

**How to Cite:**

Reyes-Pérez, J. J., Herrada, M. R., Zea, M. P. C., & Méndez-Martínez, Y. (2022). Relevance of the master's degree program in agroecology and sustainable development of the state technical university of Quevedo, Ecuador. *International Journal of Health Sciences*, 6(S2), 13933–13944.  
<https://doi.org/10.53730/ijhs.v6nS2.8650>

## **Relevance of the master's degree program in agroecology and sustainable development of the state technical university of Quevedo, Ecuador**

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**Abstract**--Agroecology as a synthesis science for the construction of food sovereignty allows setting guidelines for the sustainability and development of a country. The relevance of the Master's Degree in Agroecology and Sustainable Development of the State Technical University of Ecuador is based on the solution of the main problems presented in agroecosystems, so that trained professionals can offer scientific and technical solutions to the main problems presented in the agricultural production systems of the region, such as soil degradation, loss of biodiversity, contamination of agroecosystems and the management of regulations, economy and marketing of agricultural products, which result in low agricultural yields of crops. The Master's program is one of the first to be proposed in the agricultural area in an important agricultural zone of the country. It is projected for the professionals of zone 5 of the country, in need of training and who demand updated scientific preparation, responding to a need of the territory, for the training of professionals in the agricultural sector, both in production, with an integrating vision,

which allows reaching greater efficiency in the productive processes, with levels of social and economic stability to reach food security and sovereignty.

**Keywords**---relevance, program, agroecology, sustainability, development.

## **Introduction**

The development of agricultural and livestock systems without ecological and environmental principles has affected the balance of ecosystems, generating the loss of biodiversity and natural resources (Goyes and Ángel, 2021). Agroecology takes advantage of the natural processes of interactions that occur on the farm to reduce the use of external inputs and improve the biological efficiency of cropping systems. This is achieved by expanding the functional biodiversity of agroecosystems, an essential condition for the maintenance of immune, metabolic and regulatory processes in the functioning of the agroecosystem (Sarandón and Flores, 2014).

The Master's program in Agroecology and Sustainable Development at the State Technical University of Quevedo, Ecuador is a relevant project for Zonal Region 5, since it is the house of higher education where the largest number of professionals in the agricultural sciences have been and continue to be trained in. The program is related, affinity, and effective with the training needs of the social and labor environment. It is congruent with the demands of the need for training of professionals who work in the agricultural branch of the region, based on achieving in an adequate and congruent way the improvement of professionals so that they can offer scientific and technical solutions to the main problems presented in the agricultural production systems of the region such as soil degradation, loss of biodiversity, contamination of agroecosystems and the management of regulations, economics, and marketing of agricultural products, which have as a consequence low agricultural yields of crops.

The master's program is viable, its design and planning assume the success of the project from its approach to environmental care, achieving economic profitability, and handling market need efficiently, which confers a social benefit. Agricultural sustainability refers to the quality of being able to maintain itself, without outside help and without exhausting the available resources in the field of ecology, in harmony with nature. Various trends have emerged worldwide, such as climate-smart agriculture, conservation agriculture, achieving greater production of healthy food with fewer resources, genetic improvement of varieties, systematization of agriculture, and adjustment of food production systems to changes, in the end, consumer and retail distribution channels, particularly supermarkets.

Only an adequate awareness of the problems of agriculture, their causes, and the need for the incorporation of agroecological principles, with a systemic and holistic perspective, can ensure ecologically adequate, economically viable, and socially just food production for this and future generations. Therefore, the

objective of this paper is to explain the relevance of the Master's program in Agroecology and Sustainable Development at the State Technical University of Quevedo, Ecuador.

## **Development**

The concept of agroecology is linked to the production of healthy products, but there is now consensus that agroecology is a science that expresses the integration of philosophical, political, economic, social, and agronomic sciences, aimed at the transformation of agriculture and the rural environment on a sustainable basis. But agroecology is not only a science, it is also a practice and a socio-political movement. It is also a foundation for sustainable municipal agricultural development by responding to social and ecological demands: maintenance of biodiversity, conservation of forest cover, soil and water conservation, carbon sequestration, suppression of agro-toxins and transgenics, agrarian equity, food sovereignty (at various scales) and healthy food, local self-management and self-sufficiency, fair and organic markets, and dialogue of knowledge and participatory research (Toledo, 2012).

The framework for responding to these demands is based on a multidimensional, integrative, transdisciplinary, and sustainable approach with the four generally accepted dimensions of sustainable local development: economic, sociocultural, natural, political-administrative, and institutional (Torres and Fernández, 2014). In such conditions, a sustainable agrarian development model on agroecological bases should be oriented to improve the quality of life and standard of living of citizens, increase the degree of social welfare, reduce dependence on the exterior, improve conditions to strengthen mutually advantageous exchange with the environment outside the locality, strengthen the collective spirit, as a component of conscious action for the scope of social and individual development, growth and generation of employment, conservation of the natural environment, and cultural development of the community (Suryasa et al., 2021; Suryasa, et al., 2022).

Faced with the new demands and challenges of today's world, farmers from agroecological conceptions are working on sustainable agricultural practices, respectful of the environment, introducing new technologies and resources adapted to local production conditions, promoting natural controls, eliminating pesticides, favoring biodiversity, increasing productivity and energy efficiency by closing production cycles and integrating animal and plant production. In this sense, the following are priorities for sustainable agricultural development from the perspective of agroecology:

1. Conscious redesign and operation of agricultural systems according to their natural potentialities, more rational use of available resources, and adaptation to local conditions.
2. Increased bio-diversification and complexity of agroecosystems.
3. Dynamic recycling of energy and nutrients through livestock-agriculture integration.
4. Achievement of human and animal food self-sufficiency.

The creation of local capacities is an essential alternative since it increases self-sufficiency through technological, energy, and food sovereignty while strengthening integrated management, not only for food production but for the education and health of eco-societies. The object of study of the Master of Agroecology and Sustainable Development is the agroecosystem in its socio-environmental and economic relationships, which demands scientific knowledge from a humanistic perspective, integrated with multi- and transdisciplinary relationships. The management of agroecological knowledge in master's degree students favors the appropriation of cognitive tools for the solution of agricultural production that is more environmentally friendly and with high levels of sustainability (Miguel Medina Romero, 2021).

In Latin American countries, with very few exceptions, the impact generated by the agricultural development model is evident in economic, ecological, and social terms. In the region, the peasantry is facing a real war, where the extractive industries of agribusiness, mining, green desert plantations, and agrofuels are trying to dispossess the people of their lands. Industrial agriculture is producing horrible food for supermarkets, for consumers, and the truth is that it is a war of life and death, with persecution and criminalization of social struggles.

At this juncture, agroecology is the strategy for resistance, to the transformation of territories. Agroecological peasant territories, instead of producing death, harmful food, pollution, and environmental destruction, will be territories that produce life, that preserve culture, that produce healthy and wholesome food for the population. In this sense, agroecology is a key element to improving life in rural areas for the peasant families themselves, but also to offer a better countryside for the whole society, a countryside that preserves what the population wishes to preserve in the countryside: culture, mother earth, offering healthy food and following the gastronomic food cultures of each region.

The sustainability of agricultural systems is achieved with good agricultural practices, such as biological controls, the development of biopesticides, the use of organic alternatives in plant nutrition, the application of biotechnology, the use of cultivars resistant to climate change and adequate production results; the use of non-conventional animal feed and the integration of technologies for the processing of this production and its residues, which are not aggressive to the environment, have also constituted contributions that from Agroecology science fertilize the sustainable development of Ecuadorian agricultural areas.

The Program will encourage reflection so that by channeling the problems caused by the loss of agricultural production, they will be able to provide alternatives for the solution of problems and promote the overall development of the province, the region, and the country, guided by the criteria of the zonal agendas about the productive, economic, social, environmental, political and technical aspects. For all this, the Program has structured a curriculum whose knowledge responds to the expectations and needs of the province and the area. At present, Ecuadorian policy is formulated through initiatives and programs in which local productive agricultural management is the main focus while emphasizing the need for the territories to become the true protagonists of the development processes.

For their part, the policies and strategies of governments and international organizations aimed at promoting human development have in the local perspective a broad possibility that this development is based on the potential that each locality can contribute in resources and social relations, to make it more effective and coherent with its immediate environment. The master's degree in Agroecology and Sustainable Development responds to the needs of the economic development of the country and the Ecuadorian man, it will seek that he finds his roots, his identity, valuing his ancestral knowledge that gave glory to the aboriginal knowledge, without devaluing the Ecuadorian culture, the student of this master's degree will obtain the scientific and technological knowledge of the contemporary world. Thus, the student will be forming a creative, analytical man, with mastery of his knowledge in close relation to the advancement of science, betting on local development as a basis for promoting agroecology.

According to Torres (2015), local development can be assumed as “the process of social construction and structural change that aims at generating local capacities to manage strategies, public policies, programs, and projects, oriented to take advantage of endogenous and exogenous resources, generating economic, social, natural, and institutional transformations in the localities, as well as promoting an innovative environment that harmoniously articulates national, sectorial and territorial interests on sustainable bases and in the function of raising the quality of life of the population”.

The topics that will be addressed in the research that will be developed by the master's degree program are related to the lines of research of the State Technical University of Quevedo and other important institutions of the territory to respond to the needs of the rural environment and its work in the sustainable development of the Zonal Region 5, having a close relationship of the research model of the master's program with the national policies of science, technology, and national and regional innovation.

The lines of research at the country level related to the Master's in Agroecology and Sustainable Development will be addressed by the students through topics related to the environmental and socio-economic problems of the region in particular and in general common to many of the shortcomings in the sustainable development of rural areas of the country.

The program will respond to the specificities of the matrix of tensions and problems of zone 5, which were considered when designing the curriculum. Likewise, the program intends to respond to the specificities of the matrix of tensions and problems of zone 5, which were taken into account when designing its academic structure. The contribution of the Master's program in Agroecology and Sustainable Development is given from various angles such as a) promoting the production of sufficient and healthy food, and b) the existence of alternative markets, to meet local and national demand with cultural relevance. All this favors the goal of diversifying and increasing food production in the country for the consumption of Ecuadorian households, contributing to food sovereignty.

The development of projects through the academic training process will strengthen the work in the search for praiseworthy solutions to the problems of

research, production, and teaching in Ecuadorian agriculture from a holistic vision, channeling the search for income for this purpose. The development of agroecological technologies from academic action constitutes a real contribution to the Ecuadorian reality.

The problems of agricultural production and its socio-economic environment that will act as axes for the organization of knowledge and learning in the Master's Program in Agroecology and Sustainable Development are listed below. The most important causes are among others, the use of aggressive techniques to the environment, the inadequate use of irrigation, the continued monoculture., the poor management and use of soils, by the excessive and/or inadequate use of chemical products, bring as a consequence the degradation of these, the loss of biodiversity, the contamination of the agroecosystem and therefore low agricultural yields.

Biodiversity is declining rapidly due to factors such as changes in land use, climate change, invasive species, overexploitation, and pollution. The reduction of biodiversity has resulted in the instability of agroecosystems, vulnerability to disturbances, loss of genetic base (genetic erosion), disruption of ecosystem functions, nutrient recycling, regulation of hydrological processes, microclimate control, soil fertility, population regulation, loss of adaptability, and loss of productivity. Incidence of pests and diseases due to excessive use of monocultures and poor agrotechnical crop management.

The use of chemical fertilizers is extremely costly and at the same time, their indiscriminate use causes very harmful effects of contamination in agroecosystems, from the environmental and human health point of view. However, it has been proven that the indiscriminate use of these chemical inputs not only implies a high cost but also contaminates the soil, reduces biodiversity, increases the risk of salinization, considerably reduces soil energy reserves, and contaminates surface and groundwater.

The participation of national agriculture means that all agricultural policy must be oriented towards it. A certain amount of effort is needed in national policy so that companies can successfully join the demanding international markets. But too much is also pernicious because the state infrastructure needed by these markets is not needed by suppliers in unregulated domestic markets. As informal markets are still the markets in which the bulk of farmers live and which feed most of the country's consumers. This is why a general renewal of the social market economy is necessary, which will reconcile today's social and regulatory priorities with an efficient and successful economy in the context of competition.

Moreover, the market continues to be regulated in many areas for the benefit of acquired social rights. However, so that the economy does not suffer from excessive regulation and taxation, the protection of the weakest is sacrificed, which is why, little by little, a duplication of the economy is being imposed, i.e., its split into a regulated segment, in which the strongest groups are located, and an unregulated segment, to which the weakest are exposed. There are very few projects developed in rural areas to improve their productive results, and those that do exist are not oriented toward sustainable development on agroecological

bases, reflecting a lack of an integrated vision and only responding to partial aspects of the agrarian problem with the absence of the closing of the productive chain.

Ancestral knowledge and popular wisdom have been treated as archaic knowledge and its applicability reduced to small spaces and solutions to very small problems. The important cognitive mechanisms of transmission of information and values carried by this knowledge are not recognized. Natural resources and their ecosystem services overlook the agricultural products from the exploitation of these resources without taking into account the income possibilities of many of these products, as well as the environmental responsibility of many of them in the conservation of germplasm, the conservation of endangered species and the increasing loss of diversity of both flora and fauna at micro and macro levels.

The social component is of vital importance, associated as a real guarantee of the development of agroecological family farms and the continuity of a culture that can be acquired, maintained, and enriched in them. There is a slow movement of knowledge to be applied quickly in the restoration of already affected areas or to prepare for rural areas that are predicted to be hit by climate change. For this horizontal transfer to occur quickly, emphasis must be placed on directly involving farmers in the extension of innovations through well-organized farmer-to-farmer networks, led by academic and scientific institutions.

As an integrative science, Agroecology recognizes and draws on the knowledge and experiences of farmers, indigenous peoples, forest peoples, fishermen, indigenous African communities, as well as other social actors involved in rural development processes, incorporating the endogenous potential present in the local level (Caporal *et al.*, 2006).

Agroecology claims the combination of natural and social sciences to understand the interactions between agronomic, economic, and social processes; it claims, finally, the essential link between soil, plant, animal, and human beings (Altieri, 2009).

The key concept guiding the methodological and epistemological reasoning of agroecology is sustainability (Gliesman *et al.*, 2007). This means that the knowledge it produces and the axiology on which it is based invite action, to the design and development of sustainable agricultural systems. It is a science that expresses the integration of philosophical, political, economic, social, and agronomic sciences, aimed at the transformation of agriculture and the rural environment on a sustainable basis. Agroecology as a science of synthesis for the construction of food sovereignty allows for setting guidelines for the sustainability of development (Morejón, 2018).

Agroecology aims to take advantage of key ecological processes, such as nutrient recycling and synergies between components of agrobiodiversity. An important feature of this approach is that it builds on farmers' traditional knowledge to devise solutions that respond to their needs. For example, farmers in China who grew different combinations of traditional rice varieties experienced a 44% lower

incidence of the blast (a fungus that attacks cereals) and achieved 89% higher yields compared to single-variety crops, and did so without using fungicides.

Agroecology also promotes the use of polycultures, which have a more stable yield and whose productivity is less affected than monocultures during a drought (Altieri, 2009). Promoted by FAO, it is based on the fundamental concept of integrated management of soil, water, and all agricultural resources. Its main characteristic is that under specific and continuous forms of cultivation, soil regeneration is faster than soil degradation, so the intensification of agricultural production is economically, ecologically, and socially sustainable (Friedrich, 2017).

“Conservation Agriculture” is an agricultural production system that reconciles agricultural productivity, raising the economic and social level of farmers, with the conservation of natural and environmental resources. Conservation Agriculture includes any practice that reduces, changes/eliminates soil tillage, and avoids stubble burning to maintain an adequate surface cover throughout the year (ECAAF, 2001). FAO's model for sustainable intensification of agricultural production, known as “Safe to Grow”, is based on nature's contribution to crop growth, for example, through soil organic matter, water flow regulation, pollination, and natural pest predation. It involves applying external inputs, such as mineral fertilizers, at the right time and in the right amount to improve crop varieties that are resilient to climate change and use nutrients, water, and external inputs more efficiently. Increasing resource use efficiency, decreasing fossil fuel use, and reducing direct environmental degradation are major components of the approach. It saves farmers money while avoiding the negative impacts of excessive use of external inputs. This approach has been extended to other agricultural sectors (FAO, 2016).

The growing demand for food, as a consequence of the constant growth of the population within a limited area, has directed efforts in the field of agriculture towards increasing productivity through the selection of plant material, which is the principle of genetic improvement. Obtaining higher yielding varieties towards which plant breeding has long been directed, by increasing physiological efficiency, does not ensure an increase in productivity unless the stabilization of such production is simultaneously sought. This requires the adaptation of these varieties to the particular growing conditions of a given area in terms of climate, cultural practices, and plant health.

Genetic improvement can help the crops of the future. Agronomy and genetic improvement will impact future agricultural production furrowed by climate change. “There are no cultivars on the market that can be said to be heat resistant” (Eyh rabide, 2018). Participatory plant breeding as a method of non-conventional genetic improvement has gained credibility by constituting a pathway that carries knowledge and experiences and is carried out from endogenous resources. In some countries, it has played a relevant role in the mitigation and recovery from natural disasters.

This trend seeks to systematize agriculture, in such a way that the use of sensors, mobile technologies, and Apps that can be used from any Android, IOS, or

Windows device are employed. In this way, these technological offers seek to provide detailed information, minimize risks and calculate productivity. Mobile Apps are a revolution today and the agricultural and livestock sector is not far behind, with a large number of software tools for the field that is very useful for the farmer and agricultural entrepreneur. Researchers in various parts of the world are already using computer systems that contribute to improving the management and processing of information on agro-technology and plant health. Through their use, information is obtained at the moment it is needed in a detailed, precise, and more consistent way, which improves analysis, and understanding and raises the level of efficiency for the control, organization, and analysis of information. It is validated through software tests, which guarantee its correct operation (Calá *et al.*, 2017).

FAO's model for sustainable intensification of agricultural production, known as "Save to Grow", is based on nature's contribution to crop growth, for example, through soil organic matter, water flow regulation, pollination, and natural pest predation. It involves applying external inputs, such as mineral fertilizers, at the right time and in the right amount to improved crop varieties that are resilient to climate change and use nutrients, water, and external inputs more efficiently. Increasing resource use efficiency, decreasing fossil fuel use, and reducing direct environmental degradation are major components of the approach. It saves farmers money while avoiding the negative impacts of excessive use of external inputs. This approach has been extended to other agricultural sectors (FAO, 2017).

In recent years, there has been a growth in the distribution of processed foods, which has required greater vertical coordination, integration production, processing, packaging, and distribution activities. This integration translates into greater efficiency, employment opportunities, and innovation; however, it is a potential risk for smaller and less integrated producers (Navarrete, 2017).

FAO's approach to climate-smart agriculture aims to sustainably increase agricultural productivity, increase adaptive capacity and resilience to climate shocks, as well as reduce greenhouse gas emissions and increase carbon sequestration to the extent possible. The starting point for climate-smart agriculture is the technologies and practices that countries have already prioritized in their agricultural policies and planning. The potential of these technologies and practices from the point of view of food security and adaptation is assessed under site-specific conditions to determine the necessary adjustments. These adjustments include the following: adoption of heat- and drought-resistant varieties; diversification of the agricultural portfolio; improved soil and water management; and promotion of off-farm employment (FAO, 2016). Often, practices that bring large benefits in terms of adaptation and food security can also reduce greenhouse gas emissions and increase carbon sequestration (FAO, 2017).

Agroecology as the application of the concepts and principles of ecology to the design, development, and management of sustainable agricultural systems contemplates a complex system integrated by diverse structures, processes, and components. In this way, soils can be considered subsystems of the

agroecosystem of which they are a part. To appreciate soil ecology is to appreciate its ecological and life cycles. Soil has an important biological activity, due to the large number of microorganisms that live in it, as well as the ideal soil profile and edaphon, which make possible the nutrition of plants and animals. The soil has mineral elements and rock residues, organic elements (flora, fauna, roots, animal, and plant residues). Soil also consists of water and air particles, among other elements.

Soil properties are divided into biochemical, physicochemical, and biophysical and must be in balance, which together with the capacity for continuous recycling produces the natural fertility of the soil, together with factors such as climate and type of agriculture, resulting in productivity. Living and healthy soil will produce more in quantitative and qualitative terms. The interaction of the physical, chemical, and biological aspects of the soil allows a better interpretation of what is happening in the soil and allows the creation of the necessary corrective measures to protect and improve it. Ecological soil management is the only existing guarantee for the recovery of deteriorated soils. This will depend on the multiplicity of functions to be provided by the new properties and their relationships.

The fundamental purpose of an agricultural production system is to maintain the soil biologically stable, always highlighting the cause-consequence that emerges from the healthy soil-healthy plant and healthy plant-healthy soil relationship. To maintain the healthy soil-healthy plant relationship it is necessary to preserve the biological conditions of the soil, especially when working with sloping soils, where erosion and water use must be controlled (Primavesi, 1984). Farmers have historically applied agroecological techniques to conserve and improve soils, among which the following can be highlighted:

- Use of locally adapted varieties/species showing more appropriate adaptations to climate and overwintering requirements and/or increased resistance to heat and drought,
- Enhancing the organic matter content of soils through the application of manure, green manures, cover crops, etc. thereby increasing moisture holding capacity.
- Wider use of water “harvesting” technologies, soil moisture conservation through mulching, and more efficient use of irrigation water.
- Water management to prevent flooding, erosion, and nutrient leaching when rainfall increases.
- Use of diversification strategies such as intercropping, agroforestry, etc., and animal integration.
- Prevention of pests, diseases, and weed infestations that are likely to modify their biologies through management practices that promote biological and other regulatory mechanisms (antagonisms, allelopathy, etc.) and development and use of pest- and disease-resistant varieties and species.
- Use of natural indicators for climate forecasting to reduce production risks.

In the achievement of sovereign agroecosystems in food, the use of technology and energy is implicit in its management based on the principles of agroecology, and has as its ultimate goal the development of resilient family farms, with the

capacity to cope with changes of any kind: climatological, market or political (Altieri and Toledo, 2011), and creatively absorb the transformation without losing its identity as such (Escalera and Ruiz 2011). Agroecological principles can take various technological or practical forms, according to the historical context of a farm, and have a different effect on the productivity or resilience of the farm, depending on the local and environmental setting and the availability of resources (Altieri, 2010).

These principles are mainly based on ecological processes; however, the social complement associated with them is of vital importance as a real guarantee of the development of agroecological family farms and the continuity of a culture that can be acquired, maintained, and enriched on them. The challenge now is how to quickly mobilize this knowledge so that it can be applied in the restoration of already affected areas or to prepare rural areas that are predicted to be hit by climate change. For this horizontal transfer to occur rapidly, emphasis must be placed on directly involving farmers in the extension of innovations through postgraduate training.

## **Conclusions**

The proposal for a Master's Degree in Agroecology and Sustainable Development from the State Technical University of Quevedo, Ecuador, is one of the first to be proposed in the agricultural area in an important agricultural zone of the country, projected for professionals in zone 5 of the country, in need of training and who demand updated scientific preparation. The master's program is relevant, it responds to a need of the territory, training professionals in the agricultural sector, both in production, with an integrative vision, which allows achieving greater efficiency in production processes, with levels of social and economic stability to achieve food security and sovereignty.

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