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Agroecological Applications in the Home Garden: Achievements and Opportunities

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Abstract: Poverty and the low levelsof food security for large segments of rural population in Latin America and the Caribbean (LAC) continue to be a problem that requires a solution. This problem is mostly related to families that practice small-scale agriculture with low levels of production despite their high productive potential. Recent experiences, although not sufficient, indicate that the use of agroecological principles in small-scale production units; food can be produced in greater quantity and quality than if conventional procedures were used. With the purpose of confirming and improving these points, a process of systematic application of these principles in the family garden was undertaken five years ago. The general method was the action research, which included particular methods such as experimentation (trial and error) and systematization of experiences. This report summarizes the actions carried out, the achievements attained, the weaknesses perceived and the impact generated. It is concluded that it is possible to produce healthy and nutritious food in high yields implementing agroecological procedures in small areas, such as the home garden, in a continuous and sustained way to contribute to the family diet and generate income from the sale of surpluses.

Key words: sustainable agriculture, family farming, ecotechnology

1. Introduction

Poverty in Mexico has not decreased in recent years. Indeed, according to CONEVAL [1], in 2014, population in poverty was 55.3 million (46.2%) of the country's total population, and population in extreme poverty was 11.4 million (9.5%). In México, poverty in the rural sector has been worse than in the urban sector. According to this same source, in 2014, almost 17 million people (61.1%) were in poverty.

Poverty has a close relationship with people's lack of food security. According to CONEVAL data [1], in Mexico there are around 28 million (23.4%) people vulnerable due to lack of access to food. Although for some experts, the main obstacle to food security in LAC is the lack of purchasing power; recent experiences in improving human nutrition indicate that overcoming malnutrition does not depend only on an increase in income, but on the underlying causes of food and nutritional security, which are inadequate availability, poor accessibility, inadequate consumption and low biological utilization of food [2].

In the case of Mexico, the lack of food security for a significant segment of the population, especially in rural areas, has been largely due to inequality in access to resources, assets, capabilities, income and food access. One of the visible characteristics of this reality is the concentration of production and food production value in dynamic rural business economic units in a few federal states of Mexico [3]. In fact, of the 5.3 million rural economic units (REU) in the country, the business units represent 8.7% of the total and generate 74.2% of the sector's sales. Fifty percent of these RU are concentrated in seven states: Sinaloa, Sonora, Chihuahua, Jalisco, Guanajuato,

Tamaulipas and Baja California. According to the same source, the other REU are distributed as follows: subsistence units with market access account for 50.6%,

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subsistence units without market access account for 22.4% and transition units account for 18.3%. The production gap in capital, capabilities and income between the subsistence rural economic units -with and without market access- and the business units, is very large, according to the author.

According to FAO and others [2], the eradication of food insecurity requires the redesign of a policy and strategies oriented to this aim by a participatory process that considers the multidimensionality of food security, and an institutional framework that ensures coordination and coherence of policies focused on sectors and the proposal of indispensable resources. The source also pointed out that agricultural growth with the participation of small farmers, the majority in the country, especially women, will be more effective in reducing poverty if it makes it possible to increase the income of workers and generates employment for the poor. The valuation of their livelihoods can be increased with the focus on productive development — associated with welfare support —, training and organization for the recovery of natural resources. Their contribution to food security will achieve a gain in the quality and quantity of household food in a permanent and sustainable way through the conservation of genetic resources and agro-biodiversity.

Although for about three decades agricultural development programs have sought to promote the production increase and productivity of small-scale farmers; official recognition of the importance of this type of producer for the world economy is relatively recent. Indeed, in recent years, it has been recognized that more than half of the food of plant origin comes from the plots of small-scale farmers in most developing countries [4].

The small-scale agriculture, like family farming, home gardening, backyard or solar farming and others, has not been as successful as expected despite its potential value for various reasons. This situation has been largely related to the application of policies that obey the process of globalization and structural adjustment initiated in the mid-1980s [5]. To these have been added the effects of the opening of markets and unequal competition in the countries of the South, as in the case of LAC, the withdrawal of the State and its extension, credit and research agencies, which have left a vacuum and have not been covered by the private sector.

The problems currently faced by small-scale producers seem impossible to overcome. However, experiences based on the practice of alternative agriculture suggest that this type of agriculture can achieve an important development. To achieve this, programs are needed to overcome the approaches, methods and vices of the past. As part of all this, overcoming the situation of this type of producers, will depend not only on the technologies acquired or improved, but mostly on their knowledge of market demand and requirements, on their capacity to organize their production or services more efficiently, and to make efficient use of their production spaces, including the backyard, which can become an important means of overcoming the problem of malnutrition and food insecurity [6].

Regarding backyards or plots of land, in Mexico, the vast majority of families living in rural areas and even in peri-urban areas has land adjacent to their homes, ranging from a few square meters to areas of one or more hectares [7]. Although these spaces are mostly used for agricultural and livestock production; in other areas, they are also used for recreation and family gatherings. However, in most cases, despite their productive potential, they are not always used efficiently or completely. When these spaces are used for agricultural production, they become what are known as vegetable gardens and/or family farms. The orchard is the place where the family grows vegetables, corn, legumes, fruit trees, medicinal plants, edible herbs and small livestock species, such as poultry [8].

The experiences of numerous cases, based on the theoretical explanation of the biointensive mini-farm or

other alternative approaches based on Agroecology, indicate that now food yields with appropriate technologies can produce two to four times more than when they produced under a conventional system in small areas, such as backyards, food yields. [9]. These alternative small-scale production systems are based on agroecological principles. No synthetic pesticides or commercial fertilizers are used at all. Their organic character means less environmental pollution and more stable agroecological systems [10].

In these systems, instead of using chemical fertilizers, organic fertilizers such as compost are used. Likewise, these systems require much less agricultural inputs, and those that are used generally come from the system itself. The required nutrients are recycled through the elaboration of composts with or without worms, from stubble, agricultural and kitchen waste and manure. Water availability can be achieved by collecting rainwater and storing it in cisterns of sufficient capacity.

This way of farming on small properties shows several advantages: 1) it is an effective way for soil conservation and protection compared to mechanized systems; 2) it is the system that requires less capital; 3) in the productive process, family members can participate and whenever they have time; 4) generally, in the same space, more than one species is cultivated, according to the family's food needs; 5) mixed or intercropping makes it more difficult for pests and diseases to attack; 6) if a pest or disease occurs, it is easier to control it, because it can even be controlled manually; 7) the purpose of production is more for family consumption than for the market. In general, in this biointensive system, the practice of the Agroecology principles and sustainable agriculture are facilitated. It is a very appropriate system to be applied at the backyard level [11].

From these explanations it is clear that, on the one hand, there is a solid theoretical basis for sustainable backyard production and, on the other hand, there is recognition of the importance of backyards for the family economy. However, research and promotion for their improvement have been almost nonexistent. In Mexico, the attempts of governmental support to improve backyard production date back only a few years [12]. The few evaluations carried out indicate that the results were very weak, due to the partial way of dealing with it and the limited support granted [13].

Recently, with the aim of increasing food production in vulnerable areas of the country, in order to reduce food insecurity, Mexico's Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) implemented a program aimed at supporting small-scale agriculture. This agricultural program, called "Proyecto Estratégico de Seguridad Alimentaria" in Spanish language (PESA), began in 2002. It was implemented in coordination between SAGARPA and the Food and Agriculture Organization of the United Nations (FAO) [14]. Nineteen years after its implementation, the evaluations point to limited success.

2. Objective

To test the functioning of agroecological principles and the use of ecotechnologies in the family garden and to estimate the impact of agroecological food production on the family economy and teaching-learning opportunities.

3. Materials and Methods

The method applied was Action Research, with experimental procedures (trial and error) and systematization of experiences. The actions were carried out in the author's home garden, which is located in the community of San Nicolás Tlaminca, Municipality of Texcoco, State of Mexico. The community of Tlaminca is a village still considered rural. Geographically, it is located in the middle floor, between the lacustrine and mountainous zones of the municipality of Texcoco. The climate is temperate semi-dry, with an average annual temperature of

15.9°C, with infrequent frosts and the average annual precipitation is around 700 millimeters [15].

The family garden space has an approximate area of 450 square meters. The idea of using the space for a family garden began at the time of the design and construction of the house (2012). Prior to its construction, the space was never used for food production, because the surface contained stone blocks and the surface had an unevenness of approximately two meters. In order to be used as a cultivation area, the space had to be modified into terraces (3 levels), was filled with soil and enriched with compost produced in the area. In general terms, the space is currently divided into eight compartments: cellar, chicken coop, composting area, fodder production, horticultural production, grain and fruit production, wetland (treatment of soapy water), cistern to collect rainwater and green area. The agricultural production area is divided into two: 1) an open-air production area and 2) a protected area (4.0 m × 8.0 m greenhouse).

4. Results and Discussion

4.1 Infrastructure for the Use of Ecotechnologies

The necessary infrastructure was built to guarantee the implementation of Agroecology principles. According to these principles, successful food production basically requires three elements: a) sufficient water, b) good soil and c) appropriate temperature and protection environment, to favor plant development, free of pests and diseases, and to achieve optimal production.

In order to have enough water in the garden throughout the year, two systems were built: 1) a system of capture and storage of rainwater from the roofs of the house-home. The cement cistern, built below the surface, has a capacity to hold 12,000 liters of water and 2) a system of treatment of soapy water by bio-filtration, with a capacity to treat 3,750 liters of gray water/month in a space called wetland, which occupies 7.5 m².

According to the literature, there are numerous species that can be used for gray water treatment [16]. Microorganisms and green algae are also involved in the treatment process. The plants are developed in a porous gravel substrate of red volcanic rocks, which, in addition to supporting the plants, allows the biofiltration process.

The volume of soapy water is approximately 960 liters per week from the services specified below (Table 1).

Another key component of the home garden, including its infrastructure, is the worm composting area to obtain the required compost. The area is 4.00 m by 2.5 m, that includes four horizontal beds or compost bins, built of partitions and lined with sand and cement; each one has a capacity to handle 800 kilos of putrescible organic waste. Two products are obtained from the composting process: humus and leachate, which are of excellent nutritional value for plants. Humus is obtained approximately 3.5 months after the fermentation process has begun. To obtain the product (humus), the material is extracted from the beds for dehydration and separation of the earthworms (*E. foetida*). This process is carried out naturally and then sieved and packaged for later use. The leachate is deposited in plastic containers with a capacity of 20 liters each. The use of both products is according to need.

4.2 Production Area Distribution

The total area for food production and green area is a little more than 180 m², distributed in terraces of three levels. The total area, for production purposes, was divided into five parts (Table 2).

Table 1 Volume of gray water generated in the house.

Origin of gray water	Quantity in liters	Percentage (%)
Sinks	40.0	4.2
Kitchen utensil washing	320.0	33.3
Showers	280.0	29.2
Laundry	320.0	33.3
TOTAL	960.0	100.0

Table 2 Layout of the backyard for food production.

Type of surface according to use	Surface (m^2)
Open pit crops	48
Crops under protected conditions	32
Forage (alfalfa)	28
Hen house	26
Green area and fruit trees	48
Total	182

The infrastructure for production, in addition to the terraces, includes: 1) greenhouse for crop production and 2) poultry house for egg production. The poultry house occupies a space 6.5 m long and 3.00 m wide and is built to provide the animals with the desired protection, feeding and production environment.

4.3 The Production Process in the Areas Prepared for Cultivation

In the area for open-air cultivation, different crops have been planted indistinctly in small areas and according to the seasons of the year, such as: lettuce (Lactuca sativa), green tomato (Physalis ixocarpa), spinach (Spinacia oleracea), Swiss chard (Beta vulgaris), green beans (Phaseolus vulgaris), onion (Allium cepa), beet (Beta vulgaris), carrot (Daucus carota subspecies sativa), zucchini (Cucurbita pepo),among other vegetables and some grains, such as: corn (Zea mays, pea (Pisum sativum) and lately fava bean (Vicia faba).

In the protected area (8.00 m × 4.00 m greenhouse), some species, from temperate to hot climate have been grown, such as tomato (Solanum licopersicum), cucumber (Cucumis sativus), strawberries (Fragaria vesca) and some types of chili peppers (Capsicum bacaatum and Capsicum pubecens). In the forage area, alfalfa (Medicago sativa) and ryegrass (Lolium perenne) are grown for chicken feed. In the green area, which is for family recreation, there are some fruit trees, such aspeach (Prunus pérsica), apple (Malus domestica), lemon (Citrus limonum), avocado (Persea americana), two species of tubers: platform (Pasifloramollisima) and passion fruit (Pasiflora edulis), and blackberry (Rubusidaeus). There are also some medicinal and aromatic plants, such as oregano (Origanum vulgare), hierbabuena (Menta spicata) and others.

Regarding to hens, we have had up to 25 hens per season. The campaign begins with the purchase of the chicks, which are 30 days old. During the growing period, care has been taken to ensure that they have an adequate temperature environment, especially at night, protection against predators, the recommended vaccinations, appropriate feed and proper cleaning. In general, the hens started laying at six months of age. For this, we took into account that the nests (8) were well placed and positioned. During the laying stage, feeding has been varied, based on free-choice balanced commercial feed, supplemented with alfalfa and kitchen scraps.

4.4 Quantity and Quality of Products and Their Destination

Due to the nature and characteristics of the production unit, it has neither been possible to quantify the production and productivity of the crops nor to express it in kilograms per hectare, as is done in conventional measurements. However, for some species, yields were estimated (Table 3).

In general, the products were found to be of good size, natural color and pleasant taste. On rare occasions, the products were of poor quality; in these cases, the products were destined for the chickens or for composting. Almost entirely the crops have been consumed by the family of 3 members, which were

Table 3 Production yield of some species produced in the orchard.

Speciesorcrop	Performance
Tomato	6 kg/plant
Cucumber	10 kg/plant
Butternut squash	12 kg/plant
Bean	0.5 kg/plant
Red manzano chili	4 kg/plant/campaign
Green vean (vegetable)	0.5 kg/plant
Pea	0.40 kg/plant

harvested according to consumption needs or crop maturity. The products that were sold for exceeding self-consumption levels were: tomato, cucumber, chilies, beets, beets, zucchini and cilantro. The product that was sold in greater quantity was chicken eggs because it exceeded the daily need for family consumption.

In addition to the mentioned products, fruit trees such as peaches, apples, lemons and some passion flowers were harvested, although still in smaller proportions. Among other products, there are also some aromatic and medicinal plants such as chamomile, oregano, epazote and mint, which are produced in small spaces, but are of great nutritional and medicinal use.

Finally, the home garden has been useful not only to produce food, but also to learn, experiment, reflect value, educate and share with others interested in these topics like students, teachers of different education levels and the general public. The achieved experiences also served to propose agro ecological school gardens in the elementary education schools, with the purpose of integral education and within it, environmental education for sustainability.

5. Conclusion

After five years from the start of the project, it was proven that it was possible to produce quality food of different types in a sustained and sustainable way, with the implementation of agroecological principles in the backyard or plot, and the implementation of relevant ecotechnologies, according to the family's food needs. It was also proven to generate economic income from the sale of surpluses.

It was demonstrated in order to fertilize the soil, it is possible to dispense with chemical inputs, to use compost and leachates produced on site, to use water for irrigation throughout the year from the collection and storage of rainwater and the treatment of domestic soapy water by bio-filter, and to reduce or prevent the attack of pests and diseases of crops through the system of polyculture and intercropping and the use of bio-insecticides.

From the above it can be affirmed that, at a time of worsening poverty and food insecurity in rural areas mainly, backyards or plots of land converted into agroecological home gardens are important means to overcome the aforementioned problems. Therefore, public policies should strengthen their support for the promotion and implementation of these productive units, with the application of agroecological principles and the implementation of relevant ecotechnologies.

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