Scientific Paper

# Adoption of new agroecological practices in three basic units of cooperative production♦

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## Abstract

The study was conducted in order to determine which new agroecological practices were adopted in the reconversion process of three basic units of cooperative production (UBPC, for the initials in Spanish) of the center and East of Cuba. They were located in Las Tunas (UBPC Maniabo), Camagüey (UBPC Primero de Enero) and Ciego de Ávila (UBPC La Estrella) provinces. Their social objects were animal production (milk and meat), and fruit, citrus and food crop production. The agroecological practices were quantified at the beginning, and the percentage of adoption of the new practices was compared after four years. The proportion comparison analysis was used, and the data were processed through the statistical package SPSS® version 11.5.1 for Microsoft Windows®. The UBPCs Estrella and Primero de Enero incorporated 30 and 24 new practices, respectively; while Maniabo incorporated only 13, because it already had implemented 36 from the recommended ones. The most introduced practices were the establishment of agroforestry systems, biological pest control and crop rotation. It is concluded that in all the UBPCs under study diverse agroecological practices were implemented as consequence of the reconversion process. The conception of the increase of biodiversity and complexity of the productive system conditioned the development of agroecological reconversion in the entities under study.

Keywords: alternative agriculture, biodiversity, food security

## Introduction

Sustainable food production without affecting the environment is a challenge for the current society, which entails transforming the conventional systems of agricultural exploitation into agroecological systems, in productive entities (Hernández-Mansilla *et al*., 2013).

Agroecology is defined today as the fundamental science to guide the conversion of conventional production systems, based on monocrops that depend on inputs and agrochemicals, towards more diversified and self-sufficient systems, in harmony with the environment and the optimization of the agroecosystem (De Schutter, 2010). In addition, it provides the ecological bases for the maintenance of biodiversity in agriculture, and plays a relevant role in the re-establishment of the balance of agroecosystems to reach sustainable production (Toledo-Toledo, 2017).

In this sense, the development of technological strategies compatible with the rational management of agroecosystems has been, during the last decades, the main concern of the institutions in charge of promoting rural development and setting in motion a wide process of validation, dissemination and implementation of proposals under the approach of sustainability (Vera-Pérez, 2011).

Altieri and Nicholls (2007) stated that an agroecological reconversion process in a productive unit generates direct and indirect transformations, especially in biodiversity and soils. Meanwhile, García-Barrios and González-Espinosa (2017) stated the need of using agroecological paradigms,

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which integrate processes and in which the agricultural practices are adapted to the specific conditions of each rural area.

In Cuba, the basic units of cooperative production (UBPCs) emerged in the early nineties and followed the paradigm of the Green Revolution, but at present thy aim their efforts at improving their economic efficiency and profitability, from the diversification of their productions, in view of agroecological re-conversion; this means a change in technologies and management systems, as well as in the involved actors' mentality, in order to increase productivity (Vázquez-Moreno and Fernández-Trujillo, 2016).

The objective of this study was to determine the new agroecological practices adopted in the reconversion process of three basic units of cooperative production of central and eastern Cuba.

## Materials and Methods

*Location of the studied basic units of cooperative production.* The work was conducted in the UBPCs Maniabo, Primero de Enero and La Estrella. Their main characteristics are described in table 1.

### Selected indicators for the evaluation and follow-up of the agroecological reconversion process

A set of indicators was identified (table 2), mainly of sustainability, which served as basis to select the agroecological practices to be recommended for the agroecological reconversion process in each productive form. This identification was made in a coordination meeting with a group of experts from entities such as the Institute of Plant Health Research (INISAV), the Pastures and Forages Research Station Indio Hatuey (EEPF IH) and the Pastures and Forages Research Institute (IIPF), with the participation of members and the president of the National Agroecological Table of the Cuban Association of Agricultural and Forestry Technicians (ACTAF).

In the analysis the selection of easily understood and measured indicators, whose information was feasible to obtain, was considered, with the highest possible reliability, and the previous studies by Funes-Monzote *et al.* (2009), Vera-Pérez (2011) and (Blanco-Lobaina *et al.*, 2013), were taken into consideration.

### Selected agroecological practices

From group work, the expert team and the main actors involved defined 66 feasible agroecological practices (table 3) to be implemented in the farms of the studied UBPCs these practices were grouped by general topics, such as: establishment of agroforestry systems (9 practices), soil conservation and protection (6), use of organic fertilizers (11), biological pest control (4), production of organic fertilizers (6), crop rotation (5), production diversification (14), polycropping (7) and other practices (4).

The agroecological practices were quantified at the beginning and the adoption percentage of the new practices was compared after four years. A percentage evolution table of the adoption of the practices in the three UBPCs was elaborated.

*Statistical processing.* For the data analysis the proportion comparison analysis (chi-square) was used with the statistical package SPSS® version 11.5.1 for Microsoft Windows®.

## Results and Discussion

Table 4 shows the percentage evolution of the introduction of agroecological practices in the three UBPCs. It was observed that the practices related to pest biological control were all adopted in the three units. Among them were those recommended by

Table 1. Characteristics of the studied UBPCs.

| Cooperative | Municipality | Social object | Cooperative members | | Technicians | | Area (ha) |
|---|---|---|---|---|---|---|---|
| | | | Female | Male | Female | Male | |
| UBPC La Estrella | Ciego de Ávila | Citrus fruits and food crops | 61 | 27 | 4 | 3 | 450 |
| UBPC Primero de Enero | Camagüey | Fruits and fruit crops | 46 | 30 | 15 | 6 | 368 |
| UBPC Maniabo | Las Tunas | Cattle milk and meat. Food crops | 120 | 33 | 11 | 6 | 1 333 |
| Total | | | 227 | 90 | 30 | 15 | 2 151 |

Table 2. Selected indicators for the evaluation and follow-up of the agroecological reconversion process.

| Indicator | Measurement |
|---|---|
| Agroecological | |
| Species diversity | Biodiversity index |
| Reforestation | Number of trees per hectare |
| Production of organic fertilizers | Quantity of produced fertilizers (t/year) |
| Food self-sufficiency | Quantity of imported foodstuffs for human consumption/year |
| Inputs used | Types of inputs and their quantities, used in the year |
| Economic | |
| Average salary per year | Average salary per year per worker |
| Income/expense ratio | Total incomes/total expenses |
| Economic efficiency | Quantity of available financial balance |
| Productive | |
| Land utilization index (LUI) | Area under production/total area (%) |
| Total yield of the system | Sums of the annual animal and agricultural productions. This total production is determined between the total productive area of the system |
| Diversity of edible products | Number of products for commercialization |
| Social | |
| Standard of living | Living conditions of the resident families (high, medium or low) |

Table 3. Selected agroecological practices

| Practice | Practices that were considered within the group |
|---|---|
| Establishment of agroforestry systems | Planting of: living posts and/or fences, forestry and/or fruit tree plantations, tree protein banks, trees scattered in pasturelands, hydro-regulating zones, trees intercropped with agricultural crops, trees intercropped with pastures and/or forages, biological corridors and trees on non-productive/cultivable soils. |
| Polycropping. Spatial and temporary diversification | Intercropping of: annual crops, perennial crops or mosaics, annual crops intercropped with perennial ones, trees of different species, agricultural crops with forage crops, grasses associated with herbaceous legumes, agricultural and/or forage crops with flowers. |
| Biological pest control | Use of: biopesticides or biological controls, traps (color, odor traps, among others). . Sowing pest-repellent and/or medicinal plants and natural preparations (repellent or medicinal) |
| Production diversification | Existence in the production system: agriculture, cattle, fruits, sugarcane, beekeeping, aquaculture, rabbits, poultry, sheep and/or goats, buffaloes, timber, flowers and ornamental plants. |
| Crop rotation | Crop rotation: annual, perennial, annual with perennial. Rotation of agricultural areas with animal husbandry ones and recovery of idle areas or areas invaded by thorny shrubs. |
| Production of organic fertilizers | Production of: animal manure (and its treatment), compost, earthworm humus, efficient microorganisms and biofertilizers. Use of biodigester effluents. |
| Use of organic fertilizers | Application to the soil of: animal manure, compost, earthworm humus, efficient microorganisms, organic fertilizers and/or bionutrients, chicken dung, sugarcane filter cake, harvest waste, effluents of biodigesters and organic fertilizers. |
| Soil conservation and protection | Cover of the soil with: mulch (dead cover) and harvest waste, use of: legumes/green manures, rehabilitation and/or renovation of pastures and barriers (dead or living) against soil erosion, sowing in terraces against the soil slope. |
| Other practices | Use of: minimum tillage, animal draught, harvest waste and byproducts for animal feeding and alternative energy sources. |

Table 4. Evolution of the agroecological practices recommended in the three cooperatives.

| Practices | Total of practices | Existing in the first year | | | Incorporated by the fourth year | | | Total practices and their adoption percentage | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | I | II | III | I | II | III |
| Establishment of agroforestry systems | 9 | 6 (66,7) | 5 (55,6) | 7 (77,8) | 3 | 4 | 0 | 9 (100) | 9 (100) | 7 (77,8) |
| Polycropping | 7 | 1 (14,4%) | 1 (14,3) | 5 (71,4) | 3 | 2 | 1 | 4 (57,1) | 3 (42,8) | 6 (85,7) |
| Biological pest control | 4 | 3 (75,0) | - | 1 (25,0) | 1 | 4 | 3 | 4 (100) | 4 (100) | 4 (100) |
| Production diversification | 14 | 6 (42,8) | 5 (35,7) | 9 (64,3) | 4 | 1 | 0 | 10 (71,4) | 6 (42,8) | 9 (71,4) |
| Crop rotation | 5 | 2 (40,0) | - | 5 (100) | 2 | 4 | 0 | 4 (80) | 4 (80) | 5 (100) |
| Production of organic fertilizers | 6 | - | - | 2 (33,3) | 4 | 4 | 0 | 4 (66,6) | 4 (66,6) | 2 (33,3) |
| Use of organic fertilizers | 11 | 2 (18,2) | 2 (18,2) | 3 (27,3) | 5 | 6 | 5 | 7 (63,6) | 8 (72,7) | 8 (72,7) |
| Soil conservation and protection | 6 | 4 (66,7) | 2 (33,3) | - | 2 | 2 | 4 | 6 (100) | 4 (66,6) | 4 (66,6) |
| Other practices | 4 | 4 (100) | - | 4 (100) | - | 3 | - | 4 (100) | 3 (75,0) | 4 (100) |
| Total | 66 | 28 (42,4) | 15 (22,7) | 36 (54,5) | 24 | 30 | 13 | 52 (78,8) | 45 (68,2) | 49 (74,2) |

I: Primero de Enero, II: La Estrella, III: Maniabo.
() The values between parentheses represent the percentage of practices with regards to the total.

Nicholls *et al*. (2015), such as the use of biopesticides or biological means, the use of color or odor traps, the use of natural repellent or medicinal plant preparations and the application to the soil and to the efficient microorganism plants.

The practices related to the establishment of agroforestry systems were next in order of adoption, although the UBPC Maniabo did not introduce any, because at the beginning of the study it had seven of the nine recommended ones, among which living fences, underbrush, protein banks and the recovery and planting of trees in areas invaded by *Dichrostachys cinerea* and *Acacia farnesiana*, stood out.

The other UBPCs worked on planting the hydro-regulating zones, living fences, intercropped trees on non-productive soils, associations of grasses with legume trees, recovery of idle lands or lands invaded by thorny shrubs, among others.

In this regard, it is known that trees can contribute foodstuffs of high nutritional value for livestock and for humans, and this helps to achieve self-sustainability of the system, besides propitiating the maximum recirculation of nutrients and the protection and maintenance of the environment (Congo-Yépez *et al*., 2018).

They improve soil fertility, because many are capable of fixing nitrogen and their litter increases the organic matter contents; and, in turn, the biodiversity of the ecosystem is higher, by facilitating the nesting of many bird species. Tree planting offers environmental advantages that allow to establish productive, sustainable and environment-friendly agroecosystems, and it is also an alternative income source for the sale of timber or seed (Olivares-Pérez *et al*., 2018).

With regards to polycropping and crop rotation, the UBPCs La Estrella and Primero de Enero, with emphasis on fruit production, barely used any of the practices associated with the evaluated indicators; however, at the end of the reconversion process they had introduced between three and four practices, respectively, which was related to the beginning of a planned diversification process of their plant

production and intercropping in areas of fruit plantations and vice versa.

In this regard, García-González *et al*. (2015) observed that crop rotation and polycropping are developed in order to stimulate the natural fertility of the soil, control pests, restore the productive capacity and obtain higher land equivalent use (LEU), for which these practices can increase yields in most of the economically important crops.

In the efficient land use, crop associations constitute the fundamental part and are used to stimulate the natural fertility of the soil, control pests and restore the productive capacity (Espinoza *et al*., 2012). Nevertheless, the high degree of specialization of the UBPC La Estrella in previous years did not allow that during the studied reconversion process a high degree of productive diversification was achieved (it introduced six of the 14 recommended practices to improve the LEU).

The production of organic fertilizers constituted the least achieved practice during the agroecological reconversion process. The UBPC Maniabo was the only one that produced these fertilizers at the beginning of the study, mainly compost and humus, from cattle manure; however, the other entities based their fertilization on chemical products.

After four years of evaluation, the UBPC Maniabo had not introduced any other practice and the others used four agroecological practices from the six recommended ones, for 66,6 % of adoption, for which they wasted the advantages of these organic products that minimize or eradicate the imports of chemical fertilizers and improve long-term soil fertility (Latifah *et al*., 2017).

The introduction of new agroecological practices in the farms of the UBPCs allowed the cooperative members to start producing with higher biological, productive, economic, energy and environmental efficiency (Funes-Monzote, 2009); and thus obtain healthy and abundant foodstuffs from the rational use of inputs, which propitiates higher incomes in the farm and improvements in the workers' welfare.

Table 5 shows the adoption percentage of the agroecologcal practices at the beginning and end of the evaluation, with highly significant differences ($p < 0,001$) in the three UBPCs. The UBPC La Estrella stood out, which had implemented 15 practices at the beginning of the evaluation from the 66 recommended ones, and with the reconversion process 30 of them could be included. In the other UBPCs an increase of the use of new agroecological practices was shown, although it is necessary to clarify that they started an agroecological reconversion process with a higher diversification level than the former.

The increase of the use of new practices in all the units was influenced by the empowering of local actors and training activities carried out throughout the agroecological reconversion process.

In general, a reconversion process was observed in all the UBPCs, because at the beginning the adoption percentage varied between 22,7 and 54,5 %, and at the end, between 68,2 and 78,8 %, which proved that in spite of the short period of study the motivation of local actors for the adoption of these good practices was achieved.

The way in which the reconversion process was carried out in the farms of the UBPCs fulfilled the foundations and considerations expressed

Table 5. Adoption percentage of the agroecological practices in the UBPCs.

| Practices | First year | Percentage | Fourth year | Percentage | SE ± |
|---|---|---|---|---|---|
| UBPC Maniabo | | | | | |
| Existing | 36 | 54,55[b] | 49[1] | 74,24[a] | |
| Not implemented | 30 | 45,45[a] | 17 | 25,76[b] | |
| UBPC Primero de Enero | | | | | |
| Existing | 28 | 42,42[b] | 52[2] | 78,79[a] | ± 6,15 |
| Not implemented | 38 | 57,58[a] | 14 | 21,21[b] | $p < 0,001$ |
| UBPC La Estrella | | | | | |
| Existing | 15 | 22,73[b] | 45[3] | 68,18[a] | |
| Not implemented | 51 | 77,27[a] | 21 | 31,82[b] | |

a, b, c: different letters in the same row indicate significant differences for $p < 0,001$.
1: 13 adopted practices, 2: 24 adopted practices, 3: 30 adopted practices.

by Gliessman *et al*. (2007) about the development of transitional processes of conversion from conventional systems to diversified systems of low management intensity, in which the progressive elimination of agrochemical inputs, through the rationalization and improvement of the efficiency of external inputs through the strategies of integrated management of pests, weeds, soil and water, becomes indispensable.

In this sense, diverse reports of literature emphasize the importance of establishing higher biodiversity in the farms, to obtain agroecological production based on the conservation of nature and the respect to the environment, which also contributes to the organization of farmers to sustainably face input scarcity.

During this study work was done on the motivation and training of 1 759 farmers, professors, technicians, students and decision-makers (1 024 men and 735 women) on topics of agroecology, management, popular education, communication, crop technologies, animal husbandry technologies, among others. Nine national training workshops were also carried out, with the participation of 58 women and 96 men, mainly focused on the formation and updating of multipliers (Llanes *et al*., 2014).

In that sense, Santos-Gómez (2009) refers that these processes are effective methodological elements to establish a dialog between experts and farmers, and that they also facilitate the collective construction of knowledge and guarantee the inclusion of agroecological principles in the technological activity of reconversion.

Elizondo (2013) stated that training must contribute to the change of mentality to the improvement of the administrative management and to the increase of the capacities of men and women in the agricultural sector in the search for new sustainable alternatives for local food security.

It is concluded that in the three UBPCs diverse agroecological practices were implemented as consequence of the reconversion process, with emphasis on the ones related to the establishment of agroforestry systems, biological pest control and crop rotation. Likewise, the diversification of the productive system conditioned the higher adoption of agroecological practices during the reconversion process of the entities.

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## Bibliographic references

Altieri, M. A. & Nicholls, Clara I. Conversión agroecológica de sistemas convencionales de producción: teoría, estrategias y evaluación. *Ecosistemas*. 16 (1):3-12, 2007.

Blanco-Lobaina, Janet; Contino-Esquijerosa, Y.; Iglesias-Gómez, J. M.; Caballero-Grande, R.; Perera-Concepción, E.; Funes-Aguilar, F. *et al*. Indicadores para evaluar la reconversión agroecológica en unidades básicas de producción cooperativa. *Agricultura Orgánica*. 19 (1):27-29, 2013.

Congo-Yépez, C.; Velástegui-Lara, F.; Caicedo-Vargas, C.; Rodríguez-Iturralde, L.; Vera-Zambrano, A. & Montero-Cruz, O. Árboles dispersos y su efecto en la productividad de los potreros en la Amazonía ecuatoriana. *La Granja. Revista de Ciencias de la Vida*. 27 (1):64-76, 2018.

De Schutter, O. *Informe del Relator Especial sobre el derecho a la alimentación. Tema 3 de la agenda Promoción y protección de todos los derechos humanos, civiles, políticos, económicos, sociales y culturales, incluido el derecho al desarrollo*. New York: ONU. http://www2.ohchr.org/english/issues/food/docs/A-HRC-16-49_sp.pdf. [20/03/2016], 2010.

Elizondo, L. *Capacitar atendiendo a la demanda. Guía Metodológica del Ministerio de la Agricultura de Cuba*. La Habana: MINAG, 2013.

Espinoza, S.; Ovalle, C.; Zagal, E.; Matus, I.; Tay, J.; Peoples, M. B. *et al.* Contribution of legumes to wheat productivity in Mediterranean environments of central Chile. *Field Crops Res*. 133:150-159, 2012.

Funes-Monzote, F. R.; López-Ridaura, S. & Tittonell, P. Diversidad y eficiencia: elementos claves de una agricultura ecológicamente intensiva. *LEISA. Revista de Agroecología*. 25 (1):12-14, 2009.

García-Barrios, L. & González-Espinosa, M. Investigación ecológica participativa como apoyo de procesos de manejo y restauración forestal, agroforestal y silvopastoril en territorios campesinos.

Experiencias recientes y retos en la sierra Madre de Chiapas, México. *Revista Mexicana de Biodiversidad*. 88 (supl. 1):129-140, 2017.

García-González, M. T.; Castellanos-González, L.; Rojas-Rojas, J. A.; Grillo-Ravelo, H.; Fernández-Cancio, Y. & Vera-Águila, Y. W. Biología y enemigos naturales de *Peregrinus maidis* (Ashmead) en el maíz (*Zea mays* L.) en sistemas de policultivos. *Centro Agrícola*. 42 (2):17-24, 2015.

Gliessman, S. R.; Rosado-May, F. J.; Guadarrama-Zugasti, C.; Jedlicka, J.; Cohn, A.; Mendez, V. E. *et al*. Agroecología: promoviendo una transición hacia la sostenibilidad. *Ecosistemas*. 16 (1):13-23, 2007.

Hernández-Mansilla, A. A.; Granda-Sánchez, Regla S.; Mur-Rodríguez, R. A.; López-Madrigal, S.; Hernández, N.; López-Sosa, L. A. *et al. Reconversión agroecológica en la unidad básica de producción cooperativa "La Estrella", Ciego de Ávila, Cuba. Pasos transitorios*. M. A. Altieri, S. Sarandon, C. Felipe-Morales, F. Funes y S. Siura, eds. Congreso Latinoamericano de Agroecologia. Lima: Sociedad Centifica Latinoamericana de Agroecologia (SOCLA). htpp://orgprints.org/25093.pdf. [18/03/2016], 2013.

Latifah, O.; Ahmed, O. H. & Majid, N. M. A. Soil pH buffering capacity and nitrogen availability following compost application in a tropical acid soil. *Compost Sci. Util*. 26 (1):1-15. http://www.tandfonline.com/doi/full/10.1080/1065657X.2017.1329039?scroll=top&needAccess=true. [18/12/2017], 2017.

Llanes, Georgelina; Caballero, R. & Perera, E. Articulación agroecológica: diseño de alternativas sostenibles para la seguridad alimentaria local en Cuba. *Agricultura Orgánica*. 20 (2):19-23, 2014.

Nicholls, Clara I.; Altieri, M. A. & Vázquez, L. L. Agroecología: principios para la conversión y el rediseño de sistemas agrícolas. *Agroecología*. 10 (1):61-72, 2015.

Olivares-Pérez, J.; Rojas-Hernández, S.; Quiroz-Cardozo, F.; Camacho-Díaz, L. M.; Cipriano-Salazar, M.; Damián-Valdez, M. A. *et al*. Diagnóstico de los usos, la distribución y características dasométricas del árbol Cirián (*Crescentia alata* Kunth) en el municipio de Pungarabato, Guerrero, México). *Polibotánica*. 45:191-204, 2018.

Santos-Gómez, M. La pedagogía de Paulo Freire: de la situación límite al diálogo como utopía. En: H. Cerutti-Guldberg y J. Pakkasvirta, eds. *Utopía en Marcha*. Quito, Helsinki: Ediciones Abya-Yala, Instituto Renvall. p. 385-398. http://168.243.1.4/facultad/chn/c1170/santos2.pdf. [18/03/2016], 2009.

Toledo-Toledo, J. M. Diseño de indicadores ambientales para la gestión sostenible de los recursos del macizo montañoso Guaniguanico. *Avances*. 19 (4):412-422, 2017.

Vázquez-Moreno, L. L. & Fernández-Trujillo, Julia M. *Articulación agroecológica en municipios cubanos. Sistematización del proyecto: "Articulación agroecológica: Diseño de alternativas sostenibles para la seguridad alimentaria local"*. La Habana: Editora Agroecológica, ACTAF. https://es.calameo.com/read/004840134db398e351ef6. [18/10/2016], 2016.

Vera-Pérez, Luz M. *Estudio de indicadores de diversidad y productividad en un proceso de conversión agroecológica*. Tesis presentada en opción al título académico de Máster en Pastos y Forrajes. Matanzas, Cuba: EEPF Indio Hatuey, Universidad de Matanzas, 2011.

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