Harvey 2005) is particularly pertinent to the continued rising cost of land in Vancouver. Harvey (2008) had argued that the urban citizens have the right to remake their cities and themselves. But certain *a priori* fundamentals were never addressed. For example, why such a right should exist at all, and why cities should exist and expand? The situation of the "company town" in the earlier era of resource extraction in Canada is particularly noteworthy as the "company" owned everything including all housing and non-factory services needed by workers. There were no rights for the townspeople including general merchants who were not company employees. Engels (1845; 1872) had noted the dire social consequences of rising land cost on the affordability of housing of the proletariat (industrial workers) during the early days of the Industrial Revolution in Europe. During that period, people were migrating to the cities because of the emergence of factory work with lucrative wages. The countryside was effectively de-populated very quickly. But this reason for the influx of people to Vancouver has been absent for more than 50 years.

What, then, of other urban agricultural options to overcome the problem of land constraint? Vertical growing and rooftop gardening have been widely touted as a means to solve the land space problem. However, these approaches are fraught with techni-

Table 2: Limited space for rooftop gardening

Example calculation	Before re-zoning for development of apartments	After zoning for re-development of apartments
Typical single-family dwelling lot	100 ft x 30 ft (279 m^2)	100 ft x 30 ft (279 m^2)
Number of residents	4 (i.e. 2 adults and 2 children)	4 (i.e. 2 adults and 2 children)
Size of unit for living (maximum)	279 m^2	~75 m^2 (1)
Number of storied floor	1	4 (2)
Number of units per floor	1	3
Apparent density	~70 m^2 per person	~6 m^2 per person

Notes:

(1) CitySpaces Consulting (2009, p. 25) reported the average unit area of apartments to range from 65 m^2 to 88 m^2, depending on the sub-area of Vancouver. The minimum net size for a 2-bedroom apartment unit is set at 66 m^2 for a 3-bed unit and 84 m^2 for a 3-bedroom apartment unit (City of Vancouver, 2015a). Under the latest Micro Dwelling Policies and Guidelines, the Director of Planning of the City of Vancouver may permit a floor area as small as of 23 m^2 for a self-contained studio unit.

(2)Most post-2009 apartments built in former residential-zoned areas are typically 4 stories. Building height (i.e., number of stories) is negotiable; it is a matter of money paid to the City under the guise of "contribution to community amenities" by the development project proponent (City of Vancouver, 2015b).

ISSN-Internet 2197-411x OLCL 862804632

cal and logistical problems in affording significant food security for the local population. In the case of Vancouver, the vertical growing approach has unequivocally failed the economic test of viability (Howell, 2014; St. Denis & Greer, 2015). It has been intimated that the cropping of presently-illicit marijuana (*Cannabis sativa*) for medicinal uses might be the only economically viable means to sustain the vertical growing concept in Vancouver (St. Denis & Greer, 2015). The general deficiency of the community gardening (including vertical growing) is discussed in detail elsewhere (Wong & Hallsworth, 2015b). A rooftop gardening strategy has a limited utility to only a number of participating citizens. As illustrated in Table 2, the lack of space for rooftop gardening becomes particularly acute as single family dwellings are converted to apartment buildings. It is evident that 24 m^2 of space (maximum assignable) for food cropping could not support a family of two adults and two children. It is may be noted that from a structural engineering perspective, the rooftops of many older multi-storied apartments were never built to accommodate any extra weight of wet soil or water (hydroponic) used for rooftop gardening.

Would, or could, the City of Vancouver stop the conversion of single-family dwellings into multi-storied apartment buildings purely in order to preserve private gardens as growing spaces? An apartment building with considerably higher tax assessment would provide higher tax revenue. Because the City always seeks more revenue, creative justifications are already routinely formulated in order to placate the people at large who are encountering steadily decreased availability of affordable housing within the city limit. The conversion of single-family houses also serves the financial interest of real estate developers and speculators. In reality, any home (or community) gardening in microscopic-size plots could only be realized solely for personal enjoyment. Justification of urban cropped food production for increased food security must be seen as mere nostalgic fanciful thinking by some middle income citizens.

If staple cropping is not feasible within Vancouver city limits, would other less space-intense urban agriculture be practicable? Apiculture and mushroom cropping could qualify as alternative modes of urban agriculture. The practice of apiculture is sadly limited as no large fields of clover or other suitable forage crops could be developed in Vancouver. The insurmountable barrier is again the lack of "vacant" land. Mushroom growing is already practiced by several large commercial enterprises in the less-populated areas of the Fraser Valley. The control of toxic-gas emission from these intensive mushroom farms is particularly troublesome for workers as well as the receiving air environment (see, for example, Hoekstra & McKnight, 2012). In any case, if one considers alternative urban agriculture to be just another profit-making business, then the alternative mode does not necessarily embody the goal of providing food security. For example, the biggest field crop in the Fraser Valley is blueberry which is not an essential food for survival.

Comparative land use scenarios

It is conceded that the food-availability situation may be very different in many rural areas of low-income developing countries (See, for example, de Graff et al., 2011). Our question is whether or not they offer practical solutions for the food-supply problem in Vancouver. The urban gardening circumstances of Kampala, Uganda (Maxwell, 1995) and Freetown, Sierra Leone (Maconachie et al., 2012), for example, in affording food security are irrelevant in the context of the prevailing urban societal structure in North America and Western Europe. Perhaps even more marginal are the illustrations of Mayan-Yucatán and Byzantine-Constantinople civilization of the First Millennium CE expounded notably by various Swedish social scientists such as Ljungkvist et al. (2010), Barthel and Isendahl (2012), and Isendahl and Smith (2013). They may appear to demonstrate the role of urban gardening in city resiliency but is subject to the obvious criticism that the societal structure in ancient times was quite different from that of modern-day North American and Western European societies. There were also notable technical flaws in these researchers' omission of crucial dietary intake of cereal, viz., maize (*Zea mays* subsp. *mays*) in the case of Maya and wheat (*Triticum* spp.) in the case of Constantinople, which require large tracts of land for production. Neither city-state inhabitants could possibly survive on vegetables grown in urban gardens alone. Witness the 872-day siege of Leningrad (USSR) by the Third Reich military forces in 1941-1944. Starvation due to the shortage of essential grains (for bread) was the principal cause of death of most of the ~1.5 million people[15] who perished during the siege (see, for example, Jones, 2008). Prior to the siege, essential grains were imported routinely by rail from wheat-growing regions of the USSR. Despite the creation of "thousands of vegetable patches in parks, squares and on waste ground" (Reid, 2011, p. 345) in 1942 and 1943, mass death by starvation continued. It is evident that resilience of Leningrad was due to factors other than the emergence of urban gardening.

Climatic conditions

The northern-latitude climate is simply not suitable for the production of most of the wide variety of cropped foods consumed on a year round basis by middle-income/middle-class people of present-day North American and Western European societies. In addition to staples, fresh vegetables are generally recognized to be essential foods. Popular fruit crops[16] such as bell pepper (*Capsicum annuum*) and tomato (*Solanum lycopersicum*) are native to northern South America, and cropping conditions for bell peppers and tomatoes are largely similar (Masabni, 2009). In addition to mineral nutrients and CO_2, the essential elements affording satisfactory growing conditions, for example, temperature, incident solar radiation and water, are marginal in the Pacific coastal climate of Vancouver.

Temperature

The optimal temperatures for the cropping of bell peppers (or tomatoes) are about ~29 °C during the day and ~20 °C at night (see, for example, Masabni, 2011). Bell pepper and tomato plants are extremely frost intolerant. In Vancouver, there are essentially only 4 frost-free months, viz., June, July, August and September. Typically, 120 days would be required for direct seeded plant to harvest and 90-100 days would be needed for nursery-started plantlets to harvest (Masabni, 2011).

Growing degree days is an ambient air temperature-based indicator for assessing the development of plant growth, in the absence of extreme cropping conditions such as drought and disease. The growing degree-days indicator is calculated as follows:

Growing degree days for the month, GDD

$$= (T_{avg} - T_{base}) \text{ x days for the month} \qquad \text{Eq. 1}$$

where

T_{base} = +10 °C is generally used as the lowest temperature for the growth of bell peppers and tomatoes.

T_{base} = simple daily average of maximum and minimum temperatures

Figure 2 shows that this vital growing climatic pre-condition for growing in Vancouver is deficient for the field cropping of present examples of bell peppers and tomatoes. Such tropical crops would best be grown in their natural environment such as in Martinique (Wong & Ribero, 2013). Calculations using the above growing degree-days approach suggest that the threshold GDD could be reached in just 3-1/2 months in Martinique; it follows that three crop cycles would be feasible annually.

In comparison, pak choy (*Brassica rapa var. chinensis*), a cool-temperature crop, could be grown rapidly in 15 to 20-day cycles (Wong, 2010). In theory, Vancouver would have the necessary cooler temperature conditions at least during spring time. But nutritious pak choy is eaten largely by local first-generation Chinese-ethnic citizens only.

Creating the necessary artificial growing climate, such as heated green houses, would require substantial input of energy for heating (see, for example, Wong & Hallsworth, 2012). Electric lighting would be required if cropping was continuous on a year round basis. Middle income citizens have come to expect these popular vegetables to be readily available in their grocery stores on a year round basis. Conversely, the notion of seasonality of vegetables has disappeared from grocery stores decades ago. As shown in Table 3, the avoidable CO_2 emission for "local" production of tomatoes in heated greenhouses would be about six times higher than that for tomatoes grown in the field in Mexico and transported by long-haul trucks to Vancouver. This estimation made by Wong and Hallsworth (2012) was based on the assumption of a) zero CO_2 emission using hydroelectric power for lighting and b) burning natural gas for heating. Furthermore, all forms of external energy production, including biomass-based and wind-based renewables, have appreciable environmental footprints. Biomass com-

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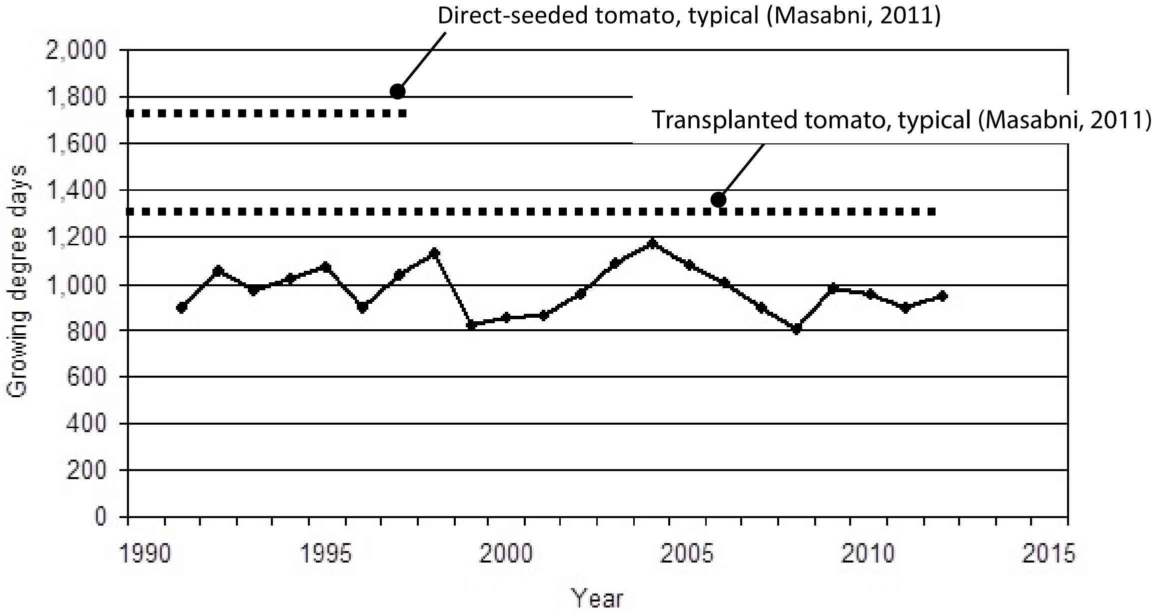

Notes:
(1) Calculated from meteorological data recorded at the Environment Canada weather station (World Meteorology Organization Identification Number 71892; 49°11'42.000" N, 123°10'55.000" W; elevation 4.3 metres) located at the Vancouver Airport (about 10 km south of Vancouver city centre).
(2) The "growing degree days" calculator available at www.farmwest.com was used for the period from May to September inclusive, at +10 °C base temperature.

Figure 2: Historical annual growing degree days in Vancouver

Table 3: Avoidable CO_2 emission in the supply of tomatoes to the Vancouver market

Supply Model		Avoidable CO_2 emission. kg/kg tomatoes (on a "farm-to-fork" basis)
A	Buy Mexican imports from mega retailers (i.e. supermarkets)	0.31
B	Buy regional greenhouse-grown produce from mega retailers (i.e. supermarkets)	1.88
C	Buy direct from regional farmers (e.g. in a Farmers' Market)	0.25
D	Grow own produce (the original urban gardening concept)	0

Source: adapted from Wong and Hallsworth (2012)

bustion in Vancouver means procuring biomass from the temperate-zone rainforests. But there is already a lucrative market for the exportation of wood pellets; thus, the economic competition for local use can be expected to be very difficult. The underlying economics is that piped-in natural gas is considerably less expensive, even though its use for this purpose would lead to increased emission of greenhouse gases. Although Model "D" in Table 3 would provide the zero CO_2 emission, this option is impracticable because of constraints of land availability and seasonal climatic conditions.

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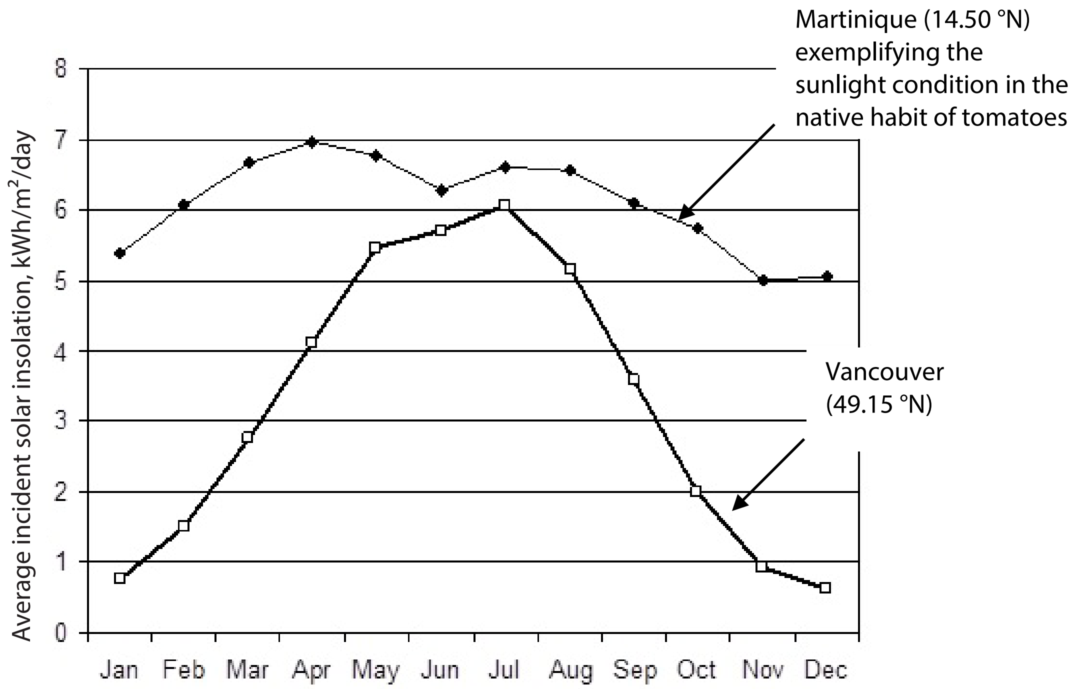


Source: ASDC, 2015

Figure 3: Monthly (22-year) average incident solar radiation on a horizontal surface

The economics of vegetable cropping does not support the use of solar panels (direct thermal or photovoltaic) to provide heating for greenhouses in northern latitudes. Natural Resources Canada (2014) had projected the average benchmark Alberta wholesale price of natural gas to be C$3.93 per gigajoule (about C$150/m^3) for the 2014-2015 heating season. In the longer term, domestic price of natural gas is expected to remain low in comparison to historical averages. Such low pricing outlook for natural gas would depress any economic justification for the installation of solar receptors. Of course, the combustion of natural gas has the direct consequence of higher emission of greenhouse gases to the atmosphere.

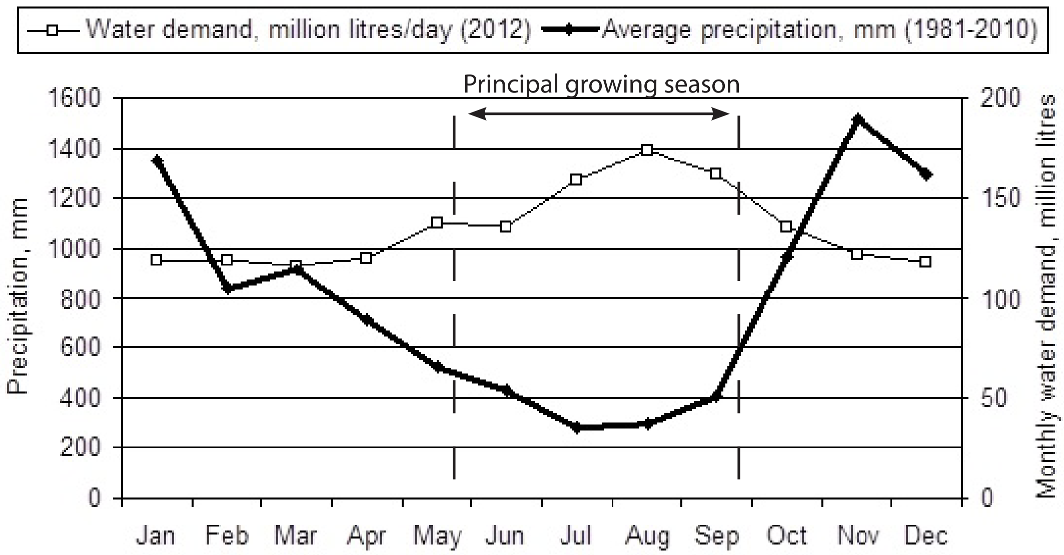
Sunlight

Incident solar radiation in Vancouver appears to be adequate during the field growing season, from May to September inclusive. Figure 3 compares the incident solar radiation between Vancouver (in the south coast of British Columbia) and Martinique in the Antilles). Artificial lighting would be required for the cultivation of most vegetable crops (in greenhouses) in other times of the year in Vancouver.

Water supply

If urban cropping was to be undertaken on a large scale, supply of sufficient water would be very problematic. The three water reservoirs supplying potable water to Metro Vancouver are dependent on local rainfall, and snow pack in nearby mountains. During the summer months, Vancouver has been under water-use restriction for the past decade. Figure 4 shows that the months with the lowest precipitation have the highest municipal water demand. Although the per capita consumption of water in Metro Vancouver (2013) has admirably decreased from ~659 litres per day in 1980 to ~487 litres per day in 2010, the growth in population has effectively increased the absolute demand from about 273 million litres per year in 1980 to approximately 292 million litres per year in 2010.

Tomatoes and peppers were chosen as examples of water demand of row field crops because Vancouver citizens (of all ethnic groups) consume them customarily throughout the year. Such food items are traditionally supplied from California and/or Mexico (Wong & Hallsworth, 2012). Dur-



Sources: Environment Canada (2014); Metro Vancouver (2013)

Notes:
(1) Meteorological data recorded by Environment Canada at its Vancouver airport weather station.
(2) Annual pattern of monthly water demand is similar for earlier years.

Figure 4: Historical annual growing degree days in Vancouver

ing the summer months, some tomatoes and bell peppers are supplied from irrigated fields in the "hotter-summer" Okanangan Valley, located some several hundred kilometres east of Vancouver. More recently, several large heated greenhouses located near Vancouver have been supplying tomatoes and bell peppers to the local market. These operations have substantially larger GHG emissions (Wong & Hallsworth, 2012). Certainly other vegetable crops could be used as examples. The transpiration ratio[17] is defined as the weight of water per unit weight of total biomass produced. Crop plants usually range from 200 to 1,000 (Martin et al., 1976: 80-82). For field-grown tomatoes, the seasonal water used would be 60 kg per kg fresh tomato fruit (Yang et al., 2012). The percentage of fruit in total tomato-plant biomass is typically in the range of 55 to 65% (Agele et al., 2011). Moisture deficit is defined as the water removed by evapotranspiration. Water evaporated from soil plus water released through the plant, which is not replaced by precipitation (Allan et al., 1998). This means of estimating crop water requirements takes in account of, among other things, growing plant requirements, local soil and prevailing meteorological conditions. Equation (2) is applied to calculate the evapotranspiration (ET) for tomato crop. The computation protocol for ET is based on that described by Allen et al. (1998).

ETc = ETo x Kc   Eq. 2

where

ETo = calculated grass reference ET for Vancouver region, mm; data provided by Pacific Field Corn Association (2014) in *www.farmwest.com*

Kc = crop efficient (tomato was set conveniently at 1.0 over the entire growing season, in view of 0.7 in initial stage, Kc = 1.05 in mid-season, and Kc = 0.80 in the end stage; data provided by Pacific Field Corn Association (2014) in *www.farmwest.com*

Etc = crop evapotranspiration or crop water use, mm

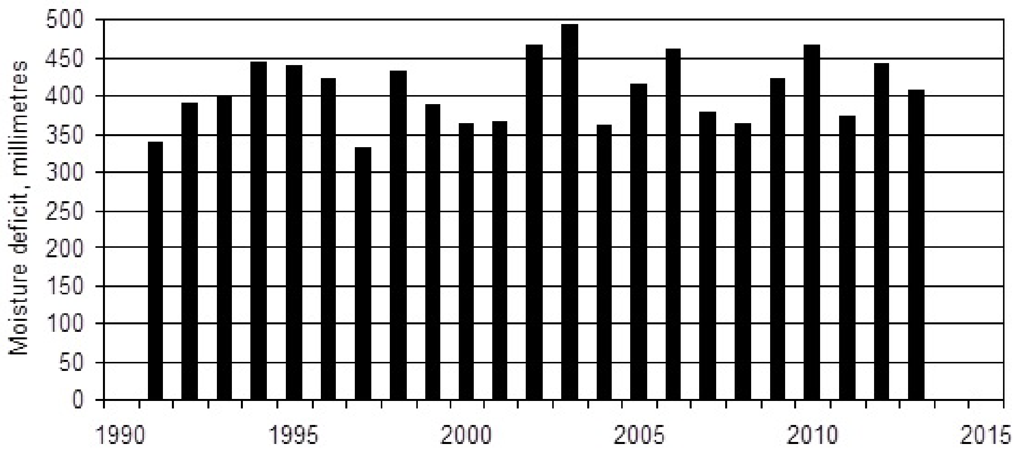


Figure 5: Calculated moisture deficit (for tomato cropping) in Vancouver, from May 1 to September 30 each year

The moisture deficit for cropping in Vancouver – for the period of May 1 to September 30 - is illustrated in Figure 5. In essence, field cropping of tomatoes in Vancouver would need an additional input of 300 mm to 500 mm of water over the growing season. The FAO (2014a) has cited a representative tomato crop demand of 400 mm to 800 mm of water (i.e. crop evapotranspiration) for the total growing period. The variation is due in part to the length of the growing period for different cultivars (FAO, 2014b). In the semi-arid San Joaquin Valley[18] of California (USA), the seasonal crop water use (i.e. crop evapotranspiration) of field-grown tomatoes is 645 mm (Hanson & May, 2006). It is evident that additional input of water through irrigation is required for satisfactory crop production in the Vancouver urban setting. However, Vancouver has inadequate rainfall and an acute (municipal) water supply deficit during the summer months. The only available source of additional fresh water is the nearby Fraser River estuary. An extensive irrigation infrastructure would need to be built for the provision of water to multiple urban food gardening plots. It is doubtful if such a costly infrastructure project could, or should, be undertaken.

The average per capita consumption of fresh tomatoes in the USA was reported to be 8.4 kg in 2008 (Boriss & Brunke, 2005) and we may assume that Canada has a similar level of per capita consumption. The estimated demand for Vancouver with a 2006 population of 578,000 (from Table 1) can thus be assessed at 4.86 million kg annually. If the aforementioned difficult issues of land pricing, GDD and water supply could all be resolved "magically", then the calculated land base needed for urban gardening of fresh tomatoes would be about 150 hectares, on the basis of reported average yield ranging from 29,000 to 35,000 kg intensively field-cropped fresh tomatoes per hectare achieved in the San Joaquin Valley (Strange et al., 2000; Boriss & Brunke, 2005). In theory, this supply scheme of using about 1.3% of the total land area for self-sufficient tomato cropping could be practicable for Vancouver. It may be noted at the prevailing land price of ~C$2,400 per m^2 (cited earlier), the set-aside 150-hectare land would be valued at C$3.6 billion. At the example retail price of C$3.29 per kg of fresh tomatoes[19] and an output of 4.86 million kg of fresh tomatoes annually, it would take about 190 years of fresh tomato sales to afford accumulated gross retail revenue to be equivalent to the "over-night" cost of the set-aside land. On a wholesale pricing basis, the 190-year time frame would at least be doubled. Moreover, all such field-cropped tomatoes would be harvested for distribution to the local market only during August and September each year. There would be no "local" fresh tomatoes for the other 10 months of the year.

The problem of using secondary sources of water for irrigation is difficult to solve. The Iona Island wastewater treatment facility (located ~10 km from

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Vancouver city centre) provides only rudimentary treatment of domestic wastewater. Suspended solids are removed by screening and gravity sedimentation, prior discharge to the receiving water (i.e. the Strait of Georgia). There is no removal of, among other things, pathogens, antibiotics from home use and household grease. Furthermore, there is enormous cost of re-piping the treated wastewater back to the city for distributed irrigation uses. Run-offs from storm sewer are a potential source of secondary water. But during the prime growing months of July and August, the rainfall is virtually nil. In essence, abundant street run-offs are available when the growing season has ended. Creating immense water cisterns and other water storage facilities for run-offs within Vancouver is economically impractical because of the high land cost.

Fertilizers and other crop inputs

The use of fertilizers is a necessity in any urban gardening undertaking for maximization of crop yield. The choice of mineral fertilizers will inevitably result in unwanted nutrients in run-offs to cause deleterious marine pollution. The deployment of organic fertilizers would entail the operation of large composting piles of highly bio-degradable food and residential garden wastes collected weekly by the City Sanitation Department. The City of Vancouver already operates a large-scale landfill composting facility in Delta (a municipality located about 20 km south of Vancouver) for the management of biodegradable household solid wastes. The end product is sold commercially to home gardening centres and hobby gardeners (City of Vancouver, 2015c). Using composted fertilizer may be practical, but crop rotation would still be required for the control of pest and other plant infestations. This practice adds restriction of discontinuous land use for cropping.

Changes in societal structure

The shift from an agricultural society to an urban society probably started in the Neolithic Age, circa 3500 - 1500 BCE (Roebuck, 1966, Chapter II). Irreversible[20] rapid changes in the structure of western societies during the past several decades have created new obstacles to "local food production". These structural obstacles include substantial changes in employment patterns, accelerated urbanization and altered family structures. Self–sufficiency in food could only be achieved if the society was still agrarian in nature; contrary to the Maya parallel (above). Growing sufficient food for one's own use could not be undertaken on a part time basis. The principal reasons include a) the land must be prepared and seeded, b) the growing crop must have control (manually or chemically) of weeds, pests and other infestations, c) the growing crop must be irrigated, and d) the crop must be harvested and prepared for storage. It is well known that in an agrarian society, it was always a full time task even to grow sufficient food for subsistence. Any occasional surpluses might produce to purchase seeds, farm implements, fertilizers, or other necessities of life.

Very few Canadians, educated or otherwise, would be willing to toil in the fields on a full time basis (see, for example, McLaren & Thompson, 2008). This problem has parallels with that of finding people to work in low paying agricultural jobs in all western societies. In the UK, "gangmasters" control contract agricultural workers though much such work is now undertaken by EU citizens from Poland. In Canada, foreign guest workers harvest field and tree crops, and Germany has offers the example of mass importation of *Gastarbeiters* from Turkey since the 1960s (Wong & Gomes, 2012). Most people would prefer full time work in well-paid jobs in comfortable offices and to simply buy food from shops. For similar reasons of "comfort", unemployed persons are not generally interested to toil in the field for a minimum wage. Nor are there (as yet) laws to force unemployed persons to accept such jobs. There are insufficient "young idealists" and "middle class green fingers" to render a city such as Vancouver self-sufficient in food, even for a single widely-consumed vegetable. Thus, if cropped food was to be grown in an urban setting and even if above issues of land and climate could be addressed satisfactorily, cheap migrant labourers would still be needed for any food cropping activities. Such a labour market policy as practiced in Canada and similar countries is overtly exploitative at best (see, for example, Wong & Gomes, 2012). Indeed, the practice of using cheap migrant workers imported from Mexico and Central America has already been evident in Fraser Valley farms for several decades (Fairey et al., 2008). The present labour situation in Vancouver (as well as

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that in many other "modern" cities in North America and Western Europe) might be a continuation of the master-slave relationship between "urban civilized life" and the peasantry since ancient times. Armstrong (2014, pp. 21-27) has noted succinctly that "Urban living would not have been possible without the unscrupulous exploitation of the vast majority of the population", in her commentary on the foundation of the first city-state in Sumer (present-day southern Iraq) in the third millennium BCE.

The essential question remains "could - or should- low-income families undertake to grow their own food for the sake of affordability?". Presently, recent immigrants earning low salaries are too busy in taking a second (or third) paid job just to survive. As of March 1, 2014, the general minimum wage in British Columbia (province) was raised to C$10.25 per hour (Government of British Columbia, 2014). For a typical 40 hour working week, the monthly wage would be C$1,640, before any tax deductions. For hand-harvested crops, the minimum wage is set according to the specific crop. For example, the minimum piece rate for hand-harvesting blueberries is C$0.396 per lb. (= C$0.872 per kg). Using data given by Zbeetnoff and McTavish (2011), a field worker would need to pick ~12 kg blueberries per hour in order to achieve the general minimum wage of C$10.25 per hour. Interestingly, Zbeetnoff and McTavish (2011) also found that almost 90% of the blueberry pickers were in the age group of 55 years or more. Women comprised nearly two thirds of the blueberry-picking workforce surveyed. The task of picking blueberries non-stop at this rate for 8 to 10 hours under the hot sun every day is generally considered to be very strenuous (Fox, 2013).

In 2014 in Vancouver the rental cost of a one-bedroom apartment in a modest cooperative housing complex was reported to be C$862 per month (Pablo, 2014), equivalent to ~53% of the above-sample worker's monthly gross income. As in other cities such as London, this level of income deployment for housing is obviously unsustainable. The Vancouver city government considers 30% of income dedicated to rental housing to be an acceptable benchmark of affordability (City of Vancouver, 2012a; City of Vancouver, 2012b; Howell, 2013). Note, however, current research that sees the low paid (ideally welfare) renter as the ideal conduit for profits to renter speculators (Wallace, 2015). More than a century ago, Friedrich Engels had recorded similar observations during his residence in Manchester, England in the mid-1800s (Anon., 2007). Separately, Ivanova and Klein (2015) have calculated the 2015 living wage meeting basic family needs in Metro Vancouver to be $20.68 per hour. One obvious solution for the minimum-wage worker is to generate additional income from a second paying job. It follows that low-income workers with the greatest need of supplementary food supply have no time to grow their own food in sufficient quantities for self-use throughout the entire year.

Conclusion

No matter how or why Vancouver emerged from a densely-forested area to a modern metropolis, there is little or no possibility that Vancouver's location could ever sustain food security or sovereignty. Notwithstanding the destructive role of neoliberal economic policies on the well-being of urban citizens, insurmountable farming realities block any possibility of self-sufficiency in food. The major systemic barriers to the realization of cropped agriculture in Vancouver were found to be 1) acute scarcity of low-cost land, 2) marginal growing temperature conditions, 3) water scarcity, and 4) changed socio-cultural circumstances of the population. Any attempt to overcome such obstacles would carry significant negative environmental and economic consequences. Despite these obvious fundamental constraints, successive civic governing regimes, not only in Vancouver but in many other cities as well, have somehow continued to pursue the goal of "local food production for increased food security". Such a public-policy position is demonstrably disingenuous when physically impractical. Even if all the claims of the societal benefits of local food production were true, the inconvenient truth of systemic limitations on urban gardening could not be ignored.

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Endnotes

1. In this context, "corporation" denotes a publicly- or privately-owned corporation with a substantial annual turnover in revenue.
2. Estimated from topographical data of The Atlas of Canada published by the Government of Canada (*http://atlas.gc.ca/toporama/en/#index.html*)
3. Shelf-edge pricing means the price of goods offered to the shopper at the edge of a grocery store shelf.
4. The designation of middle class and low class is avoided because of certain cultural connotations. Thus, a middle income person can be a low class person.
5. Although Russians had been engaged in fur trading with aboriginal people of coastal British Columbia in the 1770s, the arrival of the fleet of Captain James Cook (from Britain) in the Nootka Sound in 1778 is generally considered to be the defining milestone of "Con tact".
6. Meaning "paving or concreting over by decree" in present-day colloquial French.
7. A representative lot size in this sub-area of Vancouver would be ~30 m x ~9 m (100 ft x 30 ft).
8. UK consumption: 12 million loaves sold daily to 63.1 million people (mid 2011 estimate). A representative full-pan loaf is considered to weigh 800 grams and to yield 20 slices. The calculated per capita consumption would be 55.5 kg per year.
9. The monthly average exchange rate in January, 2010 was C$1.00 = US$0.959 (*http://fx.sauder.ubc.ca/data.html*)
10. Land share = (land value from the Shell gasoline filling station example/ all-in home value listed in this lower cost residential neigh bourhood of Vancouver, in the same time period). The average 2011 price of "single-dwelling houses" listed for sale in nearby area was $2,551 per m^2 (= average C$ 888,500 for an average lot size of 348.3 m2). Even in the exclusive residential district, the land share could be as much as 99%, for a well-kept 5-bedroom single-dwelling house built in mid-1960s.
11. Located up to ~30 km south, and ~100 km east of the Vancouver city boundary.
12. Example yield of 11,200 kg per hectare at estimated farm-gate pricing of C$6.60 per kg. The retail price of locally grown blueberries was $13.20 per kg (Whole Foods Vancouver, July 4, 2014).
13. Frequently in the context of eating little or no animal meat.
14. With the continued ascendancy of neoliberal politics, parliamentary democracy has increasingly become a façade. "Guided democracy" might be a more apt description of contemporary democracy. In its simplest form, it has the appearance of genuine popular democra cy achieved through free and fair elections, but the electoral process as well as subsequent government agenda, goals, policies, etc. are largely controlled by a minority of moneyed elites. Guided democracy was last promoted unabashedly by the Sukarno Regime in Indonesia during the early 1960s (see, for example, Steinberg, 1971, pp. 383-384; Lev, 2009, Chapter VI).
15. The pre-siege population was approximately 3.7 million. About 1.5 million people were evacuated successfully. At the end of siege, the population of Leningrad had dwindled to ~700,000. During the darkest days of the siege, the bread ration was just 125 grams per person per day (Jones, 2008, pp. xxii).
16. Other vegetable crops such as lettuce and beets could be used as examples as well. But tomatoes are widely consumed by all eth nic groups in Vancouver. Cropping of staples such as cereal grains has already been eliminated because of extremely large land base required.
17. Alternatively, transpiration ratio may also be defined as weight (or mole) of water transpired per unit weight (or mole) of CO_2 fixed (Nobel, 1983, pp. 444-446).
18. The San Joaquin Valley has the largest commercial production of fresh tomatoes in North America.
19. Locally hot house–grown fresh tomatoes on-the-vine; November 14-20, 2014 special price offer at IGA Market Place supermarkets in Vancouver. It may be noted that lower retail prices, e.g., <C$2.00 per kg, are prevalent during the summer period.
20. Irreversibility means that both man and woman (of a family unit) will be working essentially full time throughout their adult lives, in the contemporary society. This situation arose largely from the changed social attitude about women in the work place. Since the 1960s, women working outside the traditional home (especially those of the traditional man-woman middle-class family units) have become the norm principally for reasons of a) fulfillment of the woman's personal aspiration and b) acquisition of additional disposable income to enjoy an enhanced "middle-class" consumption-oriented lifestyle. This paradigm shift has far reaching consequences. For example, in Vancouver, a whole new industry of day-care of young "middle class" children and general domestic help has effectively been created in which numerous imported lowly-paid Filipina workers are now employed. In contrast, within the low-income group, women working outside the traditional home become a necessity for the economic survival of the family unit.

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Family agriculture for bottom-up rural development: a case study of the indigenous Mayan population in the Mexican Peninsula

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food security, home gardens, species diversity, sustainable development

Abstract

Since pre-colonial times the indigenous communities of Mayan origin in the state of Quintana Roo, Mexico, widely practice home gardens on a sustainable basis as the principal form of family agriculture. This study analyzes the structural complexity, functional diversity and management strategy of these indigenous home gardens in order to attempt to propose recommendations for improved family farming. The Mayan home gardens are structured into three or more vertical layers of multiple plant species of herbs, shrubs and trees, and horizontally into well-defined zones for production of both domestic and wild animals. The home gardens provide multiple services apart from food and nutrition security. For sustainable bottom-up rural development, we recommend the continuation of multifunctional home gardens.

Introduction

Home gardens embody an ancient and common practice of indigenous populations all over the world (Eyzaguirre & Linares, 2004). Home gardens, which generally consist of multiple crops, serve several purposes (Galhena et al., 2013). These purposes include food and economic security, but also knowledge sharing and community building. Home gardens also provide medicinal and ornamental plants. Although several definitions of 'home gardens' exist (cf. Torquebiau, 1992; Mendez et al., 2011), for the purposes of this paper, home gardens are considered to be farming systems which combine different physical, social and economic functions in the area of land around the family household. The home garden system produces food for consumption at the household level, and is generally managed by the female head of the household (Caballero, 1992).

Home gardens fulfil a crucial role in ensuring household food security among indigenous populations. Globally, therefore, home gardens have a strategic relevance: both the Millennium Development Goals and subsequent Sustainable Development Goals have made it a priority to end food poverty and create successful access to nutritious food. Despite significant economic development at the global level, addressing food insecurity remains a key challenge. Recent estimates suggest that 850 million people suffer from undernourishment in terms of energy consumption and about two billion people suffer one or more micronutrient deficiencies (FAO, IFAD & WFP, 2012; FAO, 2013).

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Particularly striking in the context of global food insecurity is the case of Mexico. Firstly, Mexico has decreased its national average of underweight children under five years from 14.2% in 1998 to 5% in 2006 (CONEVAL, 2013). However, Mexico's Federal Government has acknowledged that 25% of its population live in food poverty (CONEVAL, 2013) and has thus launched the Crusade Against Hunger that aims to achieve national food security whilst maintaining environmental sustainability. It is in this context that home gardens can play a significant role as they can facilitate food security outcomes without jeopardizing environmental conditions.

In order to understand the mainstreaming of home gardens in the case of Mexico however, it is important to consider the role home gardens have played historically. Indeed, home gardens played an important role for pre-colonial societies, such as the Mayans, Aztecs and Totonecs (Caballero, 1992). Through these systems, the populations were able to develop settlements with assured annual food production (del Angel-Pérez, 2013). Moreover, the communities were able to form relationships with nearby communities by means of trade and these practices continued during and after the colonial invasions (Caballero, 1992), such that home gardens are widely practiced in some of the poorest areas of Mexico (Rebollar-Dominguez et al., 2008). In this sense, home gardens allowed for the creation of positive living circumstances through resilience, food, economic and social security. Today, the combination of these aspects by means of home gardens represents a form of bottom up development.

This paper examines the role of home gardens for bottom-up rural development, with a specific focus on the contribution to food security in the context of indigenous Mayan populations in the Mexican peninsular. It examines the structural complexity, functional diversity, and management strategy of Mayan home gardens. Based on the research carried out, the paper suggests improvements to promote rural food security. This paper is structured in the following manner: section II considers the theoretical framework of home gardens through a literature review; section III presents an explanation of the context, justification of sampling and overview of methodologies; section IV includes the key research findings; section V provides an interpretation of the results. The final sections (VI and VII) draw insights into potential improvements as well as implications for home garden theory and policy.

Theoretical Framework

The practice of home gardens is considered to be one of the oldest land use activities; they have evolved through generations of gradual land use intensification (Nair and Kumar, 2006). The concept of the operational foundation of home gardens is that they are based on close multistory combinations of various trees and crops, sometimes in association with domestic animals around the homestead (Wiersum, 1982; Brownrigg, 1985; Fernandes and Nair, 1986; Soemarwoto, 1987; Kumar and Nair, 2004). Home gardens, though practiced across different socioeconomic sectors, are predominantly adopted by subsistence farmers and are widespread mainly in tropical climates in rural settings. One distinguishing characteristic of home gardens is the presence of high species diversity of different functional groups such as food crops, vegetables, fruit trees, medicinal plants, spices and condiments, beverage, ornamental plants as well as domestic and wild animals.

Several studies on home gardens have focused on structural complexity (Mariaca, 2012; Soemarwoto, 1987; Flores Guido, 2012; Arias Reyes, 2012), structure and function (Fernandes & Nair, 1986), biodiversity, food security and nutrient management (Montagnini, 2006; Cahuich-Campos, 2012), economic gains (Mohan et al., 2006; Cámara-Cordova, 2012), and sustainability issues (Torquebiau, 1992; Torquebiau & Penot, 2006). In spite of receiving high ratings on productive and service functions, home gardens have not been given importance as a bottom-up development strategy. Indeed, home gardens have come to the fore as mere practices to ensure food security in marginal areas and communities.

The mainstreaming of food security in the international development agenda has had a transformative effect on the home garden literature, with an ever increasing number of peer-reviewed publications focusing on the topic (102,000 papers in the period 1980-1990 compared to 205,000 in 1990-2000 and 937,000 in 2000-2010; Google Scholar search term="home garden*"). The increasing focus on the topic, especially since 2000 when the Millennium Development Goals were agreed upon indicates that home gardens research has geared itself towards the inclusion of issues of sustainability and resilience. For example, while the traditional literature understood home gardens as agricultural systems which provided biodiversity conservation (e.g. Caballero, 1992) the literature has recently focused on how traditional indigenous agricultural methods allow for resilience, both economic and food-wise in a sustainable manner (e.g. Galhena et al., 2013). In this stream of the literature, resilience is interlinked with sustainability, with home gardens playing a significant role in promoting both. Resilience, the capacity of a system to withstand social, political and environmental change (FAO, 1996), is achieved by the availability of additional food and income sources outside of traditional employment. Sustainability, the quality of a practice that is not harmful to the environment, both socially and ecologically (UNO, 2000; FAO, 2013), is also a key component of home garden practices as their ecological footprint is traditionally very low (cf. Galhena et al., 2013).

Furthermore, it is also important to consider the way in which the literature pairs food security with economic security. For example, the Food and Agriculture Organisation argues, firstly, that home gardens are grown to "generate income from the sale of garden produce… [which] can contribute to a family's income" (FAO, 2015:2). Food and nutrition security can be understood as the condition where "all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (FAO, 1996:2) and as "adequate nutritional status in terms of protein, energy, vitamins and minerals for all household members at all times" (Quisumbing, 1995:11) respectively. Thus the notion of food security encompasses food availability, accessibility, utilization and stability, addressing supply, household level design, income, expenditure, buying capacity and the amount and ways in which people consume food. These aspects cover important livelihood and well-being considerations such as sanitation, water, health care practices, purchasing power, economic freedom and resilience.

This understanding is corroborated by the World Bank's assessment on the economic effects of malnutrition and food poverty which suggests that due to "high food prices, many poor families cope by pulling their children out of school and eating cheaper, less nutritious food…[thus causing] infant, child and maternal illness; decreased learning capacity, lower productivity, and higher mortality" (World Bank, 2015:56). This interchangeability between economic and food security generates confusion around two very important issues. First, in the field, economic opportunities are relatively low, especially as home gardens use the same growing system to produce the same types of crops across a community. This in turn, decreases the demand openings. Second, it implies that the literature considers the home garden as a unit of economic empowerment where food operates as a commodity, rather than a necessity. This is problematic, as the understanding of home gardens is limited to simple monetary utility, rather than having intrinsic, traditional or cultural value. We argue in the present paper that home gardens can serve as viable strategy for bottom up development, especially in marginal areas left out of the benefits of advanced production technologies promoted during the past few decades.

Methodology and Materials

A. Context

The research was carried out in the municipality of Felipe Carrillo Puerto in the south-eastern state of Quintana Roo, Mexico (Latitude N 19°03′ y 20°25′: Longitude W 87°25′ y 88°43′: altitude 0-100 m.a.s.l: annual rainfall 1250 mm: warm humid climate with Leptosol and Luvisolic soils). The entire area is populated by people of Mayan heritage, engaged in the practice of home gardens. The research area is shown in Figure 1.

B. Sampling

Data about home garden production components, including both vegetation and animal components, structural complexity, functional diversity and management strategies were collected from 100 households. These households were selected using random sampling to obtain representative data. Twenty households were selected from each of the following five communities: X-Maben, X-Pichil, X-Yatil, San Jose II and Melchor Ocampo.

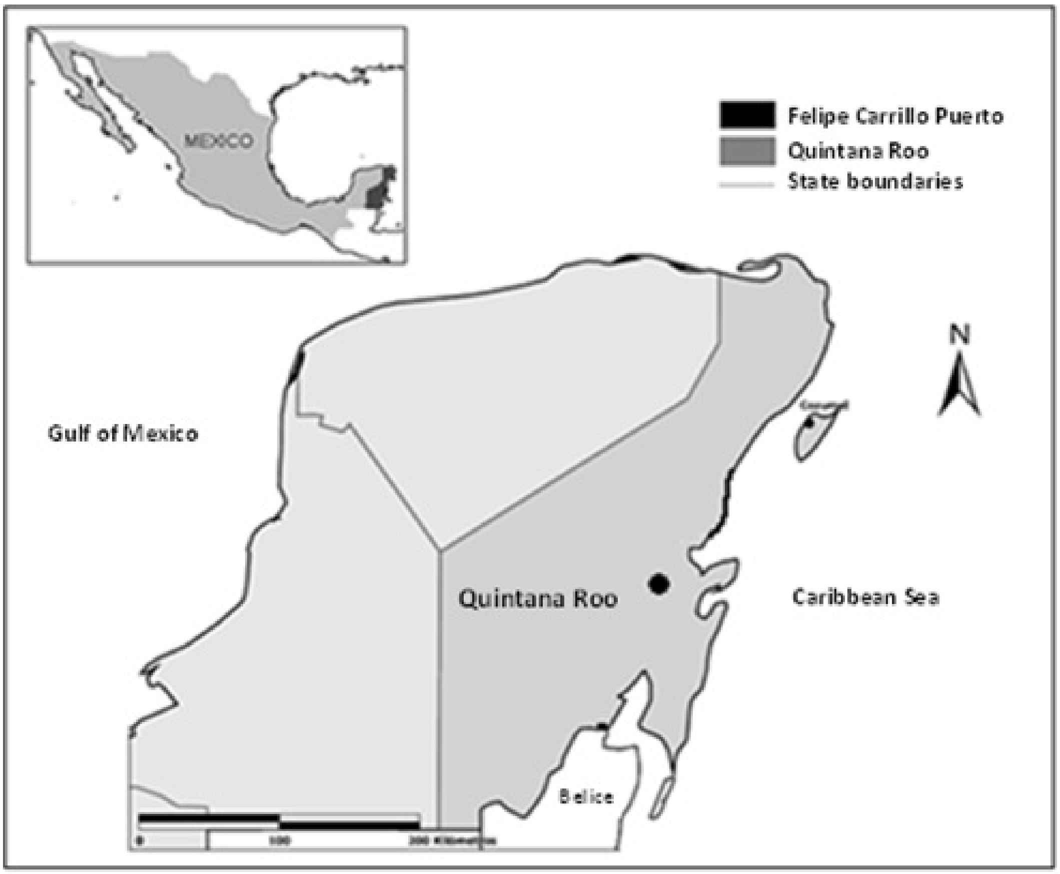

Figure 1: Figure showing the study area of the municipality of Felipe Carrillo Puerto in Quintana Roo, Mexico

C. Methods

The collection of data involved a combination of qualitative field observations, quantitative surveys and focus group discussions. Field observations were gathered by the researchers and involved randomly chosen households with families willing to participate in the research. These field observations were mostly used for the purposes of collating quantitative data such as the home garden structural complexity and its yield.

Focus groups were used to corroborate the data collected through field observations with information on indigenous knowledge related to the functional diversity and management strategies used for the maintenance of their own home gardens. Focus groups were chosen for two reasons: to allow for communication between participants for data creation (Kitzinger, 1995), and to allow for a widespread understanding of common management strategies and knowledge that is consensual, such that individual biases are openly revealed by and to participants. Focus groups are increasingly used to generate data on sustainable management of natural resources as the approach allows for a better understanding of how communities manage their own resources (Raymond et al., 2010; CBD, 2001; UNEP, 2012). Focus groups were also used to explore questions of social welfare and community relations to understand the role of home gardens in creating positive social conditions for increased well-being and development. Focus groups consisted of 15 to 25 members of both genders, with the occasional participation of children. This was replicated in each of the five communities. This allowed for a more representative understanding of social practices and knowledge, which in turn shed light on the social function of home gardens through community and network building. The participants were drawn from the randomly chosen households and they joined voluntarily. The community leader was also informed of the aims and purposes of the focus groups in advance of the research.

The research also involved the participation of translators (Mayan to Spanish) as the participants in the focus groups were of Mayan origin, and their level of comfort with Spanish was very limited. This in-

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formation was then translated into English for data analysis. The translators consisted of a group of students from the Felipe Carrillo Puerto University who were confident in both Spanish and Mayan dialect.

Evaluation of the study methodology

Although focus groups are becoming increasingly important in the study of social views, understandings of individual perceptions were left out. Indeed, focus groups are problematic in that certain voices and discourses can be ignored, as not all members would be comfortable talking in a group setting. Perhaps there might even be hierarchies in place that the researchers are unaware of, including hierarchies based on gender or social status. To avoid this, the research could have been carried out by means of semi-structured individual interviews. Another alternative could be the division of focus groups based on gender. This would have allowed for a better understanding of home gardens as a space for social well-being but also, more importantly, would have produced gender-disaggregated data on management practices. This is important when considering the fact that home gardens, in the majority of cases are usually managed by the female head of the household. Because of this, it can be argued that women are more equipped and knowledgeable in the issues of management and functional diversity. They also spend a lot more time in the home gardens compared to men, and tend to be the ones in charge of deciding how to use the produce for household consumption. Not only this, but a gendered perspective would have also shed light on the ways in which subsections of society relate to one another. For example, women's relationships, knowledge sharing and well-being are more intrinsically related to home gardens than men's, partly because men also have their work spaces to discuss amongst themselves.

Aside from the addition of a gendered understanding of home garden practices and social importance, selective rather than random sampling could have improved the study. Given the random nature of the study, it can be argued that certain aspects of home gardens were ignored. These include proximity to other social spaces, roads and cities which could have an effect on home garden practices, views and relationships.

Lastly, it is important to recognize the limitations of using translators. Although in this case, there was little to no alternative, translators have biases embedded in their own understanding of the communities and participants involved. This likely influenced the translations of the focus group discussions. Moreover, for the participants the involvement of these translators could have had implications overlooked by the researchers. These include issues such as wanting to appear a certain way to the translators and thus changing answers. Though there was no alternative, it is crucial to note these potential limitations when considering the results and conclusions.

Findings

A.Production Components and Structural Complexity
Data gathered on the production components, the various strata and plant diversity of the home gardens, shows two key results. Firstly, there is a high number (that is 4-5 strata) of architectural types and different life forms of plants. Secondly, more than 95% of the studied households contain both domestic and wild animals. These constituents of production serve a variety of purposes, including the provision of food, fodder, medicines and many others, as outlined below in Table 1.

The home gardens also contained vertically stratified plant species, with each stratum containing plants that belong to a specific life form. This trend is recognized in other home gardens (e.g. De Clerck & Negreros-Castillo, 2000).

In this sense, the Mayan home garden is an integral production system which combines agricultural, forestry, pastoral, fisheries, honey-bee, and aquaculture components and is managed within the household through family labour.

The households studied showed diverse foci of production: certain households specialized in animal production (around 82%, as animals are the main source of protein) whilst others on traditional medicine (around 90%, so as to reduce cost of medicinal care and provide immediate relief) and yet others on food production (100%, divided on vegetables or fruit trees). Therefore, the Mayan home gardens consist of highly complex, highly diversified species

Table 1: Common plant species found in home gardens in the state of Quintana Roo, Mexico outlining their uses

Local Name	Sientific Name	Family	Uses
Chincuya	*Annona purpurea*	Anonaceae	Food, aromatic, handicrafts, domestic construction, fuel wood and timber
Achiote	*Bixa orellana*	Bixaceae	Food, aromatic, ceremonial, dye, condiment, industrial use, fuel wood and medicinal
Chaka	*Bursera simarouba*	Burseraceae	Handicrafts, hedge, ceremonial, soil binding , instruments, fuel wood, timber , medicinal, tannin
Nance	*Byrsonima crassifolia*	Malpighiaceae	Food, handicrafts , ceremonial, dye, construction, fodder, soil binding, firewood, timber , medicinal, ornamental
Papaya	*Carica papaya*	Caricaceae	Food, beverage, industrial, medicinal, ornamental
Cedro	*Cedrela odorata*	Meliaceae	Handicrafts, timber, soil binding, fuel wood, repellent, ornamental
Limón dulce	*Citrus limonia*	Rutaceae	Food, aromatic, beverage, seasoning, firewood, medicinal and ornamental.
Pajarito	*Cordia alliodora*	Boraginaceae	handicrafts, instrument, firewood, timber, medicinal, ornamental
Jícara	*Crescentia cujete*	Bignoniaceae	Food, ceremonial , construction material, domestic appliances, instruments, medical, honey production
Cocoíte	*Gliricidia sepium*	Fabaceae	Fodder, crafts, hedge, dye, nitrogen fixing, firewood, medicinal, repellent, shade, tannin, ornamental.
Aguacate	*Persea americana*	Lauraceae	Food, cosmetics , condiment, industrial use, medicinal, timber

with flexible management strategies and minimal external input.

B. Utilities obtained from traditional home gardens

One of the key findings from the focus groups discussions was the unanimous recognition of the role of women in managing the productive components of the home gardens. Men and other household members are in charge of other management tasks including tree pruning and construction and small-scale sales for disposable income creation. This suggests that the management strategy of the home

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gardens is flexible and usually managed within the household through family labour with little external input.

In terms of the products obtained from the home gardens themselves, most of the food products are used for household consumption. Only a small proportion of the surplus is sold, with the excess being occasionally shared with neighbours and other community members. This is a common Mayan tradition whereby households are expected to share their home garden produce for religious festivities. This serves to preserve culture, identity and tradition whilst also encouraging social cohesion and social reproduction. Focus group discussions suggest that members consider the varied services and functions of home gardens to affect the communities in a positive way, so that it is possible to justify the practice of home gardens as much more than food necessity. This was another important consideration discussed in the focus groups.

The role of home gardens in creating social networks, cohesion and community building was considered to be important during the group discussions. During focus group discussions, participants highlighted the importance of home gardens in day to day activities as well as a starting point in creating rapport for people within each community to relate to one another. This is an important finding, as the mainstream international political agenda neglects the different ways through which social cohesion can be built from home gardens. Although there is a recognition of the exchange of ideas and traditional knowledge taking place, notions such as food sovereignty, identity, rapport and community building are often considered the result of positive accumulation of food and economic security, rather than a parallel consequence of the practice of home gardens.

In this sense the functions of the home gardens can be considered under the spectrum of security, including financial, nutrition, social, and health security. The different uses and functions of home garden produce consist of: (1) food or groceries; (2) medicinal drugs (for human and domestic animals); (3) fodder; (4) aromatic (flavourings, perfumes, etc.); (5) sweeteners; (6) soft or alcoholic beverages; (7) spices; (8) stimulants; (9) ceremonial (amulets, magic, rituals); (10) drugs (hallucinogens, narcotics, tranquilizers); (11) resins; (12) honey; (13) oil (edible and industrial); (14) fences; (15) windbreaks; (16) tools for agriculture, hunting and fishing; (17) fibers (textiles, cordage and basketry); (18) construction (furniture or houses); (19) for handicrafts; (20) musical instruments; (21) waxes; (22) dyes; (23) biological control (insecticides, fungicides, herbicides); (24) cosmetic; (25) domestic use (cooking, wrapping, drying adhesives, etc.); (26) bioenergy (coal, fuel wood, oil); (27) soil erosion control; (28) rubber and latex; (29) ornamental or aesthetic; (30) tannins; (31) toxic (poisonous to man and domestic animals); (32) honey bee stinging for medical purpose; and (33) green manure.

C. Functional services of home gardens

In addition to identifying the various uses of the products grown in home gardens, the focus group discussions also considered a series of other home garden functions as units in themselves. These include (1) services of provision: products obtained from the ecosystem, (2) services of regulation: the benefits of regulating the ecosystem include the improvement of air quality, climate regulation and the diminishing of proneness to natural hazards, (3) services of culture: non-material services gathered from spiritual enrichment, social status, recreation, entertainment, mindfulness, social rapport and social networks, and (4) services of support: services deemed important for other ecosystem functions such as soil conservation, photosynthesis and nutrient cycles. These services were outlined using the fourfold classification of the Millennium Ecosystem Assessment (MEA) of 2001 (MEA, 2005).

Discussion

Home gardens are complex systems. They are resilient, "time-tested strategies" (Galhena et al., 2013) and consist of flexible management strategies at the household level (Caballero, 1992). The home gardens practiced by Mayans in Quintana Roo conform to a very specific type of home garden (Lope-Alzina & Howard, 2012). This is because the home gardens of the indigenous communities include a high number of wild and cultivated plant species which are structured into different vertical layers and managed so as to transmit knowledge in an inter-generational manner. Furthermore, the intricate combination of plant species are arranged horizontally which takes into consideration specific soil types and nutrient cycles for the best year-round production. What makes the combination of these factors so striking in the Mayan context is that the communities do not consider these aspects as separate units of analysis but instead as a whole; where political, economic, cultural and social factors are interlinked and related to biological, agricultural and ecological factors. Leclerc & Thuillet (2014) noted similar patterns of family farming in different parts of the world.

The diversity of functions of home gardens reveals three key findings. Firstly, home gardens play an important role in creating economic and food security which in turn facilitates livelihood security. Secondly, home gardens have a presence and influence on day to day relations and activities at household, fraternal and community levels. Thirdly, within the multiplicity of the functions of home gardens it is possible to see that they support the creation and recreation of both ecosystems for food production as well as social relations in a sustainable and interrelated manner.

Bearing in mind that food security encompasses the notions of availability, accessibility utilization and stability, it is possible to understand the ways in which this research corroborates the mainstream discourse on home gardens: that the main and most important reason for the practice and maintenance of home gardens is for the continuous production of varied food sources for household level consumption (FAO, 1996; Caballero, 1992).

Aside from the recognition of home gardens as a source of food, it is important to consider their social functions too. Home gardens represent an instance of bottom-up development, because communities initiated the practice themselves. This implies that home gardens are a practice and approach that allows local communities and players to express their concerns and knowledge to define developmental pathways (European Commission, 2015). This is exemplified by the active involvement in the management of home gardens by the various family members. Focus group discussions about different management methods showed how home gardens are key in allowing communities to become agents of their own change. Communities have control over their food, economic, livelihood and social security, and are flexible and adaptable to changing conditions. The role of home gardens is different depending on whether they are analysed holistically or through an analysis of its diverse components and functions. The home garden, as a unit, has important social meanings and its symbolic use is key in creating conversations, relations and shared notions of identity. By considering crops individually, on the other hand, the key role of home gardens is production of crops to alleviate social inequalities and poverty by providing food, medicine and ornaments. Home gardens can be classified not only in terms of soil, produce, size and yield but also in terms of the management methods used. This in turn places emphasis on the instances of identity and diversity of home gardens across different regions of the world.

The fact that home gardens and their purposes and roles can be understood in these ways suggests that home gardens play into indigenous realities and lives in various ways. This is a key consideration, for in studying the home gardens, a series of lifestyles and realities are also being considered. More importantly however, consideration of the various functions of the home gardens places indigenous communities as agents of their own well-being and security.

It is also important to consider the limitations in the practices of home gardens in the Mayan context. Firstly, there is nobody such as a cooperative to whom communities can sell their excess produce. For this, perhaps the establishment of an association or a communal body can improve access to markets and other public institutions, to reduce the costs associated with the selling of produce. This could also facilitate the finding of new demand opportunities as well as to obtain training and technical knowledge and expertise from outside bodies such as government agencies, which could in turn help increase yield and production. The cooperatives could also improve the relationship and communication between the communities and the state, helping to alleviate a series of problems in the communities which are not necessarily associated with the home gardens, such as infrastructure, information sharing and modernizing the area through new methods and enterprises.

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Lastly, it is important to remember that home gardens allow for flexibility, culture, identity and resilience. In this sense, governmental bodies ought to consider the different types of family farming practices involved in managing home gardens so as to create policies that are aligned to the multidimensional realities of the indigenous experiences whilst helping macroeconomic, trade and public development.

Conclusions

Home gardens are a traditional source of food production for various indigenous communities around the world. Home gardens play a crucial role for the Maya communities of Quintana Roo as they serve to provide food, economic and social security. This is because they provide a diversity of crops, high yields and year round production but also imply a flexible space for the production of varied and nutritious food. Indeed, they consist of high species diversity, complex structures, minimal external input and flexible management systems to combine agricultural, forestry and animal components. Home gardens also serve communities by means of traditional, plant-based medicinal care which helps deal with unforeseen crises as well as a cost-efficient, self-sufficient immediate relief. Perhaps more noticeably, the research also shows that home gardens also allow for social resilience and community building through the provision of spaces for knowledge sharing and the exchange of goods. This in turn allows for the modernization and rapid diversification of secluded communities which has implications for bottom-up rural approaches to development. The research also shows that in fact, most of the communal and personal daily activities take place around the home garden, allowing it to play the role of an entity and space for development. In this sense, it is possible to argue that home gardens tap into all three recognized spheres of development: social, economic and environmental, suggesting that the home garden literature thus needs to consider more precise understandings of the role they play at the grassroots level where communities and people use home gardens to empower themselves as drivers and actors of their own change.

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Conflict of Interests

The authors hereby declare that there is no conflict of interests.

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Ecosystem services and adaptation for agriculture and food security: analysis of two decades (1991–2011) of financing by the Global Environment Facility

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ecosystem services, climate change adaptation, agro-biodiversity, sustainable intensification, sustainable land management, water resources management

Abstract

Investing in global environmental and adaptation benefits in the context of agriculture and food security initiatives can play an important role in promoting sustainable intensification. This is a priority for the Global Environment Facility (GEF), created in 1992 with a mandate to serve as financial mechanism of several multilateral environmental agreements. To demonstrate the nature and extent of GEF financing, we conducted an assessment of the entire portfolio over a period of two decades (1991–2011) to identify projects with direct links to agriculture and food security. A cohort of 192 projects and programs were identified and used as a basis for analyzing trends in GEF financing. The projects and programs together accounted for a total GEF financing of US$1,086.8 million, and attracted an additional US$6,343.5 million from other sources. The value-added of GEF financing for ecosystem services and resilience in production systems was demonstrated through a diversity of interventions in the projects and programs that utilized US$810.6 million of the total financing. The interventions fall into the following four main categories in accordance with priorities of the GEF: sustainable land management (US$179.3 million), management of agrobiodiversity (US$113.4 million), sustainable fisheries and water resource management (US$379.8 million), and climate change adaptation (US$138.1 million). By aligning GEF priorities with global aspirations for sustainable intensification of production systems, the study shows that it is possible to help developing countries tackle food insecurity while generating global environmental benefits for a healthy and resilient planet.

Introduction

With world population projected to reach 9.5 billion by 2050, it has been suggested that as much as 70-100% more food will be needed in order to meet demands (World Bank, 2008). Sustaining and intensifying agricultural, livestock and fisheries production is, therefore, essential for achieving global food security. As defined by the Food and Agriculture Organization (FAO, 2002), food security "is a situation that exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." Food security depends on three main factors — availability, access, and utilization, all of which are directly underpinned by ecosystem services.

Ecosystem services — provisioning, regulating, supporting and cultural — depend on efficient functioning of ecosystems, including the natural cycles and flows that underpin life on the planet (Millen-

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nium Ecosystem Assessment, 2005). From low-input and smallholder systems in most developing countries to the high-input and intensive systems of the developed world, ecosystem services play an important role in crop, livestock, fisheries and forest production. For example, supporting services (e.g. healthy soils, hydrological flows, and nutrient cycling) in production systems are essential for sustained productivity of food. Similarly, provisioning services (e.g. genetic resources) and regulating services (e.g. pollination) are key to the diversity and nutritional content of food crops and animals.

Harnessing the ecosystem services in production systems requires a careful and deliberate management of the natural assets (land, water and biota) to ensure long-term sustainability and resilience (Boelee, 2011; Bommarco et al., 2013). Investing in the management of ecosystem services that underpin productivity of agroecosystems is therefore an important priority in the global aspirations for achieving food security.

While much can be done to achieve food security by reworking global food systems, the need to increase food and feed production will likely increase pressure on the planet's land, freshwater, and biodiversity (Foley, 2011). It implies, however, that food production must be intensified to meet the demands of a growing world population. But agricultural intensification through increased irrigation and chemical fertilizers also tends to compromise the natural processes and services that underpin sustainability and resilience of production systems. Meeting the food security and sustainability challenges of the coming decades is possible, but will require considerable changes in nutrient and water management (Mueller et al., 2012). This reinforces the need for innovations that increase agricultural productivity, while sustaining or improving environmental goods and services in the face of climate change.

Sustainable intensification, through fostering best practices for crops, livestock, forestry and aquaculture, has been considered a key and desirable way to increase the productivity of existing land and water resources in food production (Godfray et al., 2010, Foley et al. 2011, Tilman et al., 2011). Much of the world experiences yield gaps where productivity may be limited by management (Foley, 2011). Increasing productivity in such cases involves the prudent and efficient use of production farm inputs, improved varieties and breeds, more efficient use of labor and better farm management. The challenge, however, is ensuring that all such intensification efforts are focused on existing production lands, including those under pasture (Phalan et al., 2011; Tscharntke et al., 2012). When climate change is considered, practices may be shifted to lands more suited for livestock or crops, and through rehabilitation or conservation of existing production lands based on their likelihood of productivity in the short- and long-term (Vermeulen et al., 2012; Wheeler & von Braun, 2013).

The need for generating global environment benefits through investments in agriculture and food security is an important priority for the Global Environment Facility (GEF), created in 1992 to serve as financial mechanism of the Rio Conventions — the Convention on Biological Diversity (CBD), the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Convention to Combat Desertification (UNCCD) and the Stockholm Convention. The GEF is the world's leading public financial fund dedicated to smart, environmentally sound choices that boost local economies and protect the planet. GEF provides financing to 146 recipient countries through the GEF Trust Fund, and two other trust funds that specifically support climate change adaptation (CC-A) in eligible countries: the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF).

For the GEF Trust Fund, financing is through five focal area windows: Biodiversity (BD), Land Degradation (LD), International Waters (IW), Climate Change Mitigation (CC-M), and Chemicals and Waste (CW). Financing through LDCF is driven largely by least developed countries' urgent and immediate adaptation needs, identified and prioritized in country-driven plans known as National Action Plans for Adaptation (NAPAs). The LDCF is primarily leveraged by eligible countries to finance the full cost of urgent and immediate adaptation actions that reduce vulnerability and increase adaptive capacity to the impacts of climate change. The SCCF has adaptation as its top priority in all developing countries that are non-Annex I parties to the UNFCCC. Through its two active financing windows, the SCCF supports adaptation measures in various development sectors.

Because of the importance of agriculture and food security as a development priority in many recipient countries, the GEF has been a major source of financing to address environment and natural resource management challenges. Yet there has been no systematic assessment of how GEF financing to generate global environmental and adaptation benefits supports agriculture and food security. This study addresses this need by analyzing GEF investments in the context of agriculture and food security projects financed over a period of two decades (1991-2011). The objective was threefold: a) synthesize GEF experience in supporting the agriculture and food security agenda of eligible countries; b) demonstrate the GEF's value-added for financing global environmental and adaptation benefits in the context of agriculture and food security investments; and c) establish a basis for increasing GEF role in fostering sustainability and resilience for food security.

The approach to GEF financing emphasizes targeted investments in projects that address objectives of the focal areas, including support to countries for the implementation of the Conventions for which the GEF serves as financial mechanism. The value-added of GEF financing is evident from the diversity of interventions in projects, and the potential for sustainability of outcomes for people and the global environment. Since the study did not include actual results from implementation of the projects, we do not draw any explicit conclusions about impacts of GEF financing. But by aligning focal area priorities with global aspirations for sustainable food production, we conclude that the GEF is well-placed to help feed the world while investing in our planet.

Analytical Approach

The underlying rationale for this study is that GEF financing for projects addressing agriculture and food security enables eligible countries to contribute global environment and adaptation benefits in production systems. Projects and programs included were therefore identified on the basis of their linkage to agriculture and food security; this, in turn, was determined from actual investment of GEF resources in project components that explicitly target the maintenance or improvement of ecosystem services in production systems and in climate change resilience.

Identification of Projects and Programs

To ensure a comprehensive analysis of GEF investments in the context of agriculture and food security, we used three parallel portfolio assessments to identify projects and programs. These parallel assessments were necessary to ensure consistency with the approaches and priorities of GEF financing through the focal area and trust fund windows. The first was focused on projects and programs financed under the GEF Trust Fund, and primarily through the Biodiversity, Land Degradation and Climate Change Mitigation focal area windows that include land-based priorities. The GEF project database was initially screened using keywords that reflect direct links with priorities and activities in production systems, such as *agricultural production, food production, land use, agro-ecosystems, agrobiodiversity, crop production, genetic resources, livestock production, farm management, farmers, silvopastoral systems, agropastoral, integrated landscapes, and irrigation management*. A total of 308 distinct projects and programs were identified as appropriate for the period covered, of which only 96 were determined to be designed specifically in the context of agriculture and food security investments.

The second assessment was focused specifically on projects and programs financed through the International Waters focal area, which invests primarily in management of water resources that are transboundary in nature and involve multiple countries. For the period covered by this study, 51 projects and programs financed with the focal area resources were determined to have direct links to agriculture and food security. The third assessment was focused exclusively on projects financed under the LDCF and SCCF, for which climate change adaptation benefit is the priority. A total 78 projects (49 under the LDCF and 29 under the SCCF) approved during the period covered by the study were identified, of which 45 (28 LDCF and 17 SCCF) were determined to include interventions supporting food security. The projects primarily address climate change adaptation in the agriculture sector, focus-

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ing on systems and capacities, best practices for both crop and livestock production and approaches to increase resilience of production systems.

Analysis of Trends in GEF Financing

The cohort of 192 projects and programs supporting agriculture and food security was included in the subsequent analysis of trends in GEF financing. We analyzed trends by replenishment phase, type of Trust Fund, focal areas (BD, LD, CC-M, CC-A, and IW), and geographical regions. We used the full amount of GEF grants and co-financing invested in all 192 projects and programs, from the pilot phase (1991-1992) through the first full year (2010-2011) of the fifth replenishment phase of the GEF Trust Fund. Projects financed from a single focal area window are considered as "stand-alone" projects, while those financed from multiple focal area windows are labelled "multi-focal area" (MFA). We analyzed regional trends based on the four GEF regions: Africa, Europe and Central Asia (ECA), Asia, and Latin America and Caribbean. In addition, we considered as separate all regional projects targeting specific geographies and global projects covering multiple countries.

Analysis of Financing Trends for Project Components

We conducted a detailed analysis of the 192 projects and programs to determine GEF financing for specific components and interventions supporting agriculture and food security. For GEF Trust Fund projects, we based the analysis on specific global environmental benefits associated with focal area windows from which resources are drawn. Global environmental benefits are essentially ecosystem services in production landscapes generated through management of land resources (e.g. soil and water conservation, soil carbon sequestration, improvements in vegetative cover); agricultural biodiversity (e.g. preserving genetic diversity, on-farm diversification); and aquatic ecosystems (e.g. protection of species and habitats for fisheries, sustainable flow and improved quality of water for consumptive use). For LDCF and SCCF projects, investments are associated with adaptation benefits in the agriculture and food security sector, such as reducing vulnerability and increasing resilience to climate variability and projected effects of climate change.

We analyzed financing for project and program components under four categories of direct relevant to agriculture and food security: sustainable land management, management of agricultural biodiversity (or agrobiodiversity), sustainable fisheries and water resources management, and climate change adaptation for food security. These categories are consistent with priorities of the different but complementary funding windows in the GEF. For the first three categories, GEF financing is focused on addressing global environment benefits in the context of crop and livestock production, as well as management of freshwater and fisheries. The fourth category of climate change adaptation includes GEF financing through the LDCF and SCCF.

Following the approach used to identify and select projects, we performed analysis of GEF financing separately for the GEF Trust Fund and the LDCF/SCCF. For projects and programs under the GEF Trust Fund, we derived grant amounts from the Results-based Management (RBM) framework. Project components in the RBM framework were considered relevant if the target outcomes and outputs focused directly on safeguarding ecosystem services (provision, regulating, supporting and cultural) and enhancing resilience of production systems. We counted the full amount of GEF grant for each component as contribution toward supporting agriculture and food security. For most of the projects and programs, there were components framed to accommodate a diversity of interventions in an integrated and cross-cutting manner at appropriate scales. Therefore, the breakdown of GEF grants allocated for specific components was aggregated across all projects irrespective of focal area, and whether the project was designed as stand-alone or multi-focal area.

Findings

Together, the 192 projects and programs with links to agriculture and food security accounted for a total GEF financing of US$1,086.8 million and an additional US$6,343.5 million in co-financing during the period covered by the study (Figure 1).

Trends in GEF financing

Financing trends over the years since the GEF's inception showed a steady increase during the first

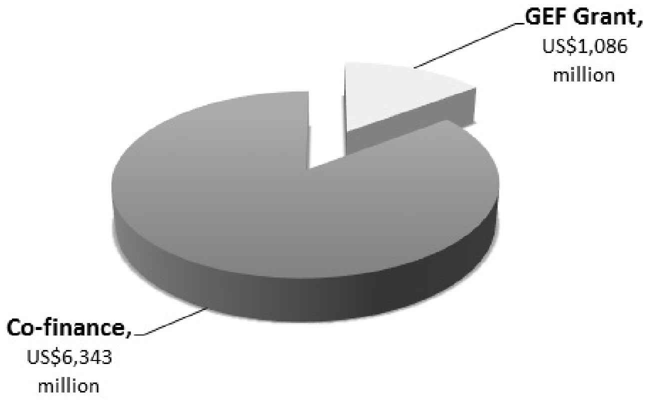

Figure 1: Total GEF Grant and Co-finance for all projects and programs with links to Agriculture and Food Security [Note: Total GEF amount includes grants from the LDCF and SCCF]

Table 1: Breakdown of GEF financing and Co-finance by Replenishment Phase and Trust Fund (Note: LDCF and SCCF funding only started during the GEF–3, and GEF–5 amount includes only projects and programs approved during the first full year of the Replenishment Phase)

Replenishment Phase / Trust Fund	Number of projects	GEF Amount (US$)	Co-finance (US$)
Pilot	4	15,056,300	10,230,000
GEF-1	5	28,592,764	105,305,500
GEF-2	25	124,704,706	346,177,783
GEF-3	36	208,186,812	980,919,418
GEF-4	69	285,166,757	2,165,149,224
GEF-5	8	217,831,857	1,905,366,429
LDCF	28	126,062,669	310,069,981
SCCF	17	81,241,762	520,284,507
TOTAL	**192**	**1,086,843,627**	**6,343,502,842**

three replenishment phases, but a significant jump during the fourth phase (Table 1). The fourth GEF replenishment phase (GEF–4) accounted for 69 projects, with US$285.1 million (26.2 %) of the total GEF funding, and US$2,165.1 million (34.1%) of total co-financing.

The major increase in GEF financing between GEF–3 and GEF–4 coincides with the start of the first full replenishment phase during which GEF resources were allocated to a dedicated LD focal area. This focal area specifically targets maintenance of ecosystem services in production landscapes through sustainable land management. While only 19 of the stand-alone BD and LD focal area projects were financed during GEF–3, the number increased to 30 during GEF–4. At the same time, the number of MFAs jumped from six during GEF–3 to 15 in GEF–4. The proportionally high amount for GEF–5 is due mainly to three major programs that will eventually

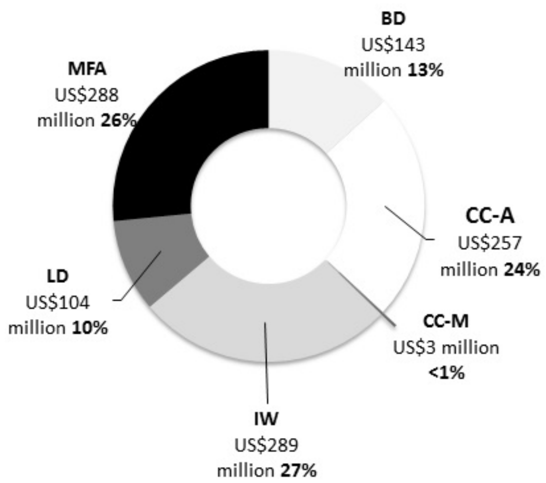

Figure 2: Amounts and Proportional breakdown of GEF Financing by Focal Area (Note: CC-A includes all financing for climate change adaptation; MFAs include financing from multiple focal areas)

be delivered through separate sub-projects. These observations are further supported by the focal area trends in GEF financing.

GEF financing under the International Waters (IW) accounted for the largest single focal area funding with US$289.09 million, representing about 27% of total GEF grants (Figure 2). Since inception of the GEF, the IW focal area has been the primary entry point for GEF investments in freshwater and coastal marine ecosystems; these focus mainly on mobilizing intergovernmental or regional agreements on policies and actions for sustainable management of shared aquatic systems. Hence the focal area plays a major role in management of fisheries and in safeguarding transboundary water resources that underpin production systems in developing country regions.

Financing for stand-alone projects under the BD focal area accounted for US$143.9 million (13%) of the total GEF grant. The BD focal area has been a signficant entry point for projects addressing agricultural biodiversity (or agrobiodiversity), with a focus on needs and priorities for protection of genetic resources (crops and livestock breeds), management of below-ground biodiversity and harnessing pest control and pollination services in production systems. Hence, some components of agrobiodiversity projects related to soil health also have direct relevance for the LD focal area.

In addition to stand-alone projects under the LD focal area accounted for US$104.7 million (10%) of total GEF financing, even though the focal area only became fully operational during GEF–3. The projects are designed to ensure a direct focus on sustainable land management interventions that generate global environment benefits while supporting the livelihood needs of poor land users. As a result, components in some of the projects also contribute to Biodiversity focal area objectives through conservation of agrobiodiversity.

Overall financing for CC-A amounted to US$257.4 million (24%) of the total GEF grant. As noted previously, CC-A focal area investments are directed towards building climate resilience in the agriculture and food security sector. CC-A projects address both the vulnerability of production systems and the practices associated with those systems. The CC-M focal area accounted for only US$3 million of the total GEF grant, which was through a single stand-alone project on “Alternatives to Slash-and-Burn”. This project was designed to assess potential of alternative land use practices such as agroforestry, that generate carbon benefits while increasing on-farm productivity in the tropical forest margins.
In addition to the stand-alone focal area investments, 30 multi-focal area (MFA) projects, three MFA programs, and one multi-trust fund program were designed to leverage GEF resources from multiple GEF windows based on their objectives. These projects account for US$288.5 million (26 %) of the total GEF grant, with contributions from the BD, LD, IW, and CC-M focal areas. In principle, MFA

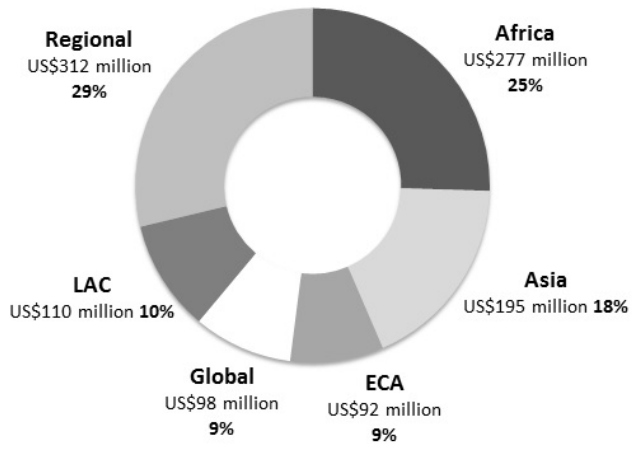

Figure 3: Amounts and Proportional distribution of GEF Financing by Geographical Regions (Note: CC-A includes all financing for climate change adaptation; MFAs include financing from multiple focal areas)

Table 2: GEF financing for components supporting Agriculture and Food Security (Note: Figures in parentheses are percentages of the total)

Type of Investments	GEF funding ('000 $)
Sustainable Land Management	179,317.9 *(22)*
Management of Agricultural biodiversity	113,432.8 *(14)*
Sustainable Fisheries and Water Resource Management	379,819.2 *(47)*
Climate Change Adaptation for Food Security	138,119.4 *(17)*
Total Investments	**810,688.9 *(100)***

and MTF project frameworks reflect priorities of the different focal areas from which GEF resources were used. However, most multi-focal area projects are often designed with integrated approaches that lead to multiple environment benefits. This helps to streamline investments for maximizing synergies during project implementation and fostering innovations in management of natural resources (land, water and biodiversity) to maintain ecosystem service flows in production systems.

Regionally, the breakdown of GEF financing shows countries in Africa accounting for US$277.1 million (25%) of the total grant, followed by those in Asia with US$195.9 million (18%), LAC with US$110.2 million (10%) and ECA US$92.5 million (9%) (Figure 3). These trends are consistent with global needs for addressing food insecurity since the world's largest population of hungry and malnourished people reside mainly in Africa and Asia. The majority of countries in these two regions are well placed to leverage GEF resources for investment in the agriculture and food security sector.

In addition to country-specific projects, there were 25 regional projects with links to agriculture and food security, with 12 focused on the Africa region, six in Asia, five in LAC and two in the ECA region. The total grant of US$312.5 million (28.7%) invested through regional projects mainly targeted specific eco-regions or multiple countries within the four geographical regions. The financing is also leveraged for thematic and cross-cutting initiatives that contributed knowledge for planning and decision-support. For example, several major regional projects were designed to strengthen knowledge

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management for agrobiodiversity (genetic resources) in Africa, the Middle East and North Africa, Central Asia and the Andes Region.

The emphasis on eco-regional or multi-country projects is a primary feature of IW focal area financing, which enables governments to cooperatively address systemic threats to water and fisheries resources that extend beyond national boundaries. IW projects benefited all four geographical regions, including coverage of major lake and river basins. Global projects, which accounted for only US$98.4 million (9%) of the total GEF grant, mainly addressed thematic issues that generate knowledge resources to support country-level efforts. There were thirteen such projects, of which six were under the IW focal area and covering issues related to management of fisheries and nutrient pollution. In the terrestrial realm, global projects also targeted knowledge needs for managing pollinators and below-ground biodiversity in production landscapes.

Trends in GEF Financing for Project Components and Interventions

The analysis of all 192 projects and programs included in the study showed that GEF grants allocated to specific components supporting agriculture and food security amounted to an aggregate total of US$810.6 million, about 75 % of the total GEF financing (Table 2). Sustainable fisheries and water resource management used the largest amount of GEF Trust Fund resources: US$379.8 million, or 47% of the total GEF financing. This is followed by sustainable land management (22% of the total grant supporting agriculture and food security), climate change adaptation (17%) and management of agricultural biodiversity (14%).

Sustainable land management:

GEF investments for sustainable land management offer direct opportunity to generate multiple environmental benefits in the context of agriculture and food security. The investments mainly target on-farm productivity of crops and livestock through improved management of land, soil, water and vegetative cover. As a means to ensure long-term sustainability of outcomes, GEF financing also supports an enabling environment for SLM, such as improvements in policy options, marketing, and extension and training programs. Because of the emphasis on integrated natural resource management, GEF financing for SLM often includes resources from the LD, BD CC and IW focal areas through multi-focal area projects. The projects using GEF resources for SLM covered a range of interventions, including soil and water conservation to reduce erosion and improve fertility; community-based landscape management, to promote collective action by land users, and creation of enabling environments or removal of barriers for land users to implement SLM. GEF support makes it flexible for countries to strengthen or create systems that help address this problem as part of agriculture and food security investments.

Management of Agricultural Biodiversity:

Agrobiodiversity is a key attribute of production systems, and includes soil fauna (below-ground biodiversity) that keep the soil healthy; genetic resources of crop and livestock used by farmers and herders; and the indigenous knowledge and traditional practices that help maintain ecosystem services (Perrings et al., 2006; Jackson et al., 2007). Although most GEF financing for agrobiodiversity is through the BD focal area, investment in soil health also used LD resources through multi-focal area projects. The investments contribute toward in situ conservation of genetic resources and soil fauna, reduction of pest and disease incidence through biological control (e.g. application-integrated pest management), harnessing pollination services and development of markets as incentives for maintaining crop diversity on farms. GEF financing was also invested in knowledge management and institutional strengthening for conservation of germplasm and awareness-raising on the importance of agrobiodiversity. Investment in institutional development, policies and regulatory frameworks helps protect indigenous varieties and knowledge for sustainable use of agrobiodiversity. At the same time, it also ensures that smallholder farmers can maintain land use practices that preserve and promote agrobiodiversity, which also contributes to SLM.

Sustainable Fisheries and Water Resources Management:

Fisheries management is crucial for poverty reduction in freshwater and coastal communities throughout the developing world, and GEF financing through the IW focal area helps safeguard the

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aquatic habitats and fish diversity for the sustainability of the sector. At the same time, sustainable agricultural systems and efficient water management practices help sustain irrigation needs and reduce pollution from agricultural areas. The level of financing is consistent with the scale of interventions necessary to tackle these challenges, which involve transboundary ecosystems and multiple countries. By working at the transboundary scale, regional knowledge-sharing and cooperative frameworks can better prepare neighboring countries in the event of crisis, such as floods and droughts. It can also allow neighboring countries to better manage migratory fish populations as climate change makes their distribution less predictable. The interventions for GEF financing include management of commercial fish stocks through ecosystem-based sustainable approaches; integrated ecosystem management of coastal and marine environments; improved governance and cooperation of transboundary freshwater lake, river basins, and aquifers to reduce pollution, unsustainable withdrawals and other conflicts; improved agricultural practices and governance to reduce chemical toxins and nutrient pollution from fertilizers that result in the poor water quality and eutrophication of lakes, rivers, coasts and marine environments.

Climate Change Adaptation for Agriculture and Food Security:

GEF financing for CC-A is through the LDCF and SCCF, and is linked directly to country priorities identified in the NAPAs and other national plans and strategies. LDCF and SCCF funds directed towards food security and agriculture were invested in six main categories of interventions: i) creation of enabling environment for CC-A at all levels, including development of policies and regulatory frameworks based on sound climate risk information; ii) promoting best practices for resilience in crop and livestock production systems, including demonstration and diffusion of resilient crop varieties, improvement in land and water management, grazing and post-harvest processes as a response to specific climate change vulnerabilities; iii) integrated approaches for the resilience of agro-ecosystems and livelihoods, including management of natural ecosystems and agro-ecosystems for generation of adaptation benefits, as well as livelihood diversification to enhance climate change resilience; iv) financial schemes to support resilient agricultural practices, including financial services for transferring risks and scaling-up proven, climate-resilient practices and technologies; v) weather-index based insurance; and micro-finance services to support implementation of new climate-resilient practices; and vi) knowledge management and dissemination, including synthesis of lessons learned through direct investments to build climate-change resilience in the agriculture sector and establishment of platforms for dissemination of such information.

Discussion

In the context of fulfilling its mandate as financial mechanism of the Rio Conventions, the GEF is playing an invaluable role in supporting eligible countries to build sustainability and resilience into agriculture and food security investments. A major result from this study is that GEF financing reflects consistency between priorities of the different funding windows and the global aspirations for environmental sustainability and resilience in production systems. Managing land, water and biodiversity in an integrated manner is key to ensuring sustainable flow of ecosystem services that underpin agriculture and food security needs in a changing climate (Power, 2010; Scherr et al., 2012).

The agriculture, livestock and fisheries sectors are major sources of anthropogenic stressors on the natural environment. The progressive deterioration of existing crop and rangelands, and of freshwater and marine systems, undermines food security for millions of poor people around the world. Safeguarding ecosystem services and building resilience in production systems is therefore a priority for developing countries where a significant proportion of the population depends on agricultural, livestock and fisheries management. GEF investments under the different focal areas create opportunities for developing countries to leverage global environment benefits in the context of agriculture and food security investments.

Sustaining Ecosystem Services Flows in Production Landscapes

The GEF plays an important role in promoting innovations to sustain flows of ecosystem services that underpin productivity of agricultural and rangeland

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systems. Trends in financing suggests that GEF support for ecosystem services in production systems is largely through sustainable land management (SLM) investments that seek to combat land degradation. GEF investment in SLM fosters a diversified portfolio of interventions from farm-level to wider landscapes, with a focus on maintaining or improving the productivity of drylands, rain-fed and irrigated systems. Interventions such as crop diversification, crop rotation, conservation agriculture, agroforestry and small-scale irrigation schemes, as well as water harvesting and water-saving techniques, are helping farmers in many developing countries to secure fragile production lands from further deterioration (Lin, 2011). As a result, potential gains in soil health and quality will enable sustained productivity of farm lands, while maximizing ecosystem service flows. Furthermore, arresting soil erosion and siltation in the production landscapes will also reduce the risk of sedimentation in aquatic systems.

In most developing countries, SLM represents a major opportunity for sustainable intensification of existing farmlands through efficient management of nutrients (e.g. combining organic and inorganic sources of fertilizers), integrated management of land and water resources, and diversification of farming systems (e.g. combining crops, trees and livestock). This approach ensures improved management of agro-ecosystem services across production systems and reduces pressure on natural areas, especially those under threat from agricultural expansion (Tscharntke et al., 2012). At the same time, it reduces the various externalities that arise from conventional approaches to intensifying production, such as the overuse of inorganic fertilizers and pesticides that lead to eutrophication and sedimentation of surface water bodies. This particular benefit of SLM is also relevant to the IW focal area, especially in geographies where the affected water bodies are transboundary in nature, and for which collaborative engagement by countries involved is crucial.

GEF financing also helps to improve and sustain the economic productivity, as well as environmental sustainability, of rangeland and agro-pastoral systems. Specifically, GEF financing targets SLM priorities such as improved grazing management and livestock fodder alternatives, as part of investments to enable livestock producers to maintain sustainable livelihoods through effective planning; animal selection, nutrition and reproduction; and herd health. The GEF also supports interventions that safeguard rangelands from risk of degradation, through actions such as reducing water and wind erosion, resolving wildlife–livestock–crop conflicts and creating fodder-banks. While the types of interventions are influenced by the context, the ecosystem service benefits are consistent with respect to keeping the rangelands productive and healthy (Reed et al., 2015).

A major global environment benefit of SLM is the potential for reducing greenhouse gas (GHG) emissions and increasing carbon sequestration in agricultural and rangeland systems, as a contribution to climate change mitigation (Lal et al., 2007). SLM interventions that improve soil and land quality also contribute to increasing soil organic carbon, as well as above-ground biomass accumulation. For most developing countries, the synergy between climate change mitigation and food security is best manifested in projects that demonstrate these multiple environmental benefits. However, while increase in soil carbon is a useful indicator of SLM achievements, the value-added for climate change mitigation is likely to vary considerably depending on type of agro-ecosystem and production practices. Therefore, climate change mitigation through SLM will likely impose tradeoffs for food security and livelihoods (Power, 2010). This implies that emphasis on GHG emissions and carbon sequestration as global environment benefit from SLM may not always be appropriate for projects targeting food security.

Agrobiodiversity — Preserving the Global Heritage

The study has shown that GEF financing plays an important role in safeguarding the genetic diversity of major food crops around the world, including fruits and vegetables that are important sources of nutrition in developing countries. This is achieved through projects that foster in-situ conservation of important crop genetic resources, livestock breeds, landraces and crop wild relatives; and through conservation and management of globally important agricultural heritage systems (e.g. Koohafkan and Altieri, 2011). GEF investment in these projects ensures that the genetic resources and associated management practices are sustained for posterity, while future options for agriculture and food security are maintained. Sustainable production of important food crops that have benefited from GEF financing include rice in Asia, date palms in the North Africa, coffee in Eastern Africa, and potatoes in the Andes region.

Agrobiodiversity also embodies the range of supporting functions associated with management of pests, diseases, and pollination in production systems (Bommarco et al., 2013). GEF financing helps in development of "diversity rich" solutions to manage pest and disease pressures for small and marginal farmers around the world. Maintaining local crop genetic diversity on-farm not only contributes to sustainable production and farmers' livelihoods, but also reduces the uses of pesticides. The use of genetic diversity can also be applied as part of Integrated Pest Management — an ecosystem-based approach to preventing and controlling pest damage that combines techniques such as biological control and habitat manipulation (Gurr et al., 2003). GEF financing has also helped to value pollination as an important service in agro-ecosystems, thereby contributing to the conservation and sustainable use of pollinators globally.

A third aspect of agrobiodiversity is the important attribute of soils in production landscapes, where the living components (e.g. microbes, mycorrhizal fungi, earthworms) play important supporting functions, such as decomposition of organic matter, nutrient cycling and disease control (Brussard et al., 2007). By investing in knowledge and tools for conservation and management of below-ground biodiversity, the GEF is helping improve and maintain healthy soils for crop and livestock productivity. This enables land users to harness the services provided by the soil organisms as natural assets, while contributing to their preservation.

Safeguarding the Aquatic Commons

Sustaining hydrological services is a growing challenge in the agriculture and food security sector, and for which GEF financing has been leveraged to target specific agro-ecosystems around the world. In the period from 1991 to 2011, 22 transboundary river basins, eight lake basins, five groundwater systems and 16 large marine ecosystems, have benefited from GEF financing; this has led to development of regional treaties, protocols and agreements for sustainable management of the resources. Strategic action programmes emerging from intergovernmental cooperation include targeted interventions to ensure long-term availability and flow of freshwater, and fisheries resources for consumptive use by the countries. GEF financing is contributing to implementation of action programmes for major lake and river basins such as Lake Victoria, which is a lifeline for over 30 million people.

The agriculture and food security linkages of integrated water resources management are mainly demonstrated through projects focusing on fisheries management, irrigation flow and control of nutrient pollution. GEF financing for collaborative fisheries management by governments helps improve the health of fish stocks, protect breeding zones for fish species and support development of policies and institutional frameworks to tackle the economic drivers of overfishing. In coastal areas, the GEF targets projects that advance ecosystem-based approaches to balance the demand for fish resources with the need for species and habitat conservation.

Safeguarding water in irrigated systems is key to ensuring long-term sustainability of food production. GEF financing specifically advances Integrated Water Resource Management (IWRM), which combines innovative technologies for irrigation with options and incentives to reduce demand for water in agricultural systems (Boelee, 2011). This approach ensures the needs of farmers are met, while reducing waste of scarce water resources. GEF financing for IWRM also plays a major role in tackling nutrient pollution from excessive use of chemical fertilizers in irrigated systems. Nitrogen pollution is an emerging global problem because of its link to coastal "dead zones" resulting from poor management of irrigated lands and floodplains. GEF investment in the Danube River basin is a model of regional cooperation for water quality improvement based on achievements in controlling nutrient pollution through IWRM.

Climate Change Adaptation and Resilience

GEF investments in adaptation help developing countries deal with a myriad of challenges related to climate change and variability. The emphasis is

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on increasing adaptive capacity of farmers and enhancing resilience of production systems (Howden et al., 2007; Lin, 2011). The first step towards making agriculture and food production resilient to climate change is the creation of awareness among farmers and policymakers of climate variability and projected changes. The second step is to understand the inadequacy of business-as-usual agriculture practices and policies in maintaining food security. Third is to use the available climate information to design agricultural systems that are resilient to climate variability and change. In almost all projects, LDCF financing supports integration of assessed climate risks into agriculture-related policies at all levels and practices. This helps improve the existing decision-making schemes at national to local levels, and to alter farm and crop management according to the expected changes.

Projects have introduced use of drought-resilient crop varieties and supported farmers with appropriate extension services that provide help with the new techniques. In water-scarce areas, climate change adaptation funds have provided infrastructure and training for infield rainwater harvesting; medium-range weather forecast systems have been developed to deal with uncertain rainfall. In some cases, the integrated approach to natural resource management is applied for addressing food security risks posed by climate change. In Bangladesh, for example, LDCF financing is helping diversify livelihoods and create project ownership by promoting small-scale aquaculture and fruit farms among the mangroves protected and rehabilitated for storm protection.

Climate change adaptation projects also engage local communities in on-the-ground activities. In addition to creating project ownership, the projects promote climate-informed management of natural resources as a long-term strategy for safeguarding and improving livelihood options. Other development opportunities, such as community-based ecotourism, alternative livelihood options, expansion of suitable insurance schemes for the agriculture sector and payment for ecosystem services, can protect investments in uncertain climate conditions. In some regions, they also offer new and sustainable sources of income for local communities.
The success of these opportunities depends on the design of incentive mechanisms that facilitate implementation of integrated land, water and forest management practices with full understanding of ecosystem flows and food production (Vermeulen et al., 2012). Harnessing these options will also require certain conditions to ensure empowerment, equity (including gender) and rights of the communities. The projects funded through LDCF and SCCF pay special attention to gender; progress is tracked through gender-disaggregated indicators. The different needs, responsibilities and interests of women and men should continue to be considered in efforts of building climate resilience in production landscapes.

Conclusion and Recommendation

This study demonstrates a strong link between the GEF mandate for investing in global environmental and adaptation benefits, and the global aspirations to foster sustainability and resilience for food security. It shows that the GEF is directing considerable amounts of resources to this development priority through its various financing windows, addressing the potential for harnessing and sustaining ecosystem services in production systems. This suggests that GEF financing creates opportunities for developing countries to integrate environmental management and adaptation needs in the agriculture and fisheries sectors. As shown in the analysis, a wide range of global environment benefits is possible based on the type of interventions eligible for GEF investment in the four categories, with direct links to priorities of focal areas through which the financing is allocated (Table 3).

The GEF role as financial mechanism of the Conventions will continue to gain importance as all developing countries seek to address environment and development goals in an integrated manner. Consequently, potential increases in development financing for agriculture and food security will create new opportunities for the GEF to target global environment and adaptation benefits in production systems. This assessment has shed some light on how the GEF mandate directly supports global aspirations for environmental sustainability and resilience in the agriculture and fisheries sectors.

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Table 3: Potential Global Environmental and Adaptation Benefits from GEF investments linked to agriculture, fisheries, and food security

Investment Category	Typology of Interventions for GEF Project Support	Potential Global Environment / Adaptation Benefits	GEF Focal Area(s)
Management of Agricultural Biodiversity	· Collection and conservation of germplasm, knowledge management and awareness-raising	· Conservation of indigenous and adaptive crop genetic resources	BD
	· Practices and technologies for optimal use of crop genetic diversity	· Maintenance of pollinators and "biocontrol" species on farms	LD
	· Development of policies at national and regional levels	· Preservation of indigenous knowledge, practices and production systems	CC-A
	· Institutional development at national, regional levels and community levels	· Diversification of crops on farms and in existing production systems	
	· Methods to improve productivity	· Maintenance and improvement of soil health and quality (i.e. below-ground biodiversity)	
	· Improve agricultural marketing services as incentives for conservation	· Increased vegetative cover and soil carbon in production landscapes	
	· Extension, demonstration and training activities for scaling-up	· Reduced demand for clearance of natural habitats (deforestation)	
Sustainable Land Management in Crop and Rangelands	· Knowledge base on SLM best practices in agricultural lands	· Diversification of farms and existing production systems	LD
	· Micro-irrigation, and soil and water conservation	· Maintenance and improvement of soil health	IW
	· Institutional capacity development for sustainable land management	· Sustained flow of water resources for irrigation	CCA
	· Innovations to reverse land degradation and restore degraded lands	· Increased tree and vegetative cover in crop lands	CC-M
	· Community-based land management	· Increased soil carbon sequestration	
	· Ecosystem and pasture management	· Reduced erosion and siltation risks in water bodies	
		· Preservation of indigenous knowledge and practices	
		· Sustainability of grazing lands and pasture systems	

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Investment Category	Typology of Interventions for GEF Project Support	Potential Global Environment / Adaptation Benefits	GEF Focal Area(s)
Sustainable Fisheries and Water Resources Management	· Fisheries management	· Conservation and maintenance of fish diversity	IW
	· Integrated water resource management in lake basins	· Sustainability of fish stocks and reduced risk of depletion	BD
	· Integrated coastal management	· Improved quality and flow of freshwater	CC-A
	· Large marine ecosystem	· Reduced risk of siltation and pollution in freshwater bodies and coastal marine areas	
	· Persistent toxic substances	· Increased protection of aquifers and wetlands	
	· Integrated water resource management in river basins		
	· Integrated water resource management in aquifers		
	· Learning and capacity building		
Climate Change Adaptation for Food Security	· Institutional capacity development at national, local and district level for planning and management of climate change adaptation	· Reduced vulnerability of crop and livestock production practices	CC-A
	· Mainstreaming climate change adaptation in the agricultural sector	· Increased resilience of crop and livestock production systems and agro-ecologies	
	· Knowledge management, codification of best practices for adaptation to climate change	· Maintenance of adaptive crop and livestock resources	
	· Development of early warning systems, hydro-meteorological databases		
	· Research development/piloting of resilient adaptation systems		
	· Water resources management in agricultural sector		
	· Community-driven initiatives to enhance livelihood and coping strategies		
	· Demonstration and technical guidance, dissemination of knowledge on adaptation and food security		

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Conflict of Interests

The authors hereby declare that there is no conflict of interests.

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The role of organic farming for food security: local nexus with a global view

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organic farming, sustainable agriculture, environment, food security, 2015 Milan Expo, global governance

Abstract

A convergence of factors has made food security one of the most important global issues. It has been the core concept of the Milan Expo 2015, whose title, Feeding the Planet, Energy for Life, embodied the challenge to provide the world's growing population with a sustainable, secure supply of safe, nutritious, and affordable high-quality food using less land with lower inputs. Meeting the food security agenda using current agricultural production techniques cannot be achieved without serious degradation to the environment, including soil degradation, loss of biodiversity and climate change. Organic farming is seen as a solution to the challenge of sustainable food production, as it provides more nutritious food, with less or no pesticide residues and lower use of inputs. A limit of organic farming is its restricted capability of producing food compared to conventional agriculture, thus being an inefficient approach to food production and to food security. The authors maintain, on the basis of a scientific literature review, that organic soils tend to retain the physical, chemical and biological properties over the long term, while maintaining stable levels of productivity and thereby ensuring long-term food production and safety. Furthermore, the productivity gap of organic crops may be worked out by further investment in research and in particular into diversification techniques. Moreover, strong scientific evidence indicates that organic agricultural systems deliver greater ecosystem services and social benefits.

Introduction

In recent decades, sharp rises in food prices and the growing level of hungry and malnourished people on the planet (Dawea and Maltsogloub, 2014), as well as a series of multiple stresses, including climate change, soil, water and air pollution that are affecting crop productivity (FAO, 2015), have raised awareness among policy makers and the general public with respect to the fragility of the global food system.

The significance of the issue was highlighted by the 2015 edition of the Universal Exposition held in Milan. The core theme chosen for the EXPO Milano 2015 was Feeding the Planet, Energy for Life—with a principal focus on the right to food for all the world's inhabitants- demonstrates the urgency of the problem and invites politics, science and business to find solutions of how to sustainably feed the planet and reduce hunger. The theme of Expo Milano 2015 reflects the title of an outstanding FAO conference held in 2009, titled How to feed the world in 2050, where experts from all continents met to discuss

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and put forward solutions to ensure food security by 2050. By that date demographers consider that the world population will reach 9 billion people and the global demand for food may increase by 70% vis-a-vis to the current demand (Godfray et al., 2010).

Currently more food is produced than needed to feed the entire world population; despite this fact, food availability will not comply with the rising demand of the planet. It means that the foremost hunger problem today is one of food distribution rather than food shortages. Today we are faced with issues of over- and under-nutrition: more than a billion people today are chronically underfed simply because they are too poor to buy the food that abounds, while much of the developed world is at the same time facing a crisis of obesity and diet-related diseases, such as cardiovascular disease, hypertension, cancer, diabetes and non-alcoholic fatty-liver disease.

Thus, simply increasing global supplies will not solve the distribution problem. However, it is clear that world food demand will continue to grow and there will be a need to grow more food. This can be achieved by increasing productivity or by expanding the total cropped land area, the demand for land conversion. The projected need for additional cropland and grassland areas implies further risks of deforestation and other land-use changes, like for example the conversion of semi-natural grasslands. This will most likely affect biological integrity, which underpins the ecosystem services and well-being of local and global communities (Maes et al., 2012). The article How Much Land Can Ten Billion People Spare for Nature? by Paul Waggoner (1997) is an important contribution towards dealing with dilemma posed by demographic trends and increased global demand for food and the compatibility between the strategies for global food security and those for nature conservation, but also on greenhouse gas emissions, soil degradation, alteration of hydrological cycles and global nitrogen and phosphorus dynamics. Change in land use also impacts livelihoods and economic systems, migration patterns and social cohesion, and on cultural norms and preferences. Along with land use change, social and economic value systems can change; markets and trade opportunities can change and political, economic, cultural and social capitals can change. Other elements of concern with respect to food security arise from endogenous (food or non-food products, such as biofuels and bioplastics) and exogenous (for water and land resources resulting from other productive sectors and the expansion of urban settlements and infrastructure) antagonisms within the agricultural system itself. These kinds of agricultural problems are connected with the concerns about the pressures arising from the intensification and expansion of modern agriculture, which is considered a major driver of climate change, land-use change, loss of biodiversity integrity and modification of nitrogen and phosphorus cycles (Hole et al., 2005; Rockström et al., 2009; Steffen et al., 2015)

To promote global food and ecosystem security, several innovative farming systems, alternative to conventional agriculture, have been identified. They include integrated, conservation agriculture, mixed crop/livestock, and perennial grains. Organic agriculture is the most popular alternative farming system, especially in Europe and North America. Some authors maintain that this approach is dangerous because organic agriculture should not be considered more sustainable because they may require more land for production. Further, organic farming does not necessarily lead to a better environment or better food products (Kirchmann and Thorvaldsson,2000) and it does not produce nutritious, affordable and accessible food in a socially and environmentally sustainable manner. Finally, broad-scale adoption of organic practices could result in decreased yields in organic system because of reduced nitrogen deposition from conventional farms.

Hence, the key issue of the debate has to do with the contribution that organic farming can make to the future of global agriculture. Will organic farming be able to produce enough food to feed an overpopulated world, ensuring food security,across the planet in next few decades, and at the same time preserving natural environment and providing short and long-term ecosystem services and benefits for society?

The choice of organic farming

Organic farming is an alternative to conventional agricultural systems for the aspects related to both

Figure 1: The EU logo (better known as Euro-leaf), made mandatory for all EU organic products and manufactured, according to the regulations of the Council EC / 834/2007 and EC / 889/2008. The Euro-leaf, which use is governed by EC Regulation 271/10, may be applied on a voluntary basis in the case of organic products not packaged or other organic food imported from third countries. For processed products, to classify them as "organic", at least 95% of ingredients must be organic.

the management of the farm and the production system. Organic farming or «bio», to use the name with which it is known in Italy, has as its main objective not the achievement of high levels of production but maintaining and increasing levels of organic matter in soils (hence the term organic farming used in England, where organic farming has taken the first steps). Thus organic farming reduces or eliminates the intake of synthetic fertilizers, herbicides, pesticides and pathogens. Only manual, mechanical and thermal practices are permitted for weed control. Wildlife species (insects, mites, snails, etc.), considered crop parasites, can be controlled through biotechnology measures or natural insecticides. This organic production method thus plays a dual function: the first responds to the demand from consumers for healthy and safe food; the second towards the public good, through a contribution to the protection of the environment, animal welfare and rural development.

In Europe, organic production and labelling is governed by a specific regulation, EC Regulation 834/2007 and the subsequent amending and correcting EC regulations 889/2008, 505/2012 and 354/2014. These contain a number of common provisions regarding production methods, product labelling, control system and financial measures to support organic farming. The regulations also integrate measures aimed at protecting the environment and biodiversity (Ciccarese and Silli, 2014). In particular, the EC Regulation 834/2007 provides for the mandatory use of the organic label, which is associated with a numerical code coupling with the proper logo, indicating the country, the type of production method, the operator code and the control code (Figure 1).

Organic farming in Italy and in the world

In 2013 the amount of land used for organic farming across the world reached 37 million hectares (Mha) (FIBL-IFOAM 2015). This figure is 3% higher than the previous year's figure. The largest area of land under organic cultivation is in Oceania, with about 12 Mha, or 40% of the world's total (Figure 2). In Europe organically cultivated land covers 11.5 million hectares. In the European Union (EU) 10.2 million hectares are organically farmed, representing 27% of the world's total. The EU countries with the largest organic areas are Spain (1.6 Mha), Italy (1.3 Mha) and France and Germany (1.1 Mha each). The share of organic agricultural land is more than 10% in eight European countries, with Liechtenstein (31%), Austria (19.5 %) and Sweden (16.3 %) having the highest organic shares.

According to SINAB (2015), in 2014 the acreage under organic farming in Italy arrived at about 1.4 Mha, an increase of more than 5.4% over the previous year. This figure corresponds to 10.8% of the national utilised agricultural area (UUA) (Figure 4). The

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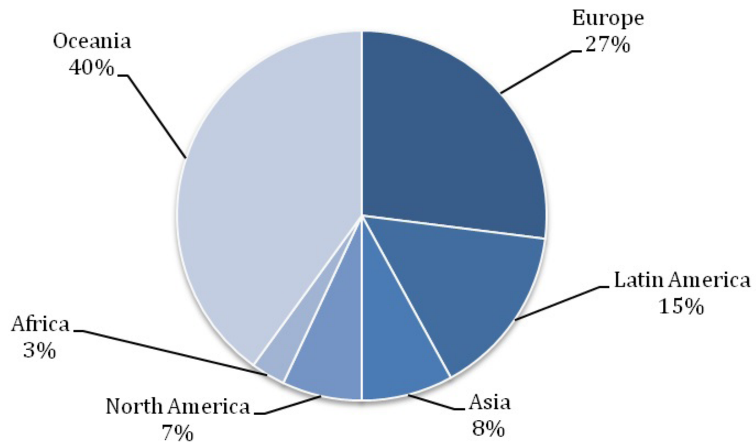

Figure 2: Percentage distribution of organic agricultural land across world (2013) (Source FIBL-IFOAM, 2015)

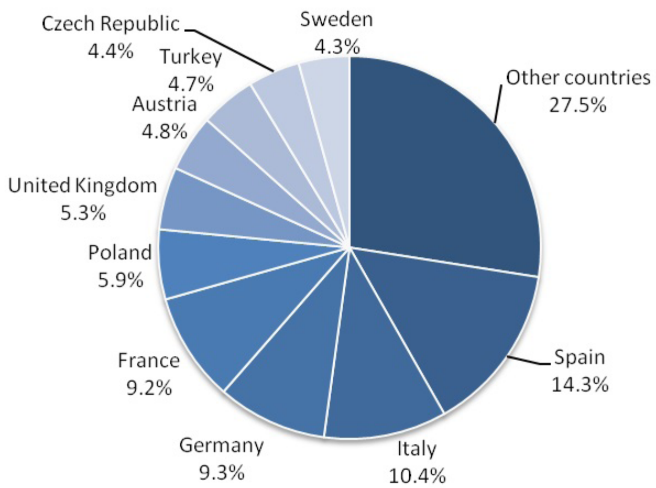

Figure 3: Percentage distribution of organic agricultural land across Europe (2013) (Source FIBL-IFOAM, 2015)

number of organic growers amount to about 46,000 farms (ISPRA, 2014). Italy is among the world's foremost producers of citrus fruits, olives, fruits (grapes, cherries, pears, plums, apples, quinces and apricots), cereals and vegetables. Moreover, Italy is at the top of the world market for the production of high quality organic jams and marmalades.

Figures provided in this paragraph confirm the growing trend of organic farms all over the world. It reflects the rising demand for healthy organic food. According to ISMEA (Institute of Services for the Food Agricultural Market) (2014), 60% of total consumers buy organic food. In 2014, there was a sharp increase of organic food consumption, both compared to 2012 (+5.8%) and compared to 2013 (+ 4.5%). These data are corroborated by a survey carried out by Nomisma (an Italian society for economic studies), and the Observatory of the International Organic and Natural (2014), according to which more than 50% of Italians said they had purchased organic products over the year. As reported by a survey of the Institute of Services for the Agricultural and Food Market (ISMEA, 2014) and by the National Information System on Organic Agriculture (SINAB, 2014), the Italian organic market continues to grow at a fast pace. In the first five months of 2014, the consumption of packaged organic products in supermarkets increased by 17% in value over the first five months of previous year, while overall spending on agri-food has decreased (-1.4%).

Coldiretti, the Italian leading farmers' association, estimates that in 2014 sales of organic produces totalled approximately 3.5 billion Euros, equivalent to more than 2% of the country's total food sales. In

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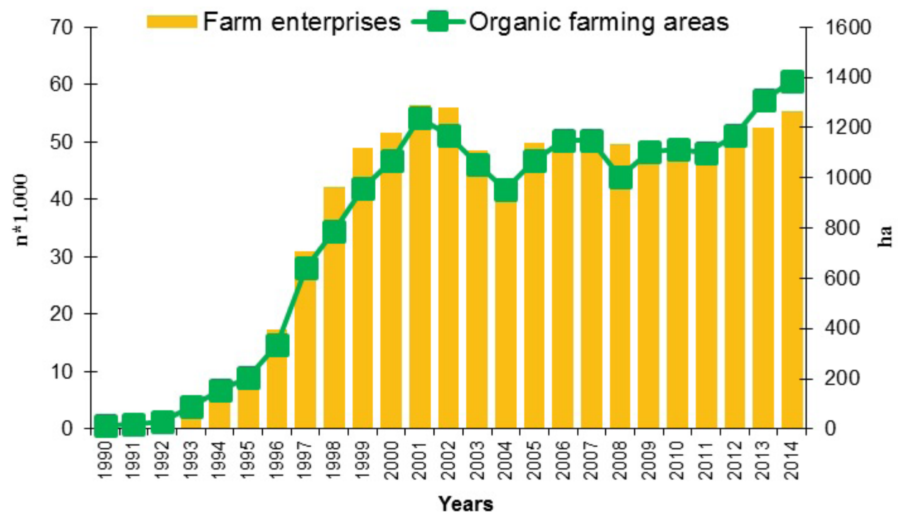

Figure 4: Trend of total organic farming areas (UAA) in Italy and of number of farm enterprises (source SINAB, 2015)

comparison with 2013, the biggest increases were for pasta, rice and bread (+73%), sugar, coffee and tea (+37.2%), biscuits, sweets and snacks (+15.1%), followed by fresh fruit and vegetables and processed (up 11%) and dairy products (+ 3.2%), eggs (+5.2%) and organic beverages (+2.5%). This data corroborates with those released from the Italian Association for Organic Agriculture (AIAB) on the steady growth of organic food compared to a decrease in conventional food consumption.

The success of organic farming indicates a growing awareness of food issues in Italy, by showing a strong tendency toward a more healthy, environmentally sustainable and natural lifestyle, even in inhabitants of cities. Organic also represents the possibility to feed children and unhealthy individuals in a more healthy and safe way; unfortunately, the higher price of organic products is still the main factor in limiting its proliferation. Despite this framework, organic farming seems to have all the requisites to respond to future environmental challenges and to the need of the Italian families (FIRAB, 2013).

Organic food, health and nutrition

It is widely considered that organic food has a better quality from a nutritional point of view when compared with food produced using traditional production techniques. This conclusion also comes from a report prepared by the Council for Research in Agriculture and Agricultural Economic Analysis (CRA, 2012). The report examined the scientific literature published in recent years on the relationship between nutritional value and organic production. What emerged from this analysis is that the quality of food is not only related to production practices, but also to the genetic characteristics of the product and those of the site, such as soil quality and climate type.

For instance, with regard to cereals, differences were observed between organic and conventional products concerning the total proteins, where products from conventional farming have higher values. This result may be explained by the large use of nitrogen-based fertilizers usually present in the conventional agriculture.

In fruits, studies showed in some cases a higher concentration of ascorbic acid in organic products. Furthermore, it is interesting to note that in a significant number of studies the average weight of fruit specimen is lower than that measured in fruits from conventional farming; this could be explained by the general lower yield per area unit of organic farming compared to conventional farming. For fruits, it was not possible to highlight significant differences in minerals and vitamins between the two cropping methods. Organic products presented higher concentrations of antioxidant compounds, such as phenols (considered beneficial for human health), than fruits produced using conventional

Table 1: Summary of nutritional study results, comparing organic and non-organic category of products (Source CRA 2012)

Component/ Product category	CEREALS	FRUITS	VEGATABLES	MILK
Weight		-		
Dry matter			=	
Soluble solids		= / +	+ / =	
Acidity		+ / =		
Sugars	+ / -		=	=
Proteins	-			=
Minerals		=	=	
Ascorbic acid		+	=	
Phenolic compounds *		=	=	
Carotens		=	+ / =	
Antioxidant capability		+ / =	=	
Total fats				=
Saturated fatty acids				=
Monounsaturated fatty acids				=
Linoleic acid				=
Linolenic acid				+
CLA				+

Where:
(+) means a difference in favour of the organic
(-) means a difference in favour of conventional
(=) indicates no differences
* In small fruits (raspberry, strawberry and blueberry) phenolic compounds, kaempferol and ellagic acid, were more present in organic products than in those deriving from conventional agriculture.

farming methods. Conversely, in tomatoes, potatoes and peppers, which also represent the most studied vegetables, there were no significant differences of antioxidant compounds, sugars and carotenoids, between the two farming methods.

However, for milk and dairy products, the limited studies available did not show significant differences in the content of vitamins A and E. Similarly, detailed data about the differences in total protein content, lactose and fat, between organic and conventional are missing. An important research outcome was that organic milk has a high ratio of omega-3 rather than omega-6 essential fatty acids (EFA). The ratio of omega-6 to omega-3 essential fatty acids (EFA) represents an important nutritional factor in milk. Several sources of information suggest that in Western diets the ratio of omega-6 to omega-3 essential fatty acids (EFA) has evolved from approximately 1/1 to 15/1-16.7/1, which means that are deficient in omega-3 EFA. This imbalance is assumed to be one of the important causes for cardiovascular disease and of some of cancers and auto-immune inflammatory diseases.

The conjugated linoleic acid (CLA in short) was found in higher concentrations in organic milk, demonstrating that feed quality, in this case forage, represents a crucial factor affecting the nutritional characteristics of milk and dairy. The content of saturated and monounsaturated fatty acids is rather similar in both types of products examined (organic and conventional). The main findings of the whole comparative study are summarized in Table 1.

It is important to observe that for products such as oil, meat and eggs, there is no statistically significant information yet, mainly because the scarcity of studies carried out.

An article published in the Time magazine thoroughly analyses the pros and cons of organic food, especially in terms of nutritional value (Kluger 2010). The study supports the idea of the superiority of organic, especially for animal products such as milk, meat and eggs. In this case, animals are free to graze and fed with forage and cereals, rather than feed from various sources; this may improve the nutritional value of meat, giving a greater supply of nutrients and lower fat content, with obvious advantages for consumer health. Organic fruit and vegetables, however, according to the same article, pose nutritional characteristics very similar to those of conventional products. To confirm this, Hoefkens et al. (2010) maintain that there are no significant differences between organic and conventional fruit and vegetables in terms of vitamins and other nutritional factors.

Organic farming and use of environmental resources

Studies carried out on different farming methods point out that organic agriculture is characterized by reduced impact on all abiotic (such as air, soil and water) and biotic (flora and fauna) environmental components, compared to conventional methods. The most important benefits deriving from the use of sustainable and biocompatible agricultural management are:

- Reduced demand for fossil energy; organic farming needs on average 30% less energy per unit of product, thanks to the use of low impact means and techniques and of very short sales chains, preferentially at local level (zero km products)
- Lower water consumption; non-intensive production, combined with the use of only organic fertilization and specific cultivation practices as green manure application, favour the accumulation of organic matter in soil, essential for improving the efficiency of plant growth and for the effectively retaining groundwater
- Organic crops are not treated with synthetic pesticides and fungicides; so biological management practices favour the natural self-defence of the plant. For this, healthy and uncontaminated soil is an important prerequisite. A series of interventions aimed at improving soil fertility and plant resistance to pathogens and environmental stresses are performed, in the full safeguard of existing ecosystems and limiting residues of pesticides and fungicides products in the environment.

Recent studies indicate that soil cultivated with organic farming techniques may be characterised by an average yield of about 20-25% lower, compared to soils cultivated through conventional intensive methods (Mondelaers et al., 2009; Tuomisto et al., 2012). This means that to achieve the same production of conventional agriculture, it whould be necessary to cultivate, in the case of biological, a soil extension of 20% greater. The average yields for organic fruits are lower than 3% of the conventional one, while it is observed a 10% average drop in yield for oil seeds; cereals and vegetables show an average yield loss of about 25% and 35% respectively. This would be attributed to a lower availability of nitrogen and phosphorus, especially in certain types of soils when they are not enriched with massive quantities of high nitrogen content chemical fertilizers which is on the contruary done in the case of conventional agriculture.

The lower demand of energy input, water and chemicals, together with a higher guarantee of long-term productivity of soils, however, could compensate, at least in part, the lower yield of this type of production. This issue, however, may represent a significant limit for organic farming, especially in some territorial contexts, given the growing scarcity of space and soils that can be devoted to food production.

Organic farming and climate change

The relationship between agriculture and climate change is very complex and multi-faceted. Climate change will have significant and generally negative impacts on agriculture and growth prospects in the lower latitudes. Over the last three decades, climate change is estimated to have reduced global yields of maize and wheat by 3.8 and 5.5%, respectively, relative to a counter-factual without rainfall and temperature trends. By 2050, climate-related increases in water stress are expected to affect land areas twice the size of those areas that will experience decreased water stress. Climate variability in the coming decades will increase the frequency and severity of floods and droughts, and will increase production risks for both crop-producers and livestock keepers and reduce their coping ability. Climate change poses a threat to food access for both rural and urban populations, by reducing agricultural incomes, increasing risk and disrupting markets. Resource-poor producers, landless and marginalized ethnic groups are at particular risk.

Secondly, while most green-house gas (GHG) emissions can be traced to fossil fuel use for energy, agriculture also plays a key role. Agricultural soils contribute to methane emissions, carbon dioxide and nitrous oxide. A relatively new GHG threat is nitrous oxide, which occurs naturally, but has increased markedly as a result of the growing use of synthetic fertilizers (which are not allowed in organic farming). According to a study carried out by Tubiello et al. (2015), refining the information available through the PCC AR5 (WGIII Section 11.2.3), global GHG emissions from agriculture reached 5.4 Gt CO_2 eq in 2012, or 11.2 ± 0.4% of total GHG emissions, roughly 1% more than the previous year.

Agriculture, (mostly because the massive increase in the number of ruminants,) accounts for about 47% of annual global anthropogenic emissions of methane. The concentration of these emissions in the atmosphere has increased by a factor of 2.5 since pre-industrial times, from 722 parts per billion to about 1850 ppb. Production of methane in the soil is also associated with the anaerobic decomposition of organic matter. Because of this, the main anthropogenic source of soil-derived methane is rice (Oryza sativa L.) production. Natural soil-derived methane comes mainly from wetlands.

The main source of GHG emissions is the enteric fermentation of ruminants, due to the natural gas that is produced during the digestion of food, which alone totals 39% of the entire agricultural sector. This source follows the distribution of synthetic fertilizers: 13% of agricultural emissions (about 725 Mt CO_2 eq.). Even in Italy, the agricultural sector is a net emitter of greenhouse gases and contributes around 7% to the total national emissions.

The world's agro-ecosystems (croplands, grazing lands, rangelands) are depleted of their soil's organic carbon (SOC) pool by 25–75% depending on climate, soil type, and historic management. The magnitude of loss may be 10 to 50 tons C ha^{-1}. Soils with severe depletion of their SOC pool have low agronomic yield and low use efficiency of added input.

Conversion to a restorative land use and adoption of recommended management practices, can enhance the SOC pool, improve soil quality, increase agronomic productivity, advance global food security, enhance soil resilience to adapt to extreme climatic events, and mitigate climate change by off-setting fossil fuel emissions.

The technical potential of carbon (C) sequestration in soils of the agro-ecosystems is 1.2–3.1 billion tons C yr^{-1}. Improvement in soil quality, by increase in the SOC pool of 1 ton C ha-1 yr^{-1} in the root zone, can increase annual food production in developing countries by 24–32 million tons of food grains and 6–10 million tonnes of roots and tubers.

The strategy is to create positive soil C and nutrient budgets through the adoption of management practices such as no-till and reduced-till farming, use of cover crops, improved residue management and crop rotations, integrated nutrient management including bio-fertilizers, as well as the conversion of marginal cropland to native vegetation or conversion of cultivated land to permanent grassland.

In this regard, the principles of organic farming

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have the potential to both reduce net greenhouse gas (GHG) emissions and to serve as a direct carbon sink through SOC sequestration. Organic farming may enhance soil quality, generating vital regulating services of buffering, filtering and moderating the hydrological cycle, improving soil biodiversity and regulating the carbon, oxygen and plant nutrient cycles, enhancing resilience to drought and flooding, and carbon sequestration (Crowder et al., 2010; Gattinger et al., 2012; Kennedy et al., 2013).
A possible path could be the use of crop varieties and livestock breeds with a high ratio of productivity when using externally-derived inputs. This would avoid the unnecessary use of external inputs, harnessing agro-ecological processes such as nutrient cycling, biological nitrogen fixation, allelopathy, predation and parasitism, minimising the use of technologies or practices that have adverse impacts on the environment and human health.

According to data published by the Rodale Institute (2011), organic farming systems use 45% less energy than conventional ones and use energy more efficiently, producing 40% less GHGs than agriculture based on conventional methods. Organic soils thus have a role of carbon sink, which is on average estimated at 0.5 tonnes C ha-1 yr-1. In this sense, organic farming provides farmers with significant options both in the policies of mitigation and adaptation to climate change.

Conclusions

There is ample scientific evidence on the positive effects of organic farming on human health, animal welfare and on the environment sensu lato when compared to conventional farming. In fact, organic farming has positive impacts on externalities such as conservation of biodiversity, GHG emissions reduction and carbon sequestration, energy efficiency, clean water availability, nutrient cycling, flood protection, groundwater recharge, and landscape amenity value. There is also growing evidence from landscape-scale studies that greater proportions of land devoted to organic and diversified techniques enhance ecosystem services such as pest control and pollination on farms.

Scientific evidence considers that conventional agricultural systems give higher levels of productivity per unit area, thus it is preferable to organic for meeting food security.

However, in comparing organic and conventional farming with respect to food security, it should be noted the notion of food security encompasses not only the concept of sufficiency, but also the concepts of health and nutritional value. In fact, according to the official definition of the World Health Organisation (1996), food security is reached when "... all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet dietary needs and food their preferences for an active and healthy life."

In addition, soils subjected to intensive forms of agriculture are susceptible to a decline in fertility and production capacity in the short- and medium-term, thus undermining the potential future production. Recent studies have estimated that nearly 40% of intensively cultivated land will be lost by 2050. Land cultivated organically, on the contrary, tends to retain the physical, chemical and biological properties over the long timeframe, while maintaining stable levels of productivity and not escalating land occupation from other land uses.

While admitting that productivity is an important parameter, sustainability cannot be measured in terms of tonnes of food per hectare. The dominant traditional farming systems have provided growing stocks of food or wood or fibre, but often at the expense of other objectives of sustainability: environmental degradation, public health problems, the loss of crop varieties and genetic biodiversity.

The productivity shortcoming of organic crops may be worked out by further investment in research and in improving organic and diversified farming techniques, culpably underfunded in comparison to conventional techniques. Encouragingly, the few long-term studies that have been conducted have demonstrated that diversification techniques improve yields while enhancing ecosystem services, profitability and stability.

Whether organic agriculture can continue to expand and increase its capacity to feed the world will primarily be determined by whether it is economically competitive with conventional agriculture.

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In this respect, a meta-analysis was carried out by Reganold and Wachter (2016), examining the financial performance of organic and conventional agriculture of a global dataset spanning 55 crops grown on five continents. It showed that when organic subsidies were not applied, benefit/cost ratios and net present values of organic agriculture were significantly lower than conventional agriculture. However, when actual subsidies were applied, organic agriculture was significantly more profitable and had higher benefit/cost ratios than conventional agriculture. The study accounted for neither environmental costs (negative externalities) nor ecosystem services from good farming practices, which likely favour organic agriculture. This suggests that organic agriculture can continue to expand even if premiums decline.

The strategic direction of the future of organic farming should be the integration of conventional and organic agriculture, combining the synergistic aspects of both systems, thus achieving good yields of high quality products, and embracing the concept of the sustainable intensification of agriculture and 'climate smart agriculture' approaches (Campbell et al., 2014).

Finally, although organic agriculture has a key and compelling role in creating sustainable agricultural systems, it is important to keep in mind that no single approach can alone resolve food security. Rather, it needs a combination of organic and other innovative alternative farming systems, like agroforestry, agro-ecology, integrated farming, conservation agriculture and intercropping. Conventional farmers have the challenge of maintaining soil productivity in the long run, without making massive use of synthetic fertilizers, pesticides and fungicides, but rather through crop rotation and the addition of organic matter, thus recovering the missing nutrients in the soil itself and also safeguarding the biodiversity in agro-ecosystems.

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Conflict of Interests

The authors hereby declare that there is no conflict of interests.

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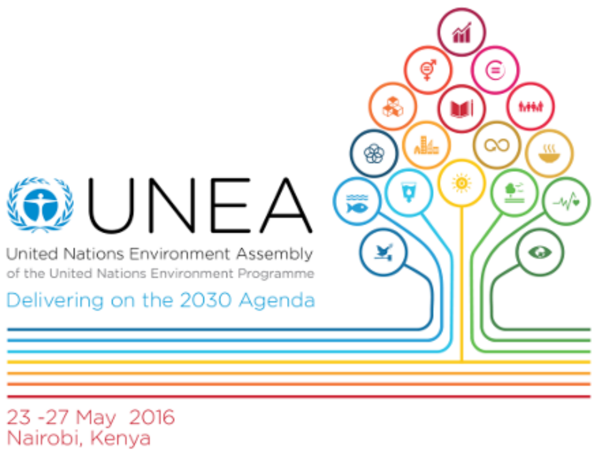
Future of Food: Journal on Food, Agriculture and Society, 4 (1)

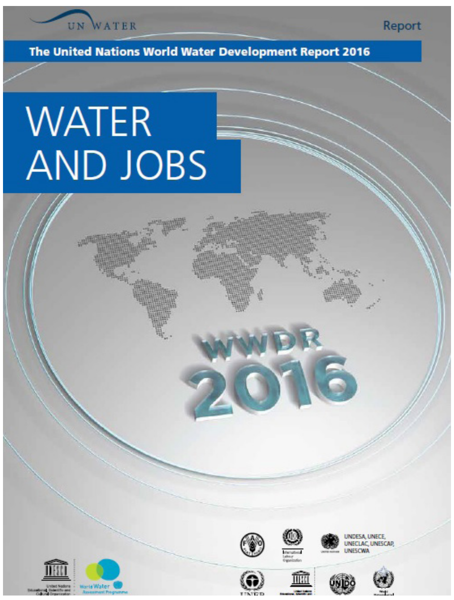
Science-Policy Forum- Delivering on the Environmental Dimension of the 2030 Agenda for Sustainable Development



UNEP is organizing the first ever global Science-Policy Forum in Nairobi, 19-20 May 2016, as part of the overall program for the second session of the UN Environment Assembly (UNEA-2) which will take place 23-27 May 2016. The purpose of the Science-Policy Forum is to engage a wide audience of policy-makers, scientists, researchers, and civil society stakeholders in an active discourse on the science and knowledge required to deliver on the environmental dimension of sustainable development. The dialogue will also address the challenges and new opportunities emerging at the science-policy interface with the aim of enhancing a collective understanding across both sides of the interface; strengthening the science-policy dialogue and recommending concrete measures for collective action in the context of the 2030 Agenda for Sustainable Development. A number of high-level and inspirational speakers will address various sessions of the Forum. Please visit at *www.myunea.org* for further information.

Source: *http://web.unep.org/unea/special-events/science-policy-forum*

2016 UN World Water Development Report, Water and Jobs



Three out of four of the jobs worldwide are water-dependent. In fact, water shortages and lack of access may limit economic growth in the years to come, according to the 2016 United Nations World Water Development Report, Water and Jobs, which was launched on 22 March, World Water Day, in Geneva. From its collection, through various uses, to its ultimate return to the natural environment, water is a key factor in the development of job opportunities either directly related to its management (supply, infrastructure, wastewater treatment, etc.) or in economic sectors that are heavily water-dependent such as agriculture, fishing, power, industry and health. Furthermore, good access to drinking water and sanitation promotes an educated and healthy workforce, which constitutes an essential factor for sustained economic growth. In its analysis of the economic impact of access to water, the report cites numerous studies that show a positive correlation between investments in the water sector and economic growth. It also highlights the key role of water in the transition to a green economy. You can download the full version at *http://unesdoc.unesco.org/images/0024/002439/243938e.pdf*

Source: *http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/wwdr/2016-water-and-jobs/*

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Future of Food: Journal on Food, Agriculture and Society, 4 (1)

Conference report: 6th Critical Agrarian Studies Colloquium on "Global governance/politics, climate justice & agrarian/ social justice: linkages and challenges"

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The convergence of multiple crises of food, energy, the environment and finance have led to a global rush to control and commodify natural resources such as land, water and forests in order to produce food, fuel and energy, including climate change mitigation and adaptation purposes. In order to make sense of these profound agrarian and environmental dynamics worldwide, 380 colloquium participants from over 46 countries participated in the 6th Critical Agrarian Studies Colloquium on "Global governance/ politics, climate justice & agrarian/ social justice: linkages and challenges" which took place from 4th to 5th of February 2016 at the Institute of Social Sciences (ISS) in The Hague, Netherlands. As a unique encounter of academics, activists and policy makers, the colloquium addressed an extensive range of topics from the rise of new political economic players (such as the MICs and BRICS) and new production forms (such as flex crops) to politics of transnational corporations and new forms of global governance.

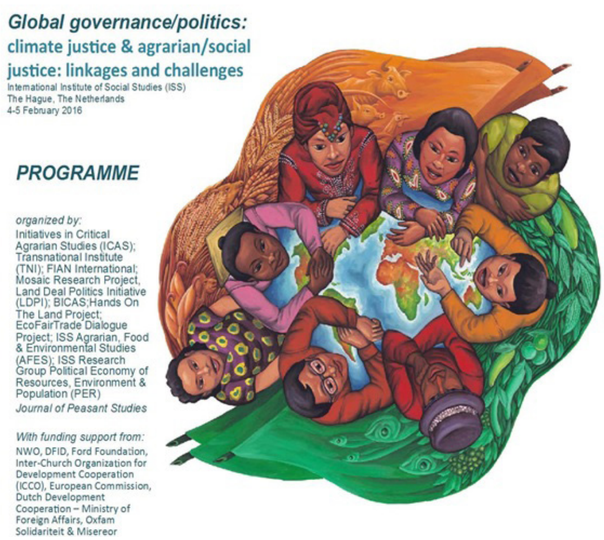
Keynote speakers included Olivier de Schutter (UN Committee on Economic, Social and Cultural Rights), Raj Patel (University of Texas, Austin), Maria Fernanda Espinosa (Ecuador's Ambassador to the UN) and Godwin Ojo (Environmental Rights Action, Nigeria).

A collection of 70 conference papers including those of renowned scholars such as Jun Borras, Philip McMichael, Harriet Friedmann, Henry Bernstein or Nora McKeon on a rich diversity of issues are freely accessible at the conference website:

http://www.iss.nl/research/research_programmes/political_economy_of_resources_environment_and_population_per/networks/critical_agrarian_studies_icas/icas_colloquium/global_governancepolitics_climate_justice_agrariansocial_justice/
Short link: http://tiny.cc/icas6

At the same website, video recordings of the keynote speakers and plenary panels on topics such as the politics of global governance institutions, corporate alliances and trade, climate change, BRICS and MICs as well as of social/climate/agrarian/environmental justice movements and their alternatives will be available soon.

Furthermore, students interested in Critical Agrarian Studies are encouraged to refer to the following sources: The Journal of Peasant Studies, The Journal for Agrarian Change and a highly recommended series of small books on big issues of the "Agrarian Change & Peasant Studies" series by Practical Action Publishing.



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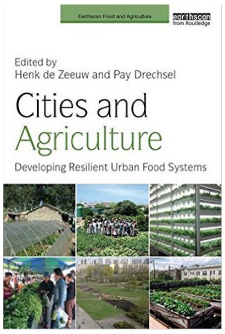

Cities and Agriculture: Developing Resilient Urban Food Systems

A book review by Aiperi Otunchieva

Authors: Henk de Zeeuw and Pay Drechsel
Book title: Cities and Agriculture: Developing Resilient Urban Food Systems (450 pages, 57.50 Euro)
Year of publication: 2015
Publisher: Earthscan Food and Agriculture, Routledge
ISBN: 978-1138860599

Growing populations pose serious challenges to urbanization by putting natural resources under the risk. Within the last few decades migration from rural to urban areas has increased in most countries. As points of economic development, opportunities for employment and technological advancement, cities attracted those in search of better incomes and higher standards of life. However, these trends put stress on limited resources. Urban ecological footprints have dramatically increased due to large populations within cities covering relatively small spaces and intensified use of resources. Securing safe and sufficient food for urban populations is one of the main objectives of sustainable development. The fact that around eight million people go hungry every day, 12.9% of people in developing countries are undernourished, one of six children in developing countries are underweight and 45% of child mortality is due to poor nutrition (World Food Programme) forces us to think about ways of ensuring food security for everyone.

Henk de Zeeuw was the first director of the International Network of Resource Centres on Urban Agriculture and Food Security (RUAF) until 2012. Pay Drechsel works in IWMI Headquarters in Sri Lanka as the Theme Leader on Resource Recovery, Water Quality, and Health. Having been engaged in a number of national and international urban food projects, the scholars wrote a unique contribution to the debate which should be used by multiple stakeholders within the urban food circle.

The first chapter of the book presents world food consumption patterns, changes and increases in the last fifty years. Nutrition transition takes place putting pressure on the resources such as energy, soil, air and water. However, the inclusion of food resilience policies in the city planning agenda is a recent phenomenon which is rapidly increasing in such cities as Casablanca, Kesbewa, Antananarivo, Bogota and others. The authors engage in a thorough discussion of urban food policies in the second chapter outlining various existing programmes around the world. Although given examples of how urban food policies differ from each other, four main objectives have been outlined. These are: insurance of access to safe and healthy food, secure public health, ensure sustainable food value chain 'from field to fork' and promoting local economies through enhancing food resilience. The third chapter is specifically designed for the decision makers, civil society and market players directly engaged with urban food policy. It provides a detailed overview of different stakeholders and their roles and specific steps policy makers should take in ensuring food security within the administrative divisions. The fourth chapter engages with the challenges related to cost, legal rights and availability of land in intra- and peri-urban areas. It also outlines ways for the integration of agriculture in cities and the design of urban spaces suitable for farming and agricultural production. Furthermore, it is evident that consumers prefer daily, fresh, easily available and affordable food. Short food chains satisfy this market demand, if food is grown within or in the vicinity of a city. This phenomenon is dominant in a number of developing countries positioning themselves in a comparative advantage in comparison to supermarket chains. The authors believe that more research is needed in revealing how urban producers and Small to Medium Enterprises (SME) can utilize the benefits of urban agriculture. Chapter six discusses a number of factors affecting urban food security and nutrition which include access to food, nutrition change, and nutrition related health problems. Urban populations do not only consume the most resources but is also a source for renewable resources such as biological waste and wastewater. In the case of proper recycling and reusing, it would make urban agriculture comparatively independent from external inputs turning it into a sustainable project. The challenges of waste recovery and reuse are discussed in the next chapter. The complex interrelations between urban agriculture and climate change mitigation are the central point of chapter eight. Benefits of urban horticulture, among others, includes possibility for income generation for farmers, freshness of fruits and vegetables and decreased reliance on imported food. The next chapter concentrates on urban livestock keeping, its management and its risks and benefits. Research on urban forestry is increasing rapidly in the last decade. Chapter twelve makes an overview of the strategies of urban aquacultural production in terms of food security. Furthermore, urban agriculture is analyzed through the feminist foodscapes framework which implies power imbalances existing in cities. Financing projects related to agriculture in intra- and peri-urban areas is another significant and crucial aspect discussed. Finally, the last chapter outlines the role of urban agriculture in disasters and emergencies.

The book is designed both for practitioners and for scholars as it provides up to date scientific findings on improved urban food policy, successful examples on this theme around the globe, and specific guidance for government officials. It also demonstrates food policies implemented in developing countries, thus facilitating mutual learning within the Global South and Global North paradigm. Decision makers should definitely consult chapter three in order to capture the idea of city food governance. In addition, the book opens new perspectives for future research thus setting a new agenda for further scientific studies on urban agriculture.

Information of the author:

Aiperi Otunchieva is a member of the Department of Organic Food Quality and Food Culture, Faculty of Organic Agricultural Sciences, University of Kassel, Germany.

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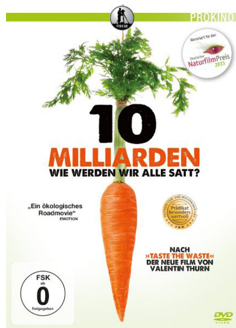
10 billion, what's on your plate? (10 Milliarden , Wie werden wir alle satt?)

A film review by Forouq (Zahra) Kanaani



Director: Valentin Thurn
Producers: Jürgen Kleinig, Tina Leeb
Film title: 10 billion, what's on your plate? (10 Milliarden , Wie werden wir alle satt?)
Production Company: Celluloid Fabrik
Production year: 2015
Country: Germany
Language: German

10 billion people by 2050. The food crisis, even with the current world population is a big issue and many people are either starving or struggling with malnutrition all around the world. Therefore, the debate about food security is getting hotter and the necessity of having a comprehensive perspective is important nowadays. Besides all nutrition problems that we have to solve, the climatic problems of current agricultural methods are another important issue which we should deal with in the near future.

This film takes a wide look into the vast vision of the production and distribution of worldwide food - from insects, industrial farming, and artificial meat to the novel methods of organic or even conventional self-cultivation. Valentin Thurn (the food activist and best-selling author of "Taste the Waste") searches for global solutions and tries to find the best suggestions to solve the future food crisis in the world.

The film "10 billion, what's on your plate? - 10 Milliarden – Wie werden wir alle satt?" a 102 minute colourful and harmonious movie, was produced in 2015. The director starts his inquiry with asking about the possible al-

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ternatives to feed the projected 10 billion people. He brings up the subject with any possible alternatives, such as the exigency of having insects as a source for food, like some populous communities, at present. Then he goes to several scientific efforts which are trying to introduce the ultimate solution for the global food crisis. During this worldwide journey, he meets scientific institutes in many developed countries like Germany and Japan and evaluates their attempts and ideas about the manner we should have to control the hunger problem.

Thurn tries to criticize some of these endeavors. In some cases, he indicates that many of these efforts, are more likely to consider the food crisis very astutely as a business subject rather than a humanitarian solution to save the people from starvation. In this frame, he provides some examples of institutions which try to keep small scale farmers all around the world more dependent to their production, like seed or sapling. The manner of these immense companies and institutes shows the financial tendency of their activities which might lead to the current problems in the area of food production and distribution.

Accordingly, he also appraises the domestic or global effect of food prices and stock exchanges on the agricultural practices and concludes that drastic fluctuation in agricultural stocks could lead to real catastrophe for poor people which could not purchase food.

Thurn also refuses to accept the gene-engineered fish and other gene-modified products as a final solution for world hunger problems in future. In the case of fish, he argues that fish like salmon, natural of genetically modified, should be fed with other fish products, which are rapidly depleting.

In the film another possible alternative for the future hunger problems is shown. Artificial meat producing programs are currently running all around the world; like "The cultured beef project" at Maastricht University in the Netherlands. Artificial meat products tend to be more of a solution for future food safety and even climate problems. However, when considering the production price of this artificial meat it is obviously an unreachable source of food for a numerous amount of people, even in the future. At the moment, it costs approximately 250,000 € for a Hamburger-size meat!
In contrast with above-mentioned pursuits, the director highlights the importance of independent small scale farming, using the example of a local farmer in Malawi, who managed the hunger issue in her rural region successfully. She applied mixed farming practices by using the local crops. The local farmers in that village, not only consume the crops as their own food, but also sell them as a way to make revenues.

Other examples of agricultural scenarios are European, American, Indian and African farmers trying to use various practices for managing their farm in the most sustainable way. Although it seems that intensive industrial agriculture is obtaining more yield, studies show that small scale farmers are acting in the more sustainable way financially, especially when stockholders are promoting local markets and trying to skip transporting

the products between long distances.

As a conclusion, it is clear from the evidence produced by the director that the solution to feed the projected 10 billion world population in the future is with local farmers who are trading their products in domestic markets and avoiding gearing their farms towards relationships with large agricultural companies. Basic human rights, where every individual has access to secure and nutritious food is the duty of our generation. We should also be responsible about the food we are consuming.

Mary Clear (founder of Incredible Edible:
A NGO organization which turns non-edible plants of urban landscapes into edible crops, foe free)

"We believe that politics would not fix the food situation of the world; money would not feed people across the world, the science will not fix the problem, only kindness will."

All photos from
http://www.10milliarden-derfilm.de/

Information of the author:
Forouq (Zahra) Kanaani has obtained a Bachelor degree in "Agricultural Engineering, Agronomy and Plant Breeding" from University of Tehran and then, she finished her M.Sc. studies in "Agronomy" in Iran in the year 2013. In her Master thesis, she investigated the organic practices to suppress the competitor plants on the crop field. Currently, she is pursuing her second Master study in Sustainable International Agriculture from University of Göttingen and University of Kassel and hopes to bring her contribution to solve the global food and water problems.

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Feeding the planet? a critical review of Expo 2015

From May to October 2015, Expo 2015 on "feeding the planet – energy for life" took place in Milan, Italy and gathered 145 countries, corporations, organizations and civil society participants as the "largest worldwide event ever organized on the theme of food". In the 21st century context of a rapidly growing population and a fast deteriorating environment, Expo wants to advocate the human "right to healthy, secure and sufficient food" for all the world's inhabitants.

Today's world exhibitions include three main elements of their history: They present technological innovations, facilitate cultural exchange and are used to improve national images. Since 2005, the thematic focus of expo seems to have shifted to environmental topics. The question arises whether Expo 2015 also falls under the main purpose of improving national images or if Expo becomes a new global platform that critically addresses the social and environmental impacts of our current food system. How do the exhibiting countries, organizations and companies address the main topic of feeding the planet with "healthy, safe and sufficient food for everyone" in harmony with nature? Which problems are mentioned and which solutions are proposed to the global challenges of food security and food sovereignty?

In order to find an answer to these questions, we have visited 10 country pavilions from four continents (Angola, Germany, USA, China, Oman, Czech Republic, Russia, Kazakhstan, Ecuador), 2 organizations (United Nations and Slow Food), and Coop´s supermarket of the future as a contribution from the corporate sector to Expo 2015.

Some of the trends which can be spotted at Expo include the increased promotion of online food shopping, reducing food waste, increase product information for consumers and a combination of traditional and modern technologies in agriculture.

The video presents the very diverse responses by countries, companies and organizations to Expo´s main topic: Feeding the planet, energy for life.

See the short video here:

https://goo.gl/G6e2iL

Length: 55 minutes

See the full video here:

https://goo.gl/BZN9lV

Length: 87 minutes

Produced by: Florian Doerr and Sisira Withanachchi
Narrated by: Damien Frettsome and Sisira Withanachchi

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We are grateful to all interviewed representatives for their insights, and send a special thanks to Ms. Oksana Smirnova for her indispensable help, as well as to Teresa de Martin and Jacopo Moreschini. We thank the "Verein zur Förderung einer natur- und sozialverträglichen Ernährungs- und Landschaftskultur e.V." for funding of this project.

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MILANO 2015
NUTRIRE IL PIANETA
ENERGIA PER LA VITA
NOURRIR LA PLANETE
ENERGIE POUR LA VIE
FEEDING THE PLANET
ENERGY FOR LIFE

The Department of Organic Food Quality and Food Culture at the University of Kassel, Germany and the Federation of German Scientists (VDW), Germany