Agriculture and Human Values **16:** 131–140, 1999.

The greening of the "barrios": Urban agriculture for food security in Cuba

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Accepted in revised form December 11, 1998

Abstract. Urban agriculture in Cuba has rapidly become a significant source of fresh produce for the urban and suburban populations. A large number of urban gardens in Havana and other major cities have emerged as a grassroots movement in response to the crisis brought about by the loss of trade, with the collapse of the socialist bloc in 1989. These gardens are helping to stabilize the supply of fresh produce to Cuba's urban centers. During 1996, Havana's urban farms provided the city's urban population with 8,500 tons of agricultural produce, 4 million dozens of flowers, 7.5 million eggs, and 3,650 tons of meat. This system of urban agriculture, composed of about 8,000 gardens nationwide has been developed and managed along agroecological principles, which eliminate the use of synthetic chemical pesticides and fertilizers, emphasizing diversification, recycling, and the use of local resources. This article explores the systems utilized by Cuba's urban farmers, and the impact that this movement has had on Cuban food security.

Key words: Urban agriculture, Cuba, Agroecology, Sustainable agriculture, Food security, Biological pest control

Abbreviations: ACAO – Asociación Cubana de Agricultura Orgánica; ANAP – Asociación Nacional de Agricultores Pequeños; CREEs – Centers for the Reproduction of Entomophagous Agents; FAO – Food and Agricultural Organization; GDP – Gross Domestic Product; INIFAT – Instituto de Investigaciones Fundamentales en Agricultura Tropical; IPM – Integrated Pest Management; MINAGRI – Ministry of Agriculture; UN: United Nations

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Introduction

The collapse of the socialist bloc in 1989 marked the beginning of a new era in Cuban history. Without the support of the international socialist economy, Cuba suddenly plunged into a severe economic slump. The socialist bloc had accounted for 85% of Cuba's trade, and with its collapse, Cuban imports dropped by 75% and the deficit reached 33% of GDP. Russian oil imports, previously purchased at below market prices, fell from 13 million tons in 1989 to less than 7 million tons in 1992. Cuba had to establish an entirely new set

of trading partners, a task made far more difficult by the Torricelli Bill, signed by the Bush administration in 1992, which tightened the United States' economic embargo. From 1989 to 1993, Cuba's gross domestic product dropped, according to official estimates, by 35% (Rosset and Benjamin, 1994).

Officially called the Special Period in Time of Peace, the ongoing economic crisis has had a devastating impact on Cuban food security. Cuban agriculture, which was highly dependent on chemical inputs from the Soviet Union, suddenly confronted a 50% reduction in fertilizer and pesticide imports. Food imports, which previously accounted for up to 57% of the caloric intake of the Cuban population, also dropped off due to the shrinking import quota bill. Food production became Cuba's most important task (Rosset, 1997a). The major challenge facing Cuban agriculture is to provide for a more equitable access not only to food but to the locally-available resources and low-input technologies required for its production.

Fortunately, some of the investments of the revolution paid off. With Cuba accounting for only 2% of the Latin American population but with 11% of the scientists, this tremendous human resource was modified along with the grassroots to face the crisis. Cuban farmers, scientists, and planners responded to the challenge of food security with a whole array of alternative agricultural technologies to sustain agricultural productivity in the farm sector. This process has been well documented (Rosset, 1997b). Less known, however, have been the urban agricultural endeavors of both spontaneous popular groups and government organizations, efforts that have been pivotal in averting a catastrophic shortfall of food availability for the urban populations (Companioni et al., 1997).

With the onset of the crisis, urban gardens began to spring up all over Cuba, especially in Havana, as a massive popular response of residents themselves to the food shortages. In the abrupt absence of the food previously provided by the government at very low prices, thousands of urban dwellers began to cultivate it for themselves. These new gardeners were growing food to satisfy family needs. Relaxing laws on the sale of garden food items has helped many gardeners improve the family economy by selling any excess. These popular gardens have been augmented by state support, both through technological and informational services and through the establishment of extensive state-run gardens, which produce horticultural products for local residents. Urban agriculture in Cuba has far surpassed the dimensions of what may be termed conventional vegetable gardening. It is rapidly becoming a significant source of fresh produce for the urban and suburban populations (Companioni et al., 1997). In fact, these programs are starting to be perceived by Cuban agricultural officials as key components of the overall national food system strategy.

This article examines some of the characteristics of the Cuban urban agriculture movement, focusing on its extent, organization, agroecological features, and the socio-economic and food security implications for the island.

Extent and typology of urban agriculture in Cuba

Cubans understand urban agriculture as all agricultural and animal production that occurs within cities or peripheries that receive direct influence from cities, so that the productive process is intimately linked to the urban population. Without having precise limits, urban agriculture includes all gardens, which are integrated into the city (Companioni et al., 1997). It is a "popular agriculture," extremely heterogeneous in size, crop mixes, and management levels. One of the primary benefits of these gardens is that they target the increased food production and supply to the communities and neighborhoods where food is needed most. It is important to mention also that several urban production systems supply primarily to the tourist trade.

The way Urban agriculture in Cuba can generally be classified can be seen in Table 1.

The *organopónicos* and *intensive gardens* are the primary methods of urban cultivation. The only difference between the two is the structure of the garden: whether cultivation occurs in raised beds or in the preexisting soil. Because of the poor quality of many urban soils, the *organopónico* method is the most popular. Although statistics are still being compiled, official estimates in 1996 calculate the total number of *organopónicos* in Cuba to be about 1,613, covering about 250 hectares. They have an average yield potential of 16 kg of produce per square meter, with a total production of about 840,092 qq. [1 quintal equals 100 pounds]. There are about 430 *intensive gardens* with a total area of 165 hectares and a total production of 421,000 qq., or about 12 kg. of produce per square meter. More data are available for the capital city of Havana, which has the largest and most developed system of urban agriculture in the country (Table 2).

The *popular gardens* are the most widespread, and easily accessible to the public. By June, 1997, there were some 26,604 gardeners working in roughly 5,000 popular gardens throughout the 43 urban districts that make up Havana's 15 municipalities. The popular gardens range in size from a few square meters to three hectares. Larger plots of land are often subdivided into smaller individual gardens. Garden sites are usually vacant or abandoned plots and are located in the same

Table 1. Types of urban gardens

Garden type	Description	Ownership patterns
Intensive gardens:	Located in areas with high quality soils, drainage, and adequate water supply. Seeds are planted directly into fertilized soil.	Mixed state and private ownership
Organopónicos:	Located in areas with poor soil unsuited for agriculture. Seeds are planted in nursery then transplanted to garden. Cultivation occurs in containers or raised beds filled with organic matter and soil mix.	Same
Suburban farms:	Located in the periphery of densely populated urban areas. Larger units (exceeding 2 ha.) which have a more highly integrated system of production. Use methods of cultivation that utilize locally produced inputs and minimize synthetic inputs.	Same
Popular gardens:	Cultivated by community gardening organizations. Established in reclaimed dumps and vacant lots in urban and suburban areas. Managed by local individuals or groups.	Generally private use of state or private land
Enterprise and factory gardens:	Located on or near the property of factories and businesses. Produce used to promote self-sufficiency by feeding factory workers and their families.	Owned by enterprise or factory
Hydroponics:	Plants cultivated indoors in a nutrient rich solution, which is run through an inert planting medium. Least extensive type of garden due to higher costs	State owned
Household gardens:	Gardens cultivated by individuals in their own yards with a high variation in size and type of produce.	Privately owned

Table 2. Extent of urban farming in the city of Havana (after Companioni et al., 1997)

Form of production	Total number of sites	Total area (ha.)
Intensive gardens	92 gardens	17.00
Organopónicos	96 gardens	23.80
Hydroponics & Zeoponics	3 locations	111
Suburban farms	2,138 private farms 285 state farms	7,718
Popular gardens 26,604 gardeners	5,000 gardens	1,854
Business and factory gardens	384 gardens	5,368
Household gardens	Unknown	Unknown
Total	7,998 gardens	15,092 ha.

neighborhood if not next door to the gardeners' households. Land for the gardens is obtained through the Poder Popular (literally "People's Power," the smallest organizational unit of Cuba's government) at no cost, as long as it is used for cultivation. Most popular gardens provide food for the family, give a significant proportion to childcare centers, hospitals, and needy community members, and sell some remaining produce for profit.

Participation in the popular gardens ranges from one to seventy people per garden site. The majority of gardeners are older retired men, although women and children also participate. Popular gardens are usually organized around a household, but it is not uncommon to find arrangements in which more than one household share or subdivide a garden site, either as a neighborhood organization or as a horticultural club.

A wide selection of produce is cultivated, depending on family needs, market availability, locality and soil suitability. In addition to vegetable and fruit cultivation, some popular gardens also cultivate spices and medicinal plants. Few integrate animal production, although in many, chicken and pigs raised in small corrals are a common feature.

The emergence of urban agriculture in Cuba

Prior to the Special Period, urban agriculture was virtually absent in Cuba and in fact urban gardening was perceived by many as a sign of poverty and underdevelopment. The urban gardening movement in Cuba was born out of absolute need and it was spontaneously headed by groups of people with little knowledge about agriculture. Many of the new gardeners were cultivating for the first time. Those growers who did have some previous agricultural experience had mostly worked in large-scale rural agriculture, based on monocultures with chemical fertilizers. Very few of Cuba's gardeners were familiar with the small scale, highly diverse, intensive techniques that are now widely used.

Nevertheless, these new urban growers were highly motivated, and they planted any seeds they could find, with whatever tools were available, on any open land in sight. Prior to 1989, government ordinances had

relegated food cultivation to back yards, but with the relaxation of such regulations, people began to plant in the back, front, and side yards, or on balconies, patios, and rooftops. Families with adjacent vacant lots planted in these areas, and thus the number of city gardens grew rapidly. Pre-existing community organizations, such as the Cuban Women's Federation, the block committees, and others, facilitated local production by providing access to land.

The Ministry of Agriculture (MINAGRI) took this popular movement very seriously, and by 1994 had created a specific Urban Agriculture Department. Together with the Provincial Office of Poder Popular, they set out to provide support services and material resources for the urban gardeners of the capital and other cities. To this day, all municipal agriculture extension offices are located in the government buildings of each municipality.

The first priority of the Urban Agriculture Department was to secure land use rights for all urban gardeners. They placed tremendous emphasis on providing land for all who wanted to grow food in the city. They worked with Poder Popular to change city laws so that all unused land would be available for residents who wanted to grow food. Any citizen could request the use rights to unused land if they wanted to establish a garden on it. This decentralized mechanism allowed for a speedy transfer with minimum of bureaucracy. Even privately owned land in the city, if not in use, was turned over to those wishing to cultivate it. In these cases the local agriculture delegates would notify the legal owner of the intention to grant the land use rights to a local gardener who planned to produce food on it. If the owners objected, they would be allowed six months to put the land into production themselves. If they did not begin to cultivate the lot, use rights would then be granted to the person who had requested it, who would be obligated to grow food on it.

Many gardeners have chosen to organize into horticulture clubs in order to pool resources and experience, and to facilitate the dissemination of information and technical knowledge among gardeners. Clubs meet regularly to exchange seeds, tools, and ideas, and some organize workshops and events to involve and educate the community on organic gardening, and to maintain model gardens. Today, there are over 400 horticulture clubs registered with the MINAGRI in Havana alone.

Another resource for urban gardeners is the agricultural extension service provided by MINAGRI to respond to the needs of producers throughout the city, and to assist them in all aspects of gardening. Each municipality has a team of two to seven extension agents who are well acquainted with the specific needs and issues in their area. Some of these extensionists are well trained in agroecology, otherwise urban farmers obtain their information from other groups such as ACAO (Asociación Cubana de Agricultura Orgánica) or ANAP (Asociación Nacional de Agricultores Pequeños). By June of 1997, Havana had a total of 70 extension agents working in 13 of the 15 municipalities. MINAGRI also operates fifteen state-owned Seed Houses (Casa de Semillas) in greater Havana. These are publicly supported private businesses that offer technical support and sell agricultural inputs that would otherwise be difficult to obtain during the Special Period such as seed stock, worms for composting, tools, and biological control agents.

With this kind of political support, thousands of gardens have sprung up in Havana, Villa Clara, Matanzas, Cienfuegos, Santiago de Cuba, Pinar del Rio, and other cities. Hundreds of vacant lots, many previously full of garbage, have been transformed into green areas of gardens and other food production sites.

Limitations to urban agriculture

Urban gardens in Cuba have not been problem-free. A permanent limitation is the scarcity of available land in the densely populated areas of Centro Habana and Habana Vieja. A major constraint is the poor quality of the urban topsoil, which is often littered with garbage, glass, rubble and shards of concrete and other building materials. Another obstacle is the scarcity of water, particularly during the dry season from November to April. Irrigation is an issue because the water pipes and pumps are very old and unreliable. There has been a serious deterioration in drinking water supply, and few households are willing to use their precious water for irrigation. In fact, the government has now restricted the use of potable water for irrigation. New projects supported by the European Union and other aid agencies are providing wells, wind mills, pumps, and highly efficient Cuban-made irrigation systems to gardeners through revolving fund loan programs.

Gardens are occasionally subjected to robbery, especially in neighborhoods where there may be a shortage of money, work, or food. In these situations, gardeners organize themselves to guard the lots against theft.

Depending on location, season, and crops grown, insect pests, diseases, and weeds can limit production in urban agricultural systems. Table 3 lists the main insects affecting the twelve primary garden crops; the severity of these attacks varies according to crop and insect species involved. It is known that certain insects prefer particular plants over others if offered a variety of crops. In Cuba, aphids prefer celery, lettuce, beans, and cabbage, whereas white flies are most attracted to solanaceous crops. Diseases, nematodes,

Table 3. Main crops grown in urban agricultural plots and associated key insect pests in Cuba (Fernandez et al., 1996)

Crop	Insect pest species	Severity of attack
Tomato	*Bemisia tabaci*	+++
	Frankliniella spp.	+++
	Liriomyza trifolii	++
	Cyrtopeltis tenuis	+
Beans	*Empoasca* spp.	+++
	Aphis gossypii	+++
	Frankliniella spp.	+++
	Liriomyza trifolii	++
	Bemisia tabaci	+
Bell Pepper	*Faustinus cubae*	+++
	Empoasca spp.	+
	Liriomyza trifolii	+
	Bemisia tabaci	+
Cucumber	*Aphis gossypii*	+++
	Bemisia tabaci	+++
Radish	*Diaphania hyalinata*	+
	Frankliniella spp.	+
	Aphis gossypii	+
Celery	*Aphis gossypii*	+++
	Pseudococcus sp.	+++
	Liriomyza trifolii	+
Chard	*Empoasca* spp.	+
	Spodoptera suria	+
Lettuce	*Empoasca* spp.	+
	Bemisia tabaci	+
Beets	*Herpetogramma bipunctalis*	+
	Empoasca spp.	+
Chinese Cabbage	*Bemisia tabaci*	+
	Empoasca spp.	+
Cabbage	*Ascia monuste cobutea*	+++

+++ severe
++ medium
+ low or absent

and weeds also affect horticultural crops but their incidence and damage levels vary depending on crop species, environmental conditions, and management. For example, crops such as Brassicas, tomato, and beans are highly susceptible to *Meloidogyne incognita*, while sunflower is tolerant.

The agroecological management of urban agriculture

The success of urban agriculture in Cuba is based on the integration of a variety of strategies that combine social, economic, and environmental concerns with the issues of food security, which have been afflicting Cubans, especially in urban areas, since the early 1990s. Some of these strategies include:

- Locating production in the vicinity of consumption, thus alleviating the difficulties of transportation and maintaining a supply of fresh fruits and vegetables throughout the year, to cover for seasonal shortages.
- Utilizing available resources by recycling animal and industrial residues from local sources and applying them as agricultural inputs in urban areas.
- Advancing an ecologically stable system of production by integrating organic methods of fertilization and pest control, which optimize the health and yields of crop plants.
- Transforming unsanitary or unsightly areas such as garbage dumps and vacant lots into healthy, productive environments.
- Contributing to the environmental and agricultural awareness of urban populations, especially of children and young people, and utilizing the expertise of rural migrants who may have a wealth of knowledge and experience in agriculture.

Much of the spread and success of urban agriculture in Cuba is due to the fact that it is based on local resources and agroecological techniques emphasizing two pillars of agricultural sustainability: integrated pest management and organic soil management (Table 4). Garden productivity has been sustained using minimal external inputs, applying principles of agroecology and organic agriculture, which are low cost, environmentally sound, and based on locally available resources. For example the use of chemical fertilizers is prohibited within city limits, and gardeners rely instead on organic fertilizers in the form of chicken or cow manure, compost from household food waste, and, increasingly, worm castings. Because the gardens utilize inputs that are produced locally and at little cost, the gardeners have a greater degree of autonomy and flexibility, allowing the gardens to flourish even in adverse economic conditions.

Pest management

Cuban gardeners use many practices that fit the strategy of Integrated Pest Management (IPM). Many gardeners believe that pests and diseases are symptomatic of systemic imbalances, and therefore should be treated by equilibrating the entire system rather than suppressing specific pests. Many also maintain that a healthy plant in optimal systems does not need chemical control because it has its own natural resistance.

Table 4. Principal components of urban agriculture in Cuba (Companioni, 1996)

Soil and substrates	Incorporate organic matter from farm residues, city, and industrial waste. Produce compost from organic matter (including worm-based compost). Apply biofertilizers (*Azotobacter, Rhizobium,* mycorrhizae, Fosforina, etc.). Cultivate green manures, particularly nitrogen-fixing legumes.
Crops and varieties	Utilize both local and hybrid seeds to maintain diversity. Vary the selection of crops according to season. Produce seeds locally, and grow seedlings in local nurseries, keeping crop varieties appropriate to the area and preventing transportation difficulties.
Pest nanagement	Practice continuous crop rotations and intercropping. Employ biological controls in the form of entomopathogens, beneficial insects, and antagonists. Apply botanical pesticides (Neem, Melia, etc.). Set out pheromone traps and trap crops to divert insect pests.
Organizational and economic aspects	Planned production and marketing strategies Maximum year-round intensive exploitation Animal integration where possible Rational use of local resources
Capacity Building	Continuous training of urban farmers Extension of varieties and appropriate techniques Participatory research and extension programs

A wide range of physical, cultural, and biological control practices are used by Cuban gardeners, thus avoiding the use of pesticides that could contaminate the urban environment and potentially affect the health of its population. Moreover, the use of synthetic chemical pesticides is strictly prohibited within city limits due to concerns for public health. The use of these chemicals is restricted across the country because of their price and limited availability. The various IPM practices used by gardeners are described in Table 5.

In the case of insects, IPM strategies are tailored according to crop susceptibility. Strategies for vulnerable crops such as tomato, beans, pepper, cucumber, and celery, differ from those used for more tolerant crops such as radish, carrot, lettuce, and Chinese cabbage. However, whatever the crop mix, biological controls are a fundamental component of the IPM strategy in urban agriculture (Table 6). For example application of the fungus *Verticillium lecanii* at a rate of 1 kg/ha can quickly achieve a 50% reduction in white fly densities. Similarly, low dosage applications of *Bacillus thuringensis* and the nematode *Steinernema carpocapse* are quite effective in suppressing *Plutella xylostella,* a caterpillar attacking cruciferous crops. Many bacterial and fungal plant diseases are controlled using *Trichoderma harzianun*, especially in seedbeds and as a "dip" when transplanting seedlings. Nematodes are controlled using the fungus *Paecilomyces lilacineas* (Fernandez et al., 1996).

Biological inputs are inexpensive compared to agrochemicals and can be obtained from the "Seed Houses" or the extensive network of Centers for the Reproduction of Entomopathogens and Entomophagous Agents (CREEs). As of 1993, there were 218 CREEs located throughout the country, combining cottage industry and semi-industrial techniques to produce and distribute populations of beneficial insects and entomopathogenic microorganisms available to farmers and gardeners throughout the country. CREES are managed by local technicians who obtain most of the materials needed for mass rearing of beneficial organisms through the recycling of local waste materials. The "Seed Houses" then provide the special storage conditions critical for some biological control agents, thus extending the functional network of the CREES, and advise gardeners on the use and application of biocontrols. Some "Seed Houses" also provide biological fumigation services (Estrada and Lopez, 1997).

Organic soil management

Cuba's red ferralitic soils are generally not of high quality. As in many tropical climates, extreme weathering contributes to the rapid oxidation of organic matter; most Cuban soils contain less than 1% of organic matter. This poor soil condition is even more critical in urban areas where soils have been compacted and contaminated with broken glass, plastic, and pieces of metal. As a result, many urban gardens are constructed with the organopónico model,

Table 5. IPM approaches and tactics used by Cuban urban farmers (MINAGRI, 1995; Fernández et al., 1996)

Biological product	Pest
Insecticidal plants	
Tobacco residues (*Nicotina nustica)*	Soft-bodied insects (*Bemisia tabaci, Myzus persicae*)
Neem (*Azadirachta indica)*	Over 160 insect pests
Paraíso (*Melia axaderach*)	Same as above
Solasol (*Solanum globiferum*)	Slugs and snails
Fungi	
Beauvaria bassiana	*Bemisia tabaci, Myzus persicae, Cylas formicalis, Cosopolites sordidus, Pachneus litus*
Verticillium lecanii	*Bemisia tabaci, Myzus persicae*
Metarhizium anisopliae	*Cosopolites sordidus, Mosis* spp.
Paecilomices fumasoroseus	*Bemisia tabaci*
Trichoderma harzianum	Viruses and Bacteria (*Xantomonas campestris pv campestris, X. campestris pv vesicatoria, E. capestris pv allicola*) and fungi (*Rhizoctonia, Phytophthora, Pythium, Fusarium*)
Insects	
Chrysopa spp.	Aphids, leaf hoppers
Trichogramma spp.	*Mosis* spp., *Erinnyis ello, Diatrella saccharalis*
Encarsia spp.	*Bemisia tabaci*
Phytotoxilus macropilis	*Tetranychus tumidos*
Bacteria	
Bacillus thuringensis	Wide variety of lepidopteran insect pests (*Plutella xylostella, Heliothis, Spodoptera* spp., *Erinnyis ello*, etc.)

which uses raised beds filled with soil enriched with compost or any organic residues available locally or from nearby farms, to enhance organic matter content. The organic matter that is used to enhance soil fertility comes from a variety of sources:

- Animal wastes
  - Manure
  - Urine
  - Feathers and fur
  - Bones and blood
  - Biodigested waste
- Plant residues
  - Crop residues
  - Tree and hedge clippings
  - Weeds
  - Leaves and branches
  - Sawdust and ashes
- Industrial waste
  - Coffee pulp
  - Sugar cane residues (cachaza)
  - Rice husks
  - Paper, cardboard, and other biodegradable waste
  - Biodigested waste
- Residential waste
  - Organic household waste

Efforts are in progress to ensure that, before composting these materials, they are free of metals and plastics, which could contaminate the resulting organic fertilizers. This is especially important when using industrial or residential waste, which can contain heavy metals and other contaminants. Most gardeners prepare mixtures of various components utilizing proportions of each organic material depending on availability or soil and crop needs. Many urban farmers combine cachaza (waste material from sugar cane) with soil in proportion of 75/25 or 50/50. Others combine in equal proportions compost, soil, and zeolite (a non-metallic active mineral with a very high proportion of exchangeable cations-nutrients) available for plants and the soil to absorb (Carrion et al., 1994).

A variety of methods are currently employed in Cuba to convert the raw organic matter obtained from the above sources into compost, with piling and vermiculture methods being the most prevalent:

- Indore Method – This method was developed in India around the turn or the century. A pit is dug and filled with alternating layers of green (fresh) and brown (dry) compostables, and manure. The compost is kept moist to encourage organic activity, and is turned over whenever the temperature drops within the pit.
- Bio-Dynamic Method – Using earthworms, fermented herbs, and other natural influences.

Table 6. Botanical pesticides and biological agents used in the control of insect pest outbreaks in Cuban urban agriculture (Estrada and Lopez, 1997; Rosset and Moore, 1997)

Maintaining garden health	
Location	Choose a location free of harmful insects and inoculum
	Know local pests and choose crops with a high resistance to them
Plant varieties	Plan a yearly cycle which uses seasonally adapted plants
	Keep diversity both within the plot and throughout the growing year, combining plants with different levels of susceptibility to diseases
Planting	Ensure quality seeds which are healthy and without disease
	Timing of planting should be during ideal weather conditions, when yearly relevant pests cycles are at a minimum
Soil	Maintain optimal soil quality and fertility
Equipment	Wash equipment brought from one plot to another in order to prevent propagation of pathogens
Preventing and controlling pest outbreaks	
Soil treatment	Solarization under a thin layer of transparent plastic sheeting
	Inversion of topsoil to expose soil pathogens
	Mulching with straw or sawdust
Protective plants	Incorporate insecticidal plants into the garden plots
	Make solutions from plants with insecticidal qualities to apply to infected crops or roots
Repellent fungi	Cultivation of mushrooms that control soil nematodes
	Application of solutions made from insecticidal mushrooms
Natural enemies	Release of parasites and predators of a variety of insect pests
	Avoid the use of chemical pesticides which could inhibit the presence of beneficial insects and make pests more resistant
Entomopathogenic microorganisms	Application of various bacteria, fungi, and viruses for the control of a wide variety of pests
Traps	Yellow traps – Metal or wooden boards, painted a vibrant yellow, are coated in a sticky substance to attract and trap insects
	Light traps – To combat nocturnal insects a lamp is placed in the garden over a mixture of water and oil into which the insects fall
	Mollusk traps – Apply a mixture of water and boiled slugs to the plants, which repels with its odor, or set out trays of beer and salt which attract then drown snails and slugs

- Bellsuille Pile – Composting partially drained aqueous waste.
- Pile Methods – Creating piles of layered green and brown compostables and kitchen refuse up to one meter in height.
- Bin Method – Same as above but within a perforated bin, turning the compost periodically to allow oxygen flow.
- Corral Method – For large amounts of compost, the same principals can be applied in a circular, wire corral, two meters in diameter.
- Biodigestors – Underground sealed case mixes organic wastes with water for anaerobic fermentation, which produces methane gas used for cooking or producing electricity. Solid and liquid fertilizers are produced as a byproduct. Producers are using a modified Chinese design made in Cuba, and industrial style swine farms are using modes up to 80 cubic meters in size.
- Vermiculture – This process, although relatively new in Cuba, is gaining great importance. It uses earthworms, typically *Eisenia foetida*, to facilitate decomposition. The earthworms are placed in a bed approximately one meter in length, which is layered with compostables. As the worms feed and excrete, the organic matter is converted into a humus rich in texture, nutrients, and enzymes.

In addition to the use of organic materials, many gardeners use biofertilizers such as *Rhizobium* to inoculate legumes as well as other agents such as mycorrhizae, *Azotobacter*, and Fosforina (a phosphorus solubilizing bacteria), all of which are available through the "Seed Houses." For instance, tomato and onion germination is dramatically improved by the application of *Azotobacter chrococcum* to the seed beds at a rate of 15–20 lts/ha diluted in 300 liters of water. This results in substantially higher yields per hectare (Martinez Vieira et al., 1994).

Socio-economic and food security impacts of urban agriculture

Urban agriculture has extended throughout the island, reaching the highest level of development in the most populated municipalities of each province. One of the goals of Cuba's national program of urban agriculture is to devote 3 m^2 per capita of land in urban and peri-urban areas to either an *intensive garden* or *organopónico*. Given the potential yearly yield of 20 kg/m^2, this would supply each member of the population with 60 kg. of fresh produce a year. This is more than half of the 109.5 kg. minimum of vegetables per year recommended by the UN Food and Agricultural Organization (Companioni et al., 1997).

During 1996, some provinces surpassed the 20 kg/m^2 level, and it is estimated that most *organopónicos* and *intensive gardens* produce an average of 18 kg of vegetables per square meter; that is a total production of 138 million kilograms nationally. During 1996, Havana's urban farms provided the city's urban population with 8,500 tons of agricultural produce, 4 million dozens of flowers, 7.5 million eggs, and 3,650 tons of meat (Companioni, 1996).

Cuba's *popular gardens* also performed well in their few years of existence. While gardeners are by no means self-sufficient in their food needs, nor can they supply all food needs of each city, they are able to provide essential vitamins, minerals, and carbohydrates crucial to people's diets, as well as medicines and spices, which were in short supply. Most popular gardeners provide food for the family, give a significant proportion of the produce to childcare centers, hospitals, and needy community members, and sell some remaining produce directly to the community. These gardens have revitalized many traditional crops, particularly starchy root crops (viandas) like the boniato (sweet potato), potatoes, and cassava, and they have helped to reduce dependency on outside food sources. In order for urban agriculture to play a more prominent role within Cuba's general food system, efforts are underway not only to expand such production but to make it more widely available to the population through farmers' markets and other types of consumer networks. Some attempts on food processing have also been initiated to extend the temporal availability of perishable produce in the form of jams, juices, cakes, dried fruits, etc.

In addition to increased food security, urban gardens have also helped to empower many individuals and communities. They have renewed solidarity and purpose within neighborhoods, sustaining morale during the ongoing economic crisis. The popular gardens have helped to build community pride; they clean up vacant urban spaces that had once been local dumps, replacing these eyesores with greenery. To some people, the gardens also serve as a source of leisure, exercise, and relaxation. For those born in the city they are an opportunity to learn about and enjoy the process of planting and cultivation. For recent migrants from the countryside, the gardens are a way of utilizing their agricultural skills, and for some, despite the fact that they labored hard for survival in the rural areas, a refuge where they can work again but differently with the land and reconnect with nature.

Conclusions

The future of Cuba's urban agriculture hinges to a large degree on the political and economic future of the country as a whole. Just as political and economic forces have triggered the gardens, so too will these forces determine their sustainability, as Cuba attempts to integrate itself into a new global economy. As the title implies, the Special Period is not perceived as a normal state of affairs, but rather an interval between the collapse of the relations with the Soviet bloc and the lifting of the US embargo. Some believe that when the embargo is lifted, Cuba will revert to chemical intensive agriculture and foreign imports for its food, particularly to serve urban centers like Havana.

Many analysts had predicted that, with the easing up of the food crisis, the urban gardens in the cities would begin to fade away. But just the opposite has occurred. The farms and gardens in Havana have been steadily increasing, both in size and number, but most importantly in quality. Knowledge about gardening is spreading thanks to the various horticultural organizations, the "Seed Houses," and to MINAGRI's extensionists. One can observe an extensive use and the benefits derived from agroecological practices such as composting, crop rotation, intercropping, and biological controls. As long as promoted techniques remain accessible and affordable, urban agriculture will continue to scale-up and benefit both urban farmers and producers.

Given Cuba's history and social organization, it is possible that urban agriculture will not only prevail, but expand. As the productive capacities of the city's food system expand, this allows for expanded employment opportunities and nutritional resources for large sectors of society. Although much of the development of urban agriculture has involved technological innovation and adaptation, the spread of gardens has been more the result of social techniques of organizing and diffusion rather than the extension of production techniques per se. This implies that prevailing forms of urban agriculture are acceptable within the social fabric of the community. Many projects are

flourishing, particularly among those gardeners who have tried to achieve more than food security by investing in the community whether through horticulture clubs, by encouraging local participation and decision-making, or by contributing to the health of the neighborhood. Their approach has stressed grassroots principles through the collective organizing of gardens that involve, educate, and reinforce the community. Urban agriculture is now part of the fabric of Cuba's urban society and its sustainability, and it is possible that it will remain that way for the long term.

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