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The Socialization of Science and Technology: The Urban Agriculture Program in Cuba

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Abstract

Urban Agriculture in Cuba has been developed as a strong popular movement, promoting an organic and sustainable agriculture in urban centers. Within the Urban Agriculture Program, the tailoring of biotechnologies plays an important role in ensuring food security for the population. This article describes the ways in which biological knowledge derived from the applications of biotechnology have been utilized for the development of social technologies that contribute to an endogenous development favoring those most in need. The article also discusses the importance of promoting an urban agricultural endogenous development based on social scientific knowledge, which takes into account the different social spaces within territories in order to achieve an appropriate implementation of tailor-made biotechnologies for the benefit of a greater number of people. Case-studies are also presented illustrating the role that the decentralization of production units - enabled by the tailoring of scientific and technological developments - has played in the urban and suburban agricultural development of Cuba.

Key words: knowledge, decentralization, endogenous, biotechnology, urban agriculture

Urban Agriculture and Tailor-Made Biotechnologies

Together with the collapse of the Soviet bloc and an increase of economic aggression by the United States, the end of the 1980s and the beginning of the 90s saw in Cuba a serious economic crisis. This crisis was especially acute in the production of food, due to the lack of resources in agriculture in that period, which was characterized by the use of imported chemical products and high fuel expenses.

During the crisis period, a new program was implemented to increase the production and consumption of vegetables through the use of organic technologies, partially incorporating a biocontrol of plague diseases. Subsequently in 1994, within the so-called 'Special Period' of the Cuban economy - governmental decisions were taken to create the National Group of Intensive Vegetable Gardens, assigning its assessment to INIFAT (Institute of Fundamental Research on Tropical Agriculture). This movement has since been organized throughout the whole country and the National Group of Intensive Vegetable Gardens transformed into the National Group of Urban Agriculture in 1997 (Rodríguez Nodals et al., 2005: 1).Other factors which also influenced the development of urban and suburban agriculture of Cuba are:

1) the need to contribute to food security for the population in harmony with nature and society,
2) the fact that three quarters of the population in Cuba is located in urban and suburban zones,
3) the scarce product and variety diversity prevailing in the large-scale cultivations and in different types of animal farming,
4) the institutional capacity for the designing of alternative technologies for the production of foods,
5) the great intensity of storm activity with a predicted duration for the next twenty years, this within the context of a prolonged period of droughts and occasionally intense rains,
6) the development at world level of high quality and diversified agricultural production and consumption using an organic approach that eases the conservation of natural resources,
7) the existing dichotomy of an agricultural production model based on the use of high consumables, mostly pollutant inputs, and another agricultural model closer to nature, based on the use of natural consumables and local production potentialities,
8) the extended period with heavy limitations of resources and consumables available for conventional agricultural technologies due to the toughening of the North American blockade, the aggressive economic war waged by the North American government on Cuba.

Within this specific social environment attempts have been made to tailor already existing biotechnological developments to local needs in order to resolve social-economic problems in specific localities. There was a quest to develop a more integral approach in which it became clear that, for instance, it was not necessary always to use molecular technologies. Instead of focusing exclusively on obtaining, for example, genetically modified organisms, plants more resistant to plague diseases, new diagnoses of diseases and other important applications, the development - supported by governmental policies - of low-tech and more accessible techniques has been aimed at, techniques that can be integrated more quickly into society and enabled to guarantee food security.

Alongside the continued development of formal biotechnological knowledge accumulated by scientific institutions, there has also been a promotion by the Cuban government of more people-centered forms of biotechnological developments in order to resolve the local problems of food security. Such people-based biotechnologies, are nominated by Ruivenkamp (2003: 14) as being tailor-made biotechnologies for endogenous developments characterized by a new conceptual frame of reference, aiming to carry out their 'dynamizing' influence in reconstituting 'locality'.

The approach of people-based or tailor-made biotechnologies implies that the biotechnological applications aim to create economic spaces for locally specific developments in interaction with (but not dependent on) global developments of markets and technologies. Tailor-made biotechnologies also recognize and re-value the knowledge and craftsmanship of farmers to use local resources for locally specific agricultural developments and stimulate an endogenizing of the technology (Ruivenkamp, 2002).

According to Ruivenkamp (2005: 32), it is necessary to reflect on the opportunities for local initiatives to re-appropriate formal and agro-industrial biotechnological developments and to modify them in tailor-made biotechnologies becoming catalysts for endogenous developments. Cuban experiences in urban agriculture illustrate the potentialities of adapting biotechnological developments to a population's need for food security, and may stimulate a critical reflection on how knowledge derived from biotechnology can be turned into social technologies in order to contribute to endogenous developments favoring those most in need of them, which is one of the main objectives on which researchers should now be focusing attention.

Socialization of Knowledge and Technology within Cuba's Urban Agriculture Program

Reference to the term 'natural' is no longer applicable in the confrontation between traditional and organic agriculture on the one side and modern, industrialized agriculture strengthened by biotechnological knowledge systems on the other. Due to long historical processes, all feeding is based on 'plant cultivation' and 'animals domestication', making the concept of nature 'artificial' (Muñoz, 2001: 144) and the distinction between nature and culture no longer tenable in agriculture.

Biotechnologies - defined as technologies that make use of the biological processes of plants, micro-organisms, cells and their parts in order to convert one product into another product - may be considered as a primarily exogenous technology (a technology from outside the domain of organic and sustainable agriculture) which is also a potentially endogenous technology (a technology reconstructed from inside the domain of organic and sustainable agriculture). Biotechnologies for endogenous developments may be applied to solve local specific problems and become powerful tools in enabling food security for localities and protecting the environment, which is of foremost importance for urban agricultural development.

The technical and scientific developments within Cuban's Urban Agriculture Program illustrate that these are no longer primarily exogenous instruments imposing a specific local pattern of urban development from the outside, but are themselves reconstructed into local social technologies within the Urban Agriculture Program.

The social development of urban agriculture is closely linked to the process of a *social appropriation of knowledge,* which is nothing more than people participating in the activities of producing, transmitting, adapting and applying knowledge in order to enhance its social benefits.

The social appropriation of knowledge does not only imply techno-productive and economic benefits but also results seen in the form of an integral social development. Under contemporary circumstances, social development is considerably based on expert knowledge and it is necessary to go towards a *'social sustainable development based knowledge'* (Nuñez, 2006: 2).

The social development previously attained in each territory has made possible the implementation of tailor-made biotechnologies (TMBT) within the urban agricultural development of Cuba. Such TMBT may be linked to the ongoing process of a social appropriation of knowledge, in which many actors

are involved in different techno-productive processes, according to their knowledge and capacities, assessing the potential of local raw materials and converting them into economic resources, thereby engaging in productive activities for the benefit of their families and locality.

The implementation of techniques derived from biotechnological developments attuned to local problems should be not be used in isolation and seen just as specific instruments to solve specific problems, but also as integrated packages of developing socialized technologies, useable by producers themselves and allowing them to shift from the conception of *socially sustainable development-based knowledge* towards an *endogenous development-based knowledge.*

The concept of endogenous development in agriculture here refers to a development within the sector in which economic and social advances are combined with care for the environment - a development which should be achieved through an organizational structure based on the power of action by local networks, and which implies an improvement of the existing institutional infra-structures, strengthening the organizational capacity of territories, making adequate use of natural resources and increasing the knowledge and experimental capacities of human resources. In this context, the concept of a *socialization of knowledge* should be addressed for those actors involved in the techno-productive processes being developed. Indeed, the Urban Agriculture Program of Cuba has caused a fast socialization of knowledge in different directions, from the scientists to the producers and vice versa as well as directly among the producers, which has been a very important aspect for encouraging a social change in favor of local food security as a basis for the endogenous development of urban agriculture.

The democratization and accumulation of knowledge, produced since the triumph of the Cuban Revolution in 1959, made it possible to realize a successful urban organic and sustainable agriculture in Cuba. It also enabled a recognition and tackling of the limitations prevalent in the industrialized agricultural system in which chemical consumables had to be acquired, either for the fight against plagues or to ensure the use of fertilizers needed for the large-scale cultivations. In this sense, the socialization of knowledge represent the emergence of considerable social spaces within different territories, and in fact has been one of the key reasons for the success of the agricultural revolution implemented in Cuba since 1994, a revolution only possible due to the *decentralization of knowledge production.*

In this way the development of organic and sustainable urban agriculture in Cuba can become an illustrative example for the transition towards a model of urban agricultural endogenous development, based on a socialization of knowledge through decentralized infrastructures in which those consumables are developed which enhance food security at the local level.

Geographical Territories and Social Spaces for the Implementation of Tailor-made Biotechnologies in Cuba's Urban Agriculture

The city is a space in which endogenous developments may be achieved rather than developments be merely imposed from outside, thereby enabling the development of a multitude of diversified production systems. The city may also be considered as a social space of different networks with relations between a variety of actors, allowing a dissemination of knowledge systems and encouraging innovation and learning processes (Mediavilla & Melis, 2006: 2). Moreover, territory can be considered as the space of a regulated society (Iñiguez, 1999: 2), as a real delineation of power, as a demarcation of state and national scenarios and of their inner divisions, whose origins and boundaries are historical-political and administrative-political. Territories (country, provinces, municipalities) can be considered as areas of jurisdiction to which laws, regulations and norms are applied for the functioning of institutional structures and social organization.

The decentralization of production units, enabled by the socialization of scientific and technological developments in Cuba, are framed in the geographical environment of specific territories, which include:

a) The whole area of Havana City province,

b) The area around provincial capitals within a ten-kilometer radius, and as a special case, Manzanillo,

c) The area around municipal cities and important towns within a five-kilometer radius,,

d) The area within a two-kilometer radius around other cities and towns with more than 1,000 inhabitants,

e) Settlements or farms with more than 15 houses.

The coordinating activities of the Urban Agriculture Program are framed within the territory of the provincial and municipal authorities with their respective urban farms, (Rodríguez Nodals et al., 2006: 2). However, for the implementation of social technologies, it is important to consider not only the *geographical territory* but also, and primarily, to focus attention on the *social space* that according to Ravanet (2006: 2) is an *'indissoluble joint of systems of objects or forms (steady) and system of actions or functions (flows) in permanent interaction.'* Socially constructed, these spaces are the memory of all prior and present means of production. Their essence identifies - to differing degrees, and with more or less clearly determined limits, - the otherness of 'other societies' through an inner homogeneity that expresses all peculiar ways of life (related to traditions and reproduction, social and cultural identity, feeding habits and behavioral norms, meaning and life projections, etc) in order to explore more fully and integrally, individuals' relations to the space which feeds them and in which they live.

An specific example of space into which urban agriculture has entered in the Guantanamo province (in the eastern region of Cuba). Most of the population is of indigenous origin and maintains feeding traditions based on yucca and corn as their traditional foods and with low consumption of vegetables. The technology of 'vegetable gardens' *(organopónicos)* was transferred into the area, and with it the beginning of a contribution to improve the quality of life of this community.

Another example of how tailor-made biotechnology can influence the food security of a locality is the social space of the urban cooperative, Organopónico Vivero de Alamar, located in Havana city. This cooperative obtained excellent results in food production and served to socialize knowledge through the communication of their lessons learned to other localities in Cuba. In this cooperative, producers bought banana vitroplants from the biofactory of a near-by territory. They adapted these in-vitroplants by integrating producers' knowledge and at the same time transmitting the socially appropriated knowledge products to near-by population groups, enabling them to buy and sell the vitroplants for use in family gardens or on family plots so that the families could become self-sufficient. In this way biotechnological know the cooperative members shifted from an exogenous technology into a catalyst for promoting local agricultural developments.

For the implementation of tailor-made biotechnologies in each space of a territory, it is important to recognize the existence of different knowledge systems so that these knowledge systems become open and accessible to differ-

ent actors within the social space of different territories. The knowledge, expectations and decisions of farming families and producers should be consulted and taken into account with respect to technologies to be introduced and from there, in addressing the capacity building required. In order to do this different methods were used, such as contacting farmers directly and carrying out interviews through posted questionnaires (Rodríguez Manzano *et al.*, 2006:.1-6), with the objective of learning areas of weakness in social knowledge which could hinder agricultural development and thus families' food security in the various real and local production spaces. In this way, strengthening the development of social technologies, based on the combination of different knowledge systems in the various social spaces of Cuban territory, is playing an important role in the improvement of people's quality of life in the geographical territory, respecting the habits and traditions of each social space.

Decentralized Research and Production Units within Cuba's Urban Agriculture Program

The development of science and technology within the Cuban Urban Agriculture Program is based on information from the institutional producers of knowledge, which apply this knowledge to create social technologies in favor of agricultural sustainability in each social space of the urban and suburban territory (Fig. 1). The production of these social technologies takes place within decentralized units of scientific and technological developments, which have direct contact with different production modalities of urban agriculture. These decentralized production units of applied knowledge and technologies sell their products, even to families with gardens or plots. This takes place through a network of Consultory Shops for the agricultural producer which are now present in every territory. Through these shops, producers are also advised and their capacities strengthened in order to stimulate the local developments.

Some of these decentralized units for applied science and technology developments are reflecting on the opportunities to convert the existing infrastructure and trained personnel, based on assimilated knowledge of social technologies into knowledge centers focused on developing products which may become catalysts for endogenous developments. This implies efforts to reduce the production costs of raw materials and at the same time to socialize tailor-made technologies for different spaces in which producers can learn from their experiences, recognize the necessity of using specific consumables for a further development of organic and sustainable agriculture, and are enabled to disseminate their knowledge to other producers.

The decentralized production units of applied science and technology are situated in different territories of Cuba. Figure 2 shows the presence of six units localized in three municipalities of Cuba: Pinar del Rio, Cienfuegos and Boyeros (Rodríguez Manzano *et al.*, 2005a: 7). These units aim to develop specific strategies for each territory in order to attune the development of tailor-made biotechnologies to the particularities of the urban social and natural environments.

The network of actors that participate in the implementation of biotechnologies in the Urban Agriculture Program is presented in Figure 1. This figure shows that different research institutions are involved, focusing on the development of social technologies in specific domains. As a result, there are production units in which specific inputs are introduced, attuned to the different needs of each territorial space. Finally, there are the producers, farmers and consumers on which the whole institutional structure of decentralized science and technologies is focused.

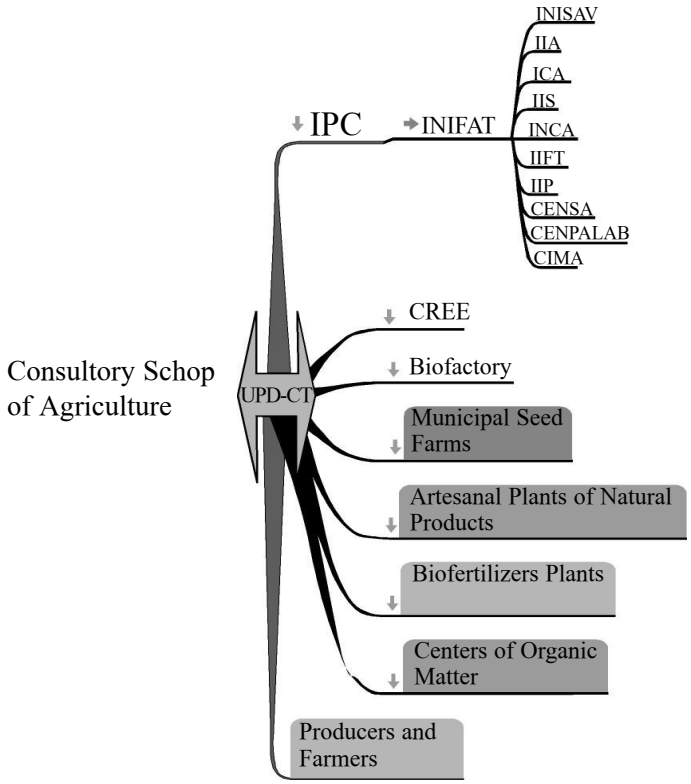

Fig. 1. Network of Actors that participate in the implementation of bio-technologies in the Urban Agriculture Program. (UPDCT: Production Units Derived from Science and Technology; **IPC:** Knowledge Producer Institutions; **INIFAT:** Institute of Fundamental Research on Tropical Agriculture; **INISAV:** Institute of Vegetable Sanitation Research; **IIA:** Institute of Rice Research; **ICA:** Institute of Animal Science; **IIS:** Institute of Soil Research; **INCA:** National Institute of Agricultural Sciences; **IIFT:** Institute of Fruit Tree Research; **IIP:** Institute of Porcine Research; **CENSA:** National Center of Agri-Sanitation; **CENPALAB:** Production Center of Laboratory Animals; **CIMA:** Research Center on Animal Breeding; **CREE:** Entomophagus and Entomapathogenous Production Center.)

A key issue for the further development of tailor-made biotechnologies is the completion of the infrastructure necessary for the required quantity and quality of products to be delivered in a timely manner to farmers, families and other producers. The future abilities of the Cuban Urban Agriculture Program to deliver healthy foods and respond to local needs will become increasingly dependent on the opportunities to improve the linkages and interrelations between the knowledge producing institutions, the decentralized production units of applied science and technologies, and the different forms and modalities of the agricultural units spread across the country.

Improvements in the social relations between the different actors within the different social spaces of each territory may be further strengthened by the implementation of tailor-made biotechnologies. A pilot project in three municipalities has therefore been formed to explore the role that tailor-made biotechnologies can play for the promotion of the Cuban Urban Agriculture Program.

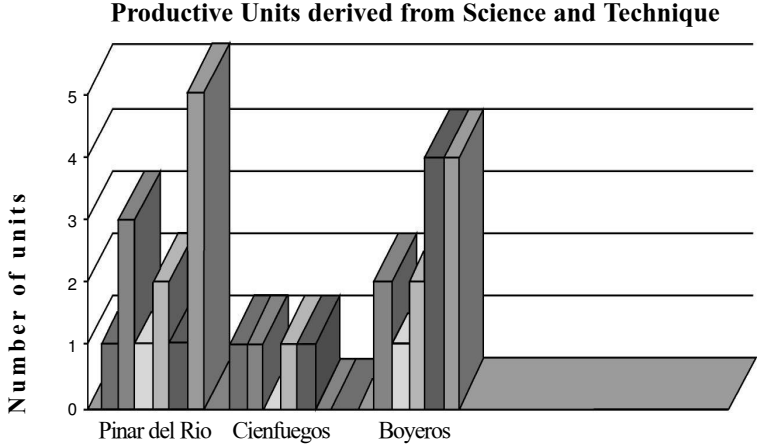

Fig. 2. Production Units derived from Science and Technique in the Pinar del Rio, Boyeros and Cienfuegos municipalities. From left to right: Plants Biofactories, Entomophagus and Entopathogenous Reproduction Centers (CREE), Biofertilizer Plants, Municipal Seed Farms, Municipal Centers of Organic Matter, Centers of Vermiculture.

In relation to the governmental support for the Urban Agriculture Program, the three TMBT pilot projects investigate ways in which the interactions between the different actors in the social spaces of the three municipalities can be enhanced to improve the local development and food security for individuals in these localities.

For the adequate development of tailor-made biotechnologies in Cuba and in order to ease the productive, economic and social impact within the context of endogenous development, the Cuban system of science and technological innovation will continue to have a tremendous importance. According to Castro Díaz-Balart (2001: 372), it should be stated that one of the goals of this system 'is to contribute decisively to a multiple development of Cuban society, either as a whole or in each of its sectors (production, educational, health, public, cultural, etc) taking into account human being and his/her environment,' for which, Castro Díaz-Balart argues of the utmost importance is scientific and technological development, the transference of knowledge and technologies, and the transformation of scientific advances and technological achievements, [all of this applied to] competitive products and technologies and solutions to social, environmental and natural resource problems by means of actions that bring the results of research and development closer to the production sector and society as a whole.'

A lot of innovation, integration and creativity are needed to 'adapt' the development of biotechnologies to the location-specific conditions in each municipality. Biotic and abiotic conditions are constantly changing as well as the idiosyncrasies of populations, their habits, traditions, agricultural experiences, the soil characteristics and mesoclimates. All these factors influence the types and quantities of productions and demands and require specific applications of biotechnological developments.

In order to improve the interrelationship between agro-biotechnologies and the urban social environment in different territories, it is necessary for each territory to settle on strategies to complete the necessary institutional infrastructure within the context of an increasing socialization and decentralization of knowledge. In the following section we describe ways in which these social technologies are developed within three specific institutional environments which play a key role in the Cuban Urban Agriculture Program.

a) The decentralized production of biocontrols within the Entomophagus and Entomapathogeus Reproduction Centers (CREE)

In the Cuban Urban Agriculture Program, cultivations are protected on the basis of an integrated handling of agri-ecosystems with an emphasis on the use of natural products. These principles have to do with the policy outlined by the State System for Vegetable Sanitation in Cuba and have been materialized, among other ways, through the creation of Entomophagus and Entomopathogenous Reproduction Centers (CREE) for the production of pathogenous microorganisms and parasitoid insects and depradators by handcrafted and semi-handcrafted methods of fermentation. At the end of 1992, there were 218 CREE's in the country employed in the service of state companies, cooperatives and private producers. Since 1994, these centers have joined the urban agriculture movement and played a crucial role in the control of plagues in cultivations, especially given the difficult situation the country experienced due to the economic blockade imposed by the United States.

Although the CREE's are playing an important role, it is necessary to improve their activities in each territory and strengthen their contributions to the endogenous developments of urban agriculture. Due to the lack of exchange of information on what is exactly being produced within the existing innumerable spaces of the territories, these important biological products of the CREE's are not always accessible to the production units in the fields. It will be necessary to improve the attuning of CREE activities to the producers' localized demands related to each cultivation type and phitosanitary requirements, so that the utilization of the location-specific potentialities may be improved.

b) The social conversion of biofactories into catalysts for endogenous developments in urban agriculture

Due to its task to supply high quality propagation materials to agriculture, the Seeds Producer Enterprise aims to maximize both the multiplication coefficient obtained from each genetic identity and the quality of the species reproduced. The biofactories are able to produce millions of high quality vitroplants, which are now used mostly in the large-scale production units of state enterprises and cooperatives.

In a study carried out in two territories of Cuba to explore producer demands in respect of propogation materials, local variations were shown. In, for example, the Cienfuegos municipality (in the central region) there was

more demand for *malanga* seeds (*Xanthosoma sagittifolium* Schott), a traditional cultivar of the area (Rodríguez Nodals, 1979: 3), whereas.in other municipalities within the Cienfuegos province, such as Cumanayagua, there was a high demand for *malanga isleña* or *taro (Colocasia esculenta)* Schott (Rodríguez Manzano et al 2001: 39), especially in the settlements of people from the Canary Islands.

Although the *in vitro* reproduction of plants within the biofactories is still mostly geared to large-scale agricultural state enterprises, it will be necessary to employ a parallel implementation of rapid reproduction of promising varieties for farmers and small-scale producers within the Urban Agriculture Program. These small production units are susceptible to specific illnesses and constrained by a lack of good propagation material, which may be resolved by converting the biofactories into decentralized suppliers of inputs for the non-urban? agricultural producers.

In the efforts to develop tailor-made biotechnologies, a focus on agamic reproduction and the segmentation frequency of propagules has been discussed. The reproduction per year is very limited and an application of tailor-made biotechnologies may allow the multiplication of a rapid-growth form of these local varieties. Focusing on high quality, disease-free seeds through the use of a combination of sustainable and socialized technologies, such vitroplants may stimulate adequate developments enabling producers to develop location-specific varieties. In addition to the dissemination of vitroplants to the small-scaled production units of the Urban Agriculture Program, the vitorplants may also be sold to the population through the network of Consultory Shops though which also the required capacity to handle these vitroplants will be built up. The development of capacity to handle these kinds of biotechnological seeds derived from the in vitro cultivation of vegetable cells, represents not only a combination of modern biotechnological products with location-specific knowledge systems and so-called traditional technologies, but also a shift towards the development of *social technologies.*

c) Municipal Seed Farm as an illustrious example of a decentralized and socialized technology development

Modern and industrialized agriculture has been characterized by an important loss of crop and variety diversity. Counteracting this, the Urban Agriculture Program in Cuba has facilitated the maintenance, validation and multiplication of varieties (Rodríguez Manzano et al., 2000: 1). This has been

realized through the creation of seed producer farms in several of the country's territories.

The social organization of seed-producing farms at local level facilitated by the Urban Agriculture Program has enabled the different territories to satisfy their specific seeds needs in different seasons of the year and reach a level of self-sufficiency in the supply of local seeds.

These seed-producing farms belong to the municipal urban farms, producing seeds for scientific institutions for further breeding and for seeds enterprises for multiplication,. as well as for the urban agricultural producers. The seeds are reproduced from the varieties kept by producers, sometimes for years, ensuring the incorporation of adapted traits, such as to the specific weather conditions in the different territories. One example which illustrates the flexibility of this system, based on the interaction between local producers and seed-producing farms, concerns the lettuce variety Fomento-95 *(Lactuca sativa)*. This variety is a cross of a variety from a producer's farm with the Chile variety 1185-3, a variety obtained in INIFAT's Improvement Programs (Rodríguez Manzano and Rodríguez Manzano, 2006: 1).

Through this system of socialized and decentralized knowledge networks, the local seed farms contribute to the increase of diversification of food at a local level and strengthen endogenous developments in the different territories in which they are located.

The functioning of the local seed farms has been improved by giving courses and publishing scientific and popular articles (Rodríguez Nodals et al., 2002), which enabled the seed farms to develop their specific capacities and to play an important role throughout the whole island.

The important role of these local seed farms is illustrated in Figure 3, showing the dissemination of their cultivated species in eight municipal seed farms within the las Tunas province (Eastern region) where seeds were produced from 27 plant species. For example, in Amancio Rodriguez municipality the municipality seed farm produced seeds for fourteen species, while in Jobabo municipality the local seed farm produced seeds for eight species.

The decentralization of seed production in Cuba, contributes to a diversification of food production and consumption, related to existing consumption habits of the inhabitants, while also ensuring the conservation and development of species within territories. These seed farm units, spread throughout the island, represent the emergence of a socialized and decentralized system of seed production, based on the interaction and exchange of information

between producers and scientists. The decentralized system of local seed farms ensures a flexibility in the development of species enabling the production of seeds according to producer demands which vary from one municipality to another, according to the habits and origins of the inhabitants in each locality. Especially in the space of urban zones where farmers have migrated from rural zones to the cities, the decentralized system of urban seed farms has facilitated a diversified pattern of food consumption corresponding to the feeding habits of the different groups of immigrants.

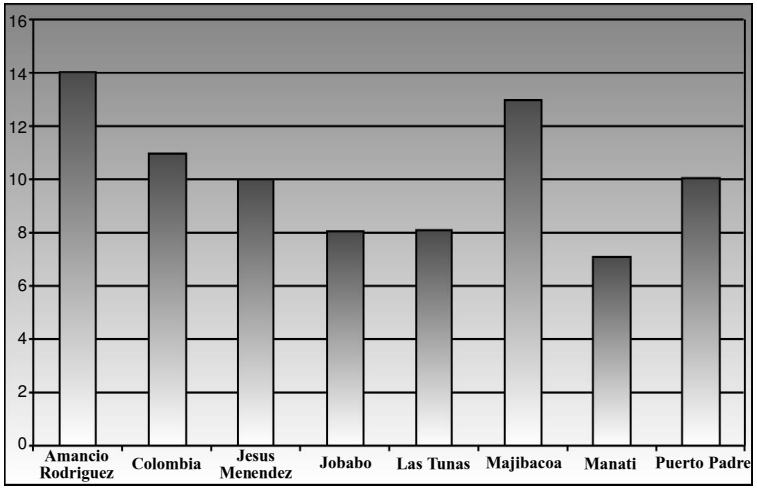

Fig. 3 Number of species in municipality seed farms in Tunas province (May 2003).

Although the decentralized and socialized system of producing seeds, vitro-plants and biological controls has made it possible to overcome the Cuban food crisis of the 1990's, still important improvements have to be realized. Many farms are remain isolated and located in social spaces within geographical territories where access to new technologies is limited. Efforts have to be made to link the social space of these isolated farms to the emerging social space of socialized and decentralized food production systems, making these social spaces part of the new geographical scenario planned by the Urban Agriculture Program in Cuba.

Potential for Tailor-Made Biotechnologies within Different Social Spaces in Cuban Territory

Derived from studies carried out by INIFAT (Rodríguez Manzano et al, 2005: 14) on the implementation of tailor-made biotechnologies at local level within the Cuban Urban Agriculture Program, the following needs have been identified for the establishment of a TMBT-program in Cuba within the Urban Agriculture Program. The tailoring of biotechnologies should be attuned to:

- Decentralized research and production units in each municipality, such as the Entomophagous and Endomophagous Reproduction Centers (CREE); small and/or medium-large production units of neem-derived products and other insecticides of botanic origin; biofertilizer units; Seed Municipal Farms, Organic Matter Municipal Centers and Vermiculture Centers.
- An ongoing social conversion process of strengthening a decentralized production system of vitroplants within the biofactories, attuning the biofactory activities to urban producer needs, and the encouraging the input of urban producers, in particular to augment stocks with seeds of their own varieties.
- The development of so-called artesian technologies, searching for opportunities to improve and be produced and used by the producers themselves.
- The development of end-products which can be used in the same municipality or for supporting other municipalities in case of a surplus.
- The demands of the local urban seed farms concerning the timely delivery of specific product types and/or quantities, which are formulated on basis of the seed farm predictions of producer demands.
- The efforts of the local urban farms to control the use of unnecessary external and biochemical consumables through the substitution of these exogenous products by biological products made from local resources.
- The capacity of the producers and their requests to improve and build up the capacities in order to make their own and accessible 'handcrafted' technologies in each territory.
- The institutional framework of the Municipal Group of Urban Agriculture and other decentralized entities in each territory stimulating endogenous sustainable developments in seeking solutions at local level.

Conclusions

Organic and sustainable urban agriculture in Cuba clearly exemplifies how food production can be organized in a decentralized way based on the use of local resources present in a territory. Confronted with an externally imposed economic crisis, solutions have been sought to take advantage of the local resources within different geographical and social spaces in order to contribute to the food security of the inhabitants. It is also clear that decentralized research and production units have played a crucial role in developing technologies with a social character, applied by the different production units at local level according to the demands of those in most need. It has been possible in Cuba to modify biotechnology as an exogenous tool into tailor-made biotechnologies for local developments within the different social and geographical spaces, both urban and suburban, in which the Urban Agriculture Program in Cuba was developed. In order to do this, a socialization of knowledge by means of the National Group of Urban Agriculture has been fundamental. For a further implementation of tailor-made biotechnologies, it will be necessary to strengthen the decentralization of knowledge and production and to realize an endogenous development-based research system. The success of an approach to develop biotechnologies for local initiatives requires that tailor-made biotechnologies for endogenous development will increasingly be based on the exchange of producer and institutionally developed knowledge systems, (further) developed and applied within decentralized systems producing inputs based on the potentialities of local resources.

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