

# AGRICULTURE IN URBAN ECOSYSTEMS: A STEP TO CITIES SUSTAINABILITY<sup>1</sup>

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## Abstract

Urban Agriculture (UA) has emerged as an alternative capable of fostering sustainable relations among the economic, social and environmental spheres in cities. It consists of growing and processing traditionally rural food products in urban zones in consonance with the environmental considerations to promote sustainability. This study set out to analyze the interactions of agricultural activities and the urban ecosystem. A review of the literature and a case study of an Urban Agriculture program developed in the metropolitan area of the city of Rio de Janeiro showed that Urban Agriculture provides considerable ecosystem services, generates income, increases biodiversity conservation and fosters social inclusion, functioning as a mechanism for achieving equilibrium among the components of the urban ecosystem.

## Introduction

One of the greatest difficulties stemming from urbanization, industrialization and population growth processes is how to establish sustainable economic growth strategies and that difficulty worsens urban environmental and living conditions (SACHS, 2002)

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The urbanization process fosters economic growth and the modernization of the cities insofar as it generates employment, increases income and strengthens the labor market. In addition, the density of people in cities facilitates knowledge and information sharing, the generation of new industries and technological innovation (GRÜBLER; FISK, 2013). Economic and demographic concentration influences disorder in urban areas, causing scarcity of natural resources, environmental degradation and a reduction in the quality of life in the form of social exclusion, extreme poverty, unemployment and violence (JACOBI, 2000). Uncontrolled urban growth together with poor planning and administration capacity are serious obstacles to the elaboration of public policies designed to promote sustainability and enable the conciliation of economic growth and environmental protection in the cities (HARVEY, 1997).

The condition for sustainability to exist is to establish limits for natural resource use and environmental degradation in a way that does not jeopardize economic growth, achieving equilibrium in the relations between man and nature (CMMAD, 1987). However there are divergences among the interpretations of that concept (GARDNER, 1989; LELE, 1991; BARTELMUS, 2002; SACHS, 2006; VEIGA, 2010; JUCÁ, 2013). What is essential in all of them, however, is their understanding of the importance of environmental preservation for the maintenance of human life and of integrating environmental and social variables to the economic development model (ACSELRAD, 2010).

According to the United Nations Organization (UNO) the world population currently stands at seven billion and it is estimated that it will reach eight billion by the year 2030 of which five billion will be living in urban zones (UNO, 2014). That means social and environmental problems stemming from the urbanization process and population growth can be expected to get worse. Human activities on a growing and cumulative scale intensify impacts such as: the limitation of natural resources (especially water); exacerbating the greenhouse gas effect; and social and demographic changes like the concentration of wealth in the developed countries and increased poverty in developing countries (UNDP, 2002). There is a need to adopt new models and tools capable of promoting social justice, economic growth and environmental protection, all in the interest of achieving urban sustainability (BUCKINGHAM-HATFIELD, PERCY, 1999).

One of the challenges confronting urban sustainability is “how can legitimacy be achieved for environmental pleas when, very often, concern for the environment is presented as being an obstacle to addressing unemployment and overcoming poverty?” (ASCERALD, 2010). Concern for the environment is considered less important than other issues such as poverty, unemployment, education and health. There is a clear need for a paradigm shift because nature is the base for human development and it is fundamental for the maintenance of life on the planet (FAO, 2016).

Against that background, Urban Agriculture (UA) emerges as an alternative capable of fostering sustainable relations among the economic, social and environmental spheres in the cities. It is defined as being an activity undertaken in the interior of a city (intra-urban) or on the edge of the urban zone of a city (peri-urban) that cultivates, processes and distributes a variety of food or non-food products and that makes use of city resources such as, labor, land, water and organic waste, contributing towards gene-

rating income, improving the urban landscape and boosting food and nutritional security (MOUGEOT, 1999)..

The main elements defining urban agriculture are: 1) the type of economic activity carried out, such as agricultural and livestock production, transformation, commercialization, auto-consumption and service provision; 2) product categories and sub-categories and whether they are food products or non-food products; 3) the characteristics of the locations which may be, for example, individually-owned areas, collective areas, or public areas including streets, squares, parks, vacant areas and wasteland; and 4) the mode of activity which can include urban horticulture, agro-forestry plots, production of medicinal and/or ornamental plants and the use of fruit trees in urban forestry projects (MACHADO, 2002; MADALENO, 2002).

According to Santandreu and Lovo, Urban Agriculture includes production, transformation and service provision to generate agricultural and livestock products destined for auto-consumption, exchange, donation or sale and it is linked to aspects of urban dynamics such as land use and environmental planning and management of the cities (SANTANDREU; LOVO, 2007).

Although urban agriculture is still very little publicized it is nevertheless being encouraged by international organizations like the United Nations Development Programme (UNDP) and the United Nations Food and Agriculture Organization (FAO) in addition to many non-governmental organizations (NGOs) and governments around the world. Examples of that are Brazil, Mexico, Russia, South Africa, Portugal, Ecuador, Cuba, Peru and Germany where UA has been stimulated in periods of social and economic fragility (FAO, 2016).

There is an obvious need for policies specifically designed to address questions associated to urban agriculture, emphasizing the fundamental importance of agricultural activity as a means raise the awareness of the inhabitants of the cities and society at large in regard to: the importance of healthy food, the natural foundations of agriculture, protecting nature and establishing the basis of a new society that is fairer, and more egalitarian and sustainable (FAO, 2016).

Meugot (2000) views it as an activity that has traditionally been associated to the rural milieu but that is carried out in an urban setting, performing a fundamental role insofar as it brings with it not just the practice of cultivation but also a whole set of social, economic and environmental factors. It contributes towards the social and environmental administration of cities and collaborates in improving the urban population's quality of life.

It is of fundamental importance that UA should be in consonance with the complex web of interactions existing in the environment in which it is inserted with the aim of fostering sustainability in the urban milieu (MOUGEOT, 2000). Ecological and human economics, sociology and agro-ecology are study disciplines capable of promoting innovative methodologies to approach and address urban sustainability issues and, more specifically, the interaction of UA with the urban environment (ARRUDA, 2006; VAZQUEZ, 2006; ARRUDA, 2011). Harvey (1997) and Lawrence (2003) consider that analyzing the urban environment from the ecological standpoint, using the classic approach of conservation and protection of natural environments when investigating the dynamic relationships and the physical biological cultural social and economic characteristics of

the urban environment, offers a better understanding of the interactions between the populace and the activities carried out.

Against that background, Urban Ecology stands out as the evolution of a systemic manner of thinking with which to approach the question of urban-environmental relations. It is a way of studying the extant urban relationships in cities in a manner that is integrated with the natural environment, identifying various ecosystems within the urban environment or even considering the city itself as being an ecosystem; one which makes it feasible to understand its dynamics and the consequences of urban expansion (TERRADAS, 2011). From the ecological point of view, society transforms the natural ecosystem, creating a new medium, a new ecosystem (ODUM, 1988) that constitutes a totality of relations and interactions in the heart of a unit readily identifiable as a niche: the urban agglomeration within a natural ecosystem” (MORIN, 1998). The features and the functioning of that ecosystem are different from those of natural ecosystems because, in them, human activity is predominant. The construction of the system takes place through a process of continuous interaction between a society in movement and a given physical space which is constantly being modified, bringing about changes that are swift and intense (COELHO, 2012).

Cities are considered to be ecosystems because they possess the biological necessities for their populations’ survival and the cultural requirements that enable them to function and grow. They perform functions in the sphere of complex interactions and relations among species for the maintenance of self-regulatory processes governing energy flows and nutrient cycles (GLIESSMAN, 2001). According to the Urban Environmental Management Research Institute (UEMRI), the urban ecosystem consists of: the natural environment, corresponding to the flora and fauna, living beings, water, land and air and the other biotic constituents; the built area, made up of structures such as buildings, houses, streets, roads, electricity and water supply installations and all the other processes, services and resources associated to them; and of the socio-economic environment, including human activities like education, health, culture and economic activities in general (UEMRI, 2008).

Thus urban ecology studies the urban environment and all the complex interactions that occur in it, investigating the relationships of the occupants of urban areas, whether they be people, animals, industries or other such things, with their impacts on the environment,. It investigates the relationships that are established among the animals, the vegetation, the land and the air in regard to the impacts that stem from their coexistence with urbanized society which is, more often than not, unharmonious (NIEMELA, 1999). Such studies can help towards understanding the interactions between UA and the components of the urban environment and they can perform innovatively in monitoring the actions involved. UA can play an important role in modifying cities’ environmental performances, incorporating itself as a strategic activity for sustainable development and for improving people’s quality of life.

Understanding agriculture in urban spaces and its interaction with their ecosystem processes is a major challenge. That makes it worthwhile analyzing UA to identify its effects on the dynamics of cities in their aspect as being ecosystems themselves and, consequently, its impacts on urban sustainability. This study set out to analyze the inte-

reactions of agricultural activities within the urban ecosystem of the metropolitan region of Rio de Janeiro.

## Methodology

This study conducted a bibliographic review embracing scientific papers obtained from reference databases such as the CAPES periodicals portal, Web of Science, SciELO and Scopus as well as books, theses, FAO publications and unindexed articles. In addition a case study was made of the Urban Agriculture Program unfolded in the metropolitan region of Rio de Janeiro by the non-profit organization Alternative Agriculture Project Services and Consultancy (*Assessoria e Serviços a Projetos em Agricultura Alternativa*) (AS-PTA, 2016). The aim was to identify UA-related initiatives (especially in Brazil), and the various factors involved, study their multi-dimensionality and obtain information on the various relationships and transformations in society involved. The intention was to describe the program's region of influence, the population involved, the actions carried out, the products cultivated and the fostering of food security, to analyze the contributions stemming from UA and to discuss, from the standpoint of urban ecology, the relationships that are established in the natural, socioeconomic and built environments of the urban ecosystem.

## Results and discussion

### *State of the Art of Urban Agriculture*

As far back as 1996, it was estimated that 800 million people around the world were engaged in Urban Agriculture (SMITH; RATTA; NASR, 1996) and many countries had incorporated UA as an urban development instrument. On the international scene there are now many outstanding UA-related programs and initiatives among them: the movement in Cuba run by the National Urban Agriculture Group (*Grupo Nacional de Agricultura Urbana - GNAU*); The Urban Agriculture Network (TUAN), based in Washington, D.C., USA; the Support Group on Urban Agriculture (SGUA); the Cities Feeding People project of the Canadian NGO International Development Research Center (IDRC); and the Resource Center for Urban Agriculture and Forestry (RUAF). In 2018, Denmark commissioned the Worcester Polytechnic Institute, an environmental organization based in Copenhagen, to conduct a study of UA and all its potential in the city of Copenhagen to support and make feasible its objective of making the city CO<sub>2</sub> neutral by the year 2025. That study examined all the environmental, social, political, economic, civic and public health implications of UA as part of the bid to identify the requirements for establishing urban farms in the region. Implementation models and costs were analyzed and the study resulted in a series of recommendations regarding UA in the city and its immediate surroundings (HOOPS et al., 2018).

In Brazil, UA came onto the political agenda under the aegis of the Federal Government's Zero Hunger policy which sought to guarantee the human right to ade-

quate food to persons with difficulty in gaining proper access to food (PROJETO FOME ZERO, 2001). According to the urban agriculture panorama as portrayed by Santandreu and Lovo (2007), there are UA initiatives present in all the Brazilian regions, financed by Federal, State and Municipal governments, by non-governmental organizations or by the private sector; approximately 600 projects distributed among the country's main metropolitan regions.

Outstanding examples of such projects are: Community Horticultural Gardens implanted by the municipal government in Campinas, Sao Paulo and by the Hunger-free Cities (*Cidades sem Fome*) organization in Sao Paulo City, Sao Paulo; the Self-supplied Inputs for Small-scale Crop and Livestock Production (*Verticalização da Pequena Produção Agropecuária*) program in Brasilia, Federal District; the Community Vegetable Gardens program in Teresina, Piaui, the Qualifying Local Agents in Food and Nutrition Security and Urban Agriculture (*Formação de Agentes de Desenvolvimento Local em Segurança Alimentar Nutricional e Agricultura Urbana*) project in Belo Horizonte, Minas Gerais, developed by the Alternative Technologies Exchange Network (*Rede de Intercâmbio de Tecnologias Alternativas - REDE*); and the Production Belt, Feeding and Preserving the City (*Cinturão Produtivo, Preservando e Alimentando a Cidade*) project in Santa Maria, Rio Grande do Sul.

## The Urban Agriculture Program of the NGO AS-PTA

Ever since 1999, the NGO *Assessoria e Serviços a Projetos em Agricultura Alternativa* (AS-PTA) has been promoting the Urban Agriculture Program in the western zone of Rio de Janeiro and in the municipalities of Nova Iguaçu, Mage, Guapimirim and Queimados. The region is riddled with social and economic problems that stem mainly from the lack of adequate public policies in the areas of food, health, education, security and housing.

The program in question stimulates the strengthening of agricultural practices in the urban spaces of peripheral communities promoting the cultivation of food crops and the raising of animals based on agro-ecological concepts. It is developed by recognizing and valuing those agricultural practices that already exist in the communities and providing technical advice and assistance with the aim of strengthening both individual and community initiatives.

The program carries out local actions in various levels in communities with backyard or collective vegetable gardens dedicated to producing for direct consumption or for exchanging, donating or selling in agro-ecological markets. There are also actions connected to the Food Acquisition program (*Programa de Aquisição de Alimentos -PAA*) and the National School Food Program (*Programa Nacional de Alimentação Escolar -PNAE*), whereby producers are responsible for delivering products to schools in the metropolitan region. The organization also seeks to generate theoretical and methodological references so that its lessons can influence and encourage other initiatives in various different socioenvironmental contexts in Brazil.

Currently the program has around 600 beneficiary farmers involved in activities such as collective vegetable gardens, domestic backyard gardens, and family-agriculture

agro-ecological production units. In regard to the type of agriculture carried out, the AS-PTA organization consistently bases its dialogue on an agro-ecological approach, stimulating a constant process of transition to sustainable production. The crops are diversified and include fruits, horticultural species, spices and medicinal herbs (Chart 1).

**Chart 1 – Main products cultivated in the Urban Agriculture Program promoted by the non-governmental organization *Assessoria e Serviços a Projetos em Agricultura Alternativa*.**

Category	Products
Fruits	Jamun ( <i>Syzygium cumini</i> ), Jack fruit, avocado, acerola cherry ( <i>Malpighia emarginata</i> ), ciriguela ( <i>Spondias purpurea</i> ) mango, apple, persimmon, rose apple ( <i>Syzygium jambos</i> ), banana, five-corner fruit ( <i>Averrhoa carambola</i> ), papaya.
Greens	(conventional and non-conventional greens and salad plants)
Vegetables	Sweet cassava, maize, beans and solanaceous plants.
Seasoning and medicinal herbs	Bitter-leaf ( <i>Vernonia condensata</i> ), cathedral bells ( <i>Kalanchoe pinnata</i> ), parsley, spring onion, coriander, basil, salvia, blade-apple cactus ( <i>Pereskia aculeata</i> ), climbing spinach, turmeric, ginger, mint.

Source: AS-PTA (2016).

In cases where space is very limited, such as back yards, the plants are grown in pots or other recipients or agro-forestry modalities showing some degree of input self-sufficiency. In regard to production conditions for urban growers, most have access to piped water supply and electricity. However in more outlying areas on the urban perimeter the source of water may be springs, streams, wells, or systems for capturing rainwater. In regard to sanitation they are mostly linked to a public sewage system. Most of them make use of organic waste by turning it into compost in the household area or some local spot. The money needed to implant the UA vegetable gardens usually comes from the families themselves. Financing for the AS-PTA activities, however, comes from government. Currently the program enjoys the financial support of a German international cooperation agency, Misereor.

The AS-PTA organization establishes a series of partnership arrangements with community organizations and public and private institutions such as: the Federal Rural University of Rio de Janeiro (UFRRJ) which developed the social technology of low-cost irrigation that is currently being used by urban farmers participating in the program, the Federal University of Rio de Janeiro (UFRJ), the Brazilian Agriculture and Livestock Research Company (EMBRAPA), the Rural Extension and Technical Assistance Company (EMATER), the Ministry of Agriculture, Livestock and Supply (MAPA), the Ministry of Agrarian Development (MDA), the Rio de Janeiro municipal government's Department for Solidarity in Economic Development as well as with farmers' associations and cooperatives like: the Organic Farmers Associations of Vargem Grande (AGROVARGEM), and of Pedra Branco no Rio da Prata (AGROPRATA), the Association of Crop and Livestock Farmers of Jacarepagua (ALCRI) and the Catholic Church's social assistance organization *Pastoral da Criança*.

According to the program's general coordinator, the greatest difficulty facing program implantation is urban violence, especially that which affects the communities' young people. In addition, it is very difficult to gain access to public policies that specifically seek to make the practice of urban agriculture feasible and there is a generalized lack of interest and support on the part of governments.

## **Agriculture Within The Urban Ecosystem**

### *The socioeconomic environment*

According to the participative diagnosis conducted by the AS-PTA in the Western Zone of the city of Rio de Janeiro in one of the areas that receives the Urban Agriculture program, families have a monthly income of 200 Brazilian reals or no monthly income at all and some families go two or three weeks at a time without consuming meat or horticultural products (MONTEIRO; MENDONÇA, 2004), revealing their great social and economic vulnerability.

That extremely low income level makes an adequate diet impossible so the needy population only has access to the most basic and essential foodstuffs. In the Urban Agriculture program the production of food for consumption by the producers themselves works as a strategy to guarantee food and nutritional security for the participating families. It means that the local production provides far better access to food but in a different way from the traditional market mechanisms, making it possible to produce good quality food at low cost without having recourse to agricultural pesticides or chemical fertilizers.

As a result of that improvement in food and nutritional security a greater variety of healthy food becomes more readily available in the daily life of the population. Accordingly UA can also function as an important nutritional education tool. Involvement in the agricultural practices leads to an enhanced awareness and knowledge of good nutritional habits and an enrichment of families' diets.

The program stimulates and puts into practice the transformation and commercialization of the UA products and that makes it possible for the participating families to generate some income. So in addition to its aspect as a contributor to food security and nutritional education, UA constitutes a source of income, employment and occupation for the persons who practice it. It develops and enhances the value of services in the locality, cuts down spending on food and complements family incomes, thereby enhancing people's financial autonomy and diversifying the incomes of the families involved.

In regard to the systems program beneficiary families adopt to distribute their products, there are forms of organization within the communities to offer the products for sale in agro-ecological markets, to donate them or to exchange them. Those systems for distributing the production have the effect of stimulating local trade insofar as local traders in general and families purchase locally-produced food products, creating new market options and developing a local economy that has an element of solidarity with a production that is linked to the community's own demand. In the case of actions associated to the PAA and the PNAE, there is the additional possibility of further integrating the



UA actions with the policies designed to guarantee school food supply and food security and that further strengthens urban family agriculture, creating opportunities to value and expand the actions being carried out.

Thus UA presents certain readily identifiable central features such as: social cooperation and partnerships between producers and consumers; reconnection of production and consumption in consonance with standards of sustainability; infusing dynamism into local markets with territorial identities and re-attributing value and importance to the circulation of products with a different quality, that is, products with a sound ecological basis (DAROLT et al., 2016).

One of the program's objectives is to empower the population living in the peripheral areas as a way of integrating marginalized individuals to society, offering encouragement to community leaders and political representatives. The beneficiaries are people who find themselves in situations of social vulnerability; men and women, young and old, unemployed or with very low incomes living in the peripheral areas of the city.

In that sense, urban agriculture is capable of promoting community mobilization and fostering better relations and interactions among the inhabitants. It influences the articulation and participation of local residents in solving local problems and addressing issues involving UA and the community. Furthermore, the diversity of the population involved propitiates the construction of knowledge and skills and exchanges of experience and wisdom thereby contributing towards social inclusion.

The Carioca Urban Agriculture Network (*Rede Carioca de Agricultura Urbana - REDE CAU*) calls attention to the numbers of women involved in AS-PTA program activities; they form the majority of participants because among them there is "greater concern for family health, grater care with diet and living space, greater dedication of their time to the family and greater amount of time spent in the home and the community" (REDE CAU, 2014). That shows how UA is also an instrument capable of boosting the efforts to achieve gender equity by improving women's living conditions.

The program also stimulates agro-ecological-type production insofar as it makes it feasible to achieve a production under family administration whether it is in family back yard or a community vegetable garden. The outstanding feature of agro-ecology is that it provides the methodological tools needed to ensure that community participation strengthens the agricultural activities undertaken and ensures the articulation of the local population as a decision-making protagonist (CHAMBERS, 1983).

Research has shown how having green areas present in their daily round improves people's sense of well-being, which is evidence of the positive link between quality of life and urban agriculture (SMIT; NASR, 1992; RIBEIRO, 2013). As has been mentioned, most of the beneficiaries are victims of social inequality and devoid of access to environments for leisure or recreation.

In the program under analysis, the participants receive capacity building and professional counselling to enable them to exercise their activities and that propitiates enhanced self-esteem and motivation, inserting them once more as active citizens in their communities. The financial profit obtained from the sale of their products also stimulates even greater interest in the activities. Furthermore, involvement with UA places the

participants in a situation in which they live in a context where nature is present as well as in the company of other individuals and that transforms the UA activity into a kind of refuge from the problems of the daily round.

According to Oishi, Schimmack and Diener (2001) and Comasseto et al. (2013), the personal incentive to participate in daily activities such as UA that require considerable effort and activity, in addition to including the person in work groups and actions in favor of the community, is that it offers the individual a sense of pleasure, enhanced self-valuation and better expectations in regard to the future.

It has also been found that participating in UA can raise the population's awareness and sensitivity in regard to the environment because it involves the individual directly in the production process, leading to a better understanding of environmental relations and enhanced concern for urban living conditions. In that sense, UA configures itself as an educational action capable of making those involved sensitive to, and aware of environmental issues and the collective need to defend the medium they live in.

## **Built environment**

AS-PTA unfolds its Urban Agriculture program in municipalities where there is a lack of provision of public services such as basic sanitation, health, housing etc. Implanting agricultural activities makes local development feasible and that can influence public and private investments in urban infrastructure. Furthermore, UA calls for improvement in the maintenance of the respective areas involving clearing up and preparing the vacant lots for planting and improving the conditions of local physical spaces.

It is acknowledged that with UA the proximity of the food production to the food consumer can reduce transportation mobility between cities that depend exclusively on external resources for their supply, improving ecosystem energy flows. Producing food in urban zones reduces the use of fossil fuels that otherwise would be burned to transport the products and consequently, effectuates savings of those natural resources (NOLASCO, 2009).

That same proximity means: there is a reduction in the consumption of resources such as electricity and in the wear and tear of roads and highways; trade relations are decentralized improving transit conditions in the local neighborhoods and consequently improving transportation flows in the large urban centers;

## **Natural environment**

The urbanization process and the alterations that stem from changes in land use patterns such as the removal of the vegetation cover and the paving of the land surface cause significant impacts on the natural environment within the urban ecosystems. Among the consequences are a reduction in rainwater absorption by the soil, biodiversity loss and climate change (BRAGA; CARVALHO, 2003).

The development of Urban agriculture leads to an expansion of green areas and that helps water management in general, improves soil drainage, reduces surface runoff of rainwater in the areas destined for production and also in surrounding areas, avoids

the accumulation and overflowing of large volumes of water reducing the risk of flooding, reduces soil loss through erosion and increases the reserves of underground water (MACHADO, 2002).

Among other techniques, the sustainability of the AS-PTA's Urban Agriculture Program is based on agro-ecological management that includes the use of organic substrates and organic management of the soil, rotation techniques and associations of different crops, composting to produce organic fertilizer, crop diversification, and the non-use of agricultural pesticides. Altieri (2004) believes that agro-ecology consists of an agricultural approach that incorporates the idea of taking special care not to focus exclusively on production but also on the ecological sustainability of the environment and, consequently, of the human being.

According to data obtained from the AS-PTA's program, the crops are diversified, including horticultural leaf and vegetable species, fruits, spices/seasonings and medicinal herbs and they may even embrace agro-forestry systems. That being so, agricultural cultivation increases biological diversity and makes it feasible to increase green areas in the cities so that they may even constitute ecological corridors thereby improving the flows of flora and fauna species among any forest vegetation fragments there may be in the surrounding areas (MACHADO, 2002).

Urban ecosystems are rich in biodiversity and one of the greatest challenges to be faced is the preservation of species in the cities (SCDB, 2012). UA offers shelter and food for individuals of different species and therefore represents an alternative capable of improving biodiversity conservation in the urban environment.

In addition, insofar as they perform photosynthesis, the plant species cultivated capture CO<sub>2</sub> from the atmosphere and therefore contribute towards diminishing the intensity of the greenhouse gas effect. Furthermore, expanding green areas in the form of vegetable gardens also propitiates the formation of a much pleasanter micro-climate, contributing towards maintaining humidity levels and diminishing temperature in the locality (CULLEN Jr. *et al.*, 2003).

Fernandes (2014) and Pinto (2007), however, underscore the risk of vegetable garden contamination represented by the retention of dust present in the polluted air and captured by the leaves of the plants. They state that pollution is the main counterpoint consideration in regard to food production in urban zones.

Another important point related to the natural environment is the importance of cleaning those areas that are usually the site of accumulations of waste and rubbish. The land usually used for implanting community vegetable gardens consists of vacant or abandoned lots. Cleaning them for the purpose of planting crop or other forms of production brings about a considerable improvement in the local environment, avoiding pollution and soil contamination and also reducing the proliferation of vectors and the occurrence of the diseases that they carry.

It can also be seen that the organic residues originating from the AS-PTA's vegetable gardens program are all re-used to produce fertilizer by means of composting. In addition, waste items residues such as pots and other recipients are made use of as vases for production in vases in household backyards. In that light, the agricultural activities

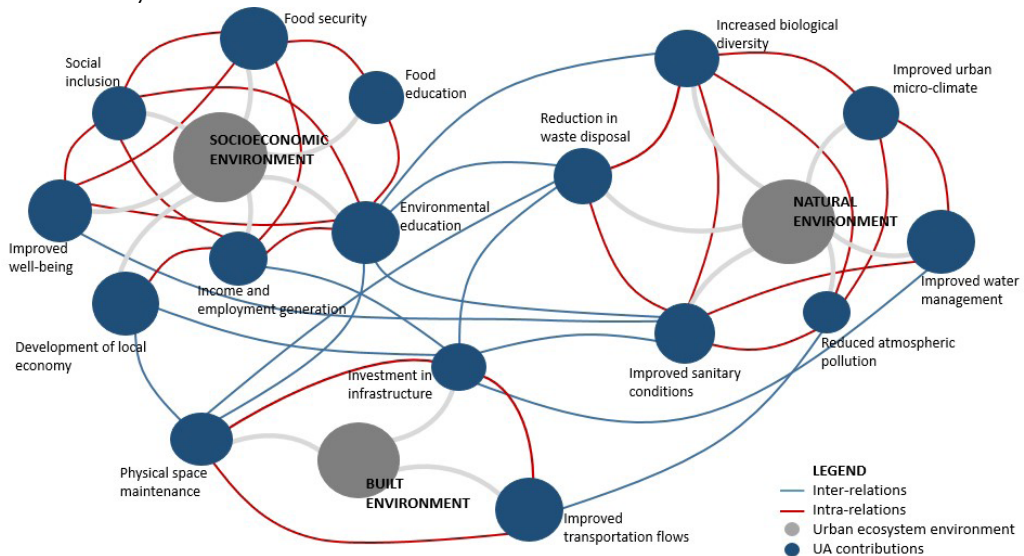
can also serve to reduce the frequently improper disposal of solid waste and improve nutrient cycling in the urban ecosystem.

The Hunger-free Cities Organization (*Organização Cidades Sem Fome* - CSF) points out that UA's reuse of both organic and inorganic residues may indirectly "reduce the production of methane stemming from the decomposition of organic detritus in the sanitary landfills and increase their useful lifespans" (CSF, 2005).

## Dynamics of Relations Within The Urban Ecosystem

It is easy to perceive that in regard to UA's contributions its agricultural activities provide a large number of ecosystem services which have a dynamic association with the inter- and intra-relations among the natural, built and socioeconomic environments (Figure 1).

**Figure 1 – Inter and intra-relationships between Urban Agriculture (AU) and the urban ecosystem.**

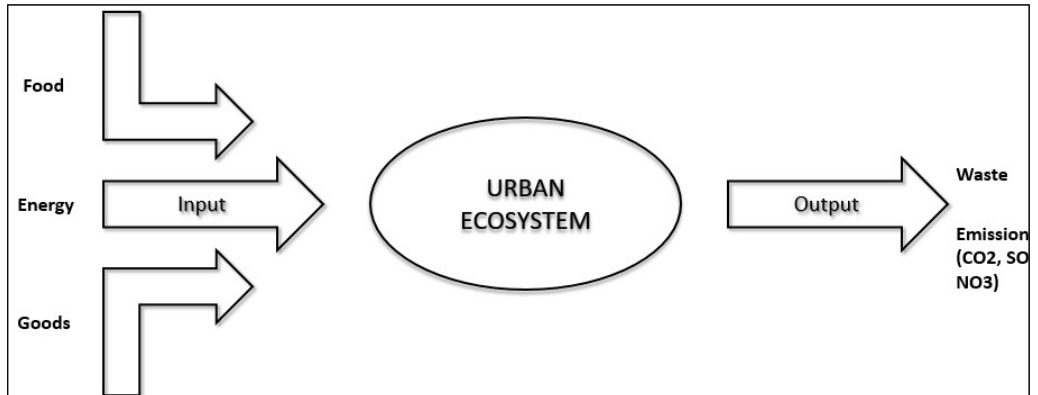


Source: Elaborated by the authors.

The best way to analyze the urban ecosystem and understand its metabolism is to evaluate the city's flows. Urban metabolic processes are linear by nature (Figure 2) with high levels of energy processing and a large production of residues (BETTINI, 1998; MONTEIRO; MONTEIRO; LOPES, 2013).

The solution for the problem of achieving sustainability lies in the circular urban mechanism whereby the consumption is reduced by implanting efficiency and the maximizing the re-use of resources. That process of use, re-use, minimizing resource use and maximizing recycling, enhances the city's efficiency and reduces its impact on the environment (BETTINI, 1998).

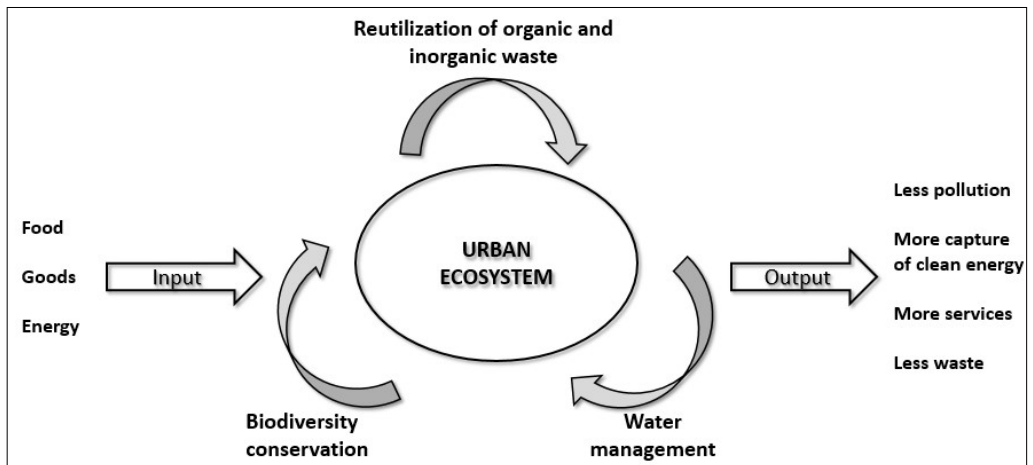
Figure 2 – Linear transformations in the urban ecosystem.



Source: Rogers (1991).

In the same vein, with the development of UA various cycles emerge capable of minimizing the inputs of resources and improving the energy flows and the cycling of nutrients. On the other hand there is a reduction in fossil fuel use, re-utilization of organic and inorganic residues, an increase in biodiversity, better water management and there are other positive effects. Such interactions have a positive influence on the dynamics of the urban ecosystem guaranteeing support for it and its sustainability (Figure 3).

Figure 3 – Schematic diagram of the dynamics of urban agriculture showing inputs and outputs of materials and energy.



Source: Elaborated by the authors.

The analysis of the Urban Agriculture Program unfolded by the NGO AS-PTA reveals the innumerable benefits that agriculture brings to the city among which are: strengthening food and nutritional security; generating income; improving urban environmental management; improving the well-being of the urban population and the development of a more participative and less excluding form of administration.

## Final considerations

Urban Agriculture constitutes an important tool for achieving the equilibrium of urban ecosystems and promoting sustainability in the cities. It shows itself to be a new function for the city; a function that has requirements, relations and potential that go far beyond the production of foodstuffs and in that light it should be taken into consideration in urban development affairs.

Incentives for the practice of urban agriculture need to bear in mind the multidimensional aspect of agricultural activity and not be restricted to a production-orientated vision whereby priority is placed on financial gains. Promoting agriculture in the cities means setting a high value on people, their knowledge and their experience to date, not merely imposing methods on them.

Accordingly, it should: encourage exchanges based on solidarity and spaces for interacting with the natural environment; foster the construction of dialogues of knowledge; do away with social isolation; and stimulate the creativity of community organizations and people, bringing back the former sociability.

This it is essential that planners should begin to acknowledge the importance of urban agriculture and to incorporate it into public policies as a fundamental element for achieving urban sustainability. Transforming cities into places that are self-sufficient in terms of food and nutrients and promoting the integration of the urban environment with the natural one in such a way as to restore equilibrium to the ecosystem are aspects that should be considered crucial for the sustainable development of the cities.

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Original Article

# AGRICULTURE IN URBAN ECOSYSTEMS: A STEP TO CITIES SUSTAINABILITY

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## AGRICULTURE IN URBAN ECOSYSTEMS: A STEP TO CITIES SUSTAINABILITY

**Abstract:** Urban Agriculture (UA) has emerged as an alternative capable of fostering sustainable relations among the economic, social and environmental spheres in cities. It consists of growing and processing traditionally rural food products in urban zones in consonance with the environmental considerations to promote sustainability. This study set out to analyze the interactions of agricultural activities and the urban ecosystem. A review of the literature and a case study of an Urban Agriculture program developed in the metropolitan area of the city of Rio de Janeiro showed that Urban Agriculture provides considerable ecosystem services, generates income, increases biodiversity conservation and fosters social inclusion, functioning as a mechanism for achieving equilibrium among the components of the urban ecosystem.

**Keywords:** Urban agriculture, Sustainable development, Urban ecology.

## A AGRICULTURA EM ECOSISTEMAS URBANOS: UM PASSO PARA A SUSTENTABILIDADE DAS CIDADES

**Resumo:** A Agricultura Urbana (AU) desempenha relações sustentáveis nas dimensões econômica, social e ambiental das cidades. Estando localizada na zona urbana, cultiva e processa produtos alimentares, tradicionais do meio rural, mas em consonância com as relações do ambiente, a fim de promover a sustentabilidade. O objetivo desse estudo foi analisar as interações das atividades agrícolas no ecossistema urbano. Para tal, foi realizada uma revisão bibliográfica e um estudo de caso sobre o Programa de Agricultura Urbana, promovido na região metropolitana do Estado do Rio de Janeiro. Os resultados indicam uma grande provisão de serviços através da AU, como geração de renda, aumento na

conservação da biodiversidade e inclusão social. Conclui-se que a AU funciona como um mecanismo de equilíbrio com os componentes do ecossistema urbano.

*Palavras-chave:* Agricultura urbana, Desenvolvimento sustentável, Ecologia urbana.

## **AGRICULTURA EN ECOSISTEMAS URBANOS: UN PASO PARA LA SOSTENIBILIDAD DE LAS CIUDADES**

**Resumen:** La Agricultura Urbana (AU) desempeña relaciones sostenibles en las dimensiones económicas, sociales y ambientales de las ciudades. Definida como una actividad situada en el área urbana, donde se cultiva productos alimenticios tradicionales del medio rural, pero en consonancia con las relaciones ambientales con el fin de promover la sostenibilidad. Por lo tanto, el objetivo de este estudio fue analizar las interacciones de las actividades agrícolas en el ecosistema urbano por medio de una revisión de la literatura y un estudio de caso sobre el Programa de Agricultura Urbana, en Rio de Janeiro. En este estudio se observó gran prestación de servicios, como aumento de la conservación de la biodiversidad y la inclusión social. Así, constituye como un mecanismo de equilibrio con los componentes del ecosistema urbano.

*Palabras-clave:* Agricultura urbana, Ecología urbana, Desarrollo sostenible.

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