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Expo Melilla

Strategies and tools for the transition to agroecological-based vegetable production systems

Estrategias y herramientas para la transición hacia sistemas de producción de hortalizas basados en la agroecología

Estratégias e ferramentas para a transição para sistemas de produção de hortaliças baseados em agroecologia

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Agroecology (AE), integrating ecological and social concepts and principles, seeks to promote harmony between humans and the nature of which we are a part, encouraging sustainable, inclusive, and fair food systems[1]. It deals with food systems as a whole, from those who produce to those who consume food, from the technical-productive, socio-ecological, political-institutional, and organisational aspects[2]. Since the "conventional" model of production, based on specialisation and input-based intensification, has degraded natural resources and generates health risks, AE is conceived as an alternative[3] involving various approaches, science, practice and social movement to solve the actual challenges of agricultural production[4].

At the production systems level, AE aims to maintain or increase production by enhancing ecological processes —such as carbon, nutrient and water cycling, energy flow, and biotic regulation— reducing the use of external inputs and minimising negative impacts on the environment and the society[5]. Thus, AE proposes guiding principles for system design and management to be thought out and implemented according to each situation[6]. Within these principles for designing and managing agroecological systems, the enhancement and management of soil quality and biodiversity over time and space are crucial[5].

Practices that improve the physical, chemical, and biological quality of soil result in healthier, more diverse, and richer soils that provide better conditions for plant growth, retain more carbon, have greater water storage capacity, and are better able to suppress disease and generate beneficial associations with plant roots[5][7]. Systems with greater plant diversity are more efficient in solar energy capture and carbon sequestration, water, and nutrient use, and generate greater above- and belowground biodiversity, which supports natural population regulation mechanisms[5][8]. These aspects result in more resilient and stable systems, better positioned to cope with extreme, variable, and uncertain events related, for example, to the climate or the economy.

To achieve these resilient and stable production systems, we must undertake processes of change, which require knowing where we start from, how the current production system is like and works to define how to move from this current situation to the desired one. This process involves learning and changing our practices to produce, observe, evaluate, and make decisions[2][9-10].

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In Uruguay, 88% of horticultural farms are family farms and are concentrated in the south of the country (80%)[11]. In recent decades there has been a reduction in the number of farms (5300 to 2600)[12] accompanied by an intensification and specialisation of production: more area of fewer crops, less opportunity for rotation leading to greater pressure on already deteriorated soils, and greater use of external inputs[13-14]. Some of the most important consequences have been high erosion rates, reduced mineralisable soil carbon, low yields, low family incomes, low labour productivity, overwork, and work-related health problems[13-18].

The process of transition from this current situation towards agroecological systems can be conceptualised at different levels[19]: 1) increasing the efficiency of "conventional practices" to reduce the use of costly, scarce or harmful inputs, 2) substituting or changing an input or practice for a more sustainable one, 3) redesigning the production system to operate based on a set of ecological processes, and 4) transitioning towards a change in ethics and values.

Most horticultural farms obtain yields well below what they could obtain for current resources and management conditions. Several authors working in southern Uruguay with different horticultural crops reported yield gaps of around 50%[13-14][20-22], and showed that these gaps were not associated with the level of fertiliser and pesticide use[18]. In this context, it is possible to maintain or even increase yields by reducing input use, reducing the risk of negative impacts, and improving the productive efficiency of the system, reducing costs and labour per unit of output[16]. For example, reducing and increasing input use efficiency could be achieved by adjusting the amount and timing of nutrient inputs according to soil conditions and crop requirements, reducing the number of applications by monitoring crop and environmental conditions, rotating active ingredients, and reducing the number of products per application.

Going one step further, to eliminate the use of these harmful inputs by more sustainable ones, some biological or "alternative" inputs have become more accessible in Uruguay in the last decades. For example, there are entomopathogenic fungi (e.g. *Beauveria* sp., *Trichoderma* sp., *Isaria* sp.), natural enemies (e.g. *Orius* sp., *Amblyseius* sp., *Tupiocoris* sp.) or pheromone traps for pest control[23]. Other inputs are oriented to soil improvements and nutrient supply, such as organic amendments (compost, vermicompost, animal manure, bokashi, among others) and biofertilizers (compost tea, bostols, supermagro, among others), or products to stimulate soil biological activity and plant responses to control diseases and pests, and/or increase the availability of nutrients (native effective microorganisms, among others)[24-25]. There is a growing interest and demand for the availability, information, and legislation for registering this type of alternative products for horticultural use. However, the fact that in many cases they are living organisms, as well as the heterogeneity in original materials and forms of preparation pose a great challenge, and further research is needed to understand the complex biological relationships generated and the results of their use.

These strategies mentioned above are relevant and facilitate a transition path. However, national studies also showed that the reasons determining low incomes in production systems[13-14][26] or crop yield gaps[20-22] are not just linked to input use but mainly to general farm organisation and management, e.g. installation dates and crop cycles, or soil management and quality. These aspects —improve soil quality, include activities to diversify production, or perform the activities in each crop on time— cannot be solved by inputs. Instead, it involves strategic decisions, land use planning and management according to the resources available to the system, where labour plays a central role[16]. Therefore, starting redesigning the system from the beginning of the transition process is essential in agroecological transition, changing the bases of the system functioning.

For instance, to improve soil health, we need to think at the scale of each crop (tillage, amendments, or soil cover by crop canopy), but also beyond the crop cycle (crop rotation and the inclusion of green manures, cover crops, grassland in the crop rotation), and beyond the field where each crop is located (vegetation and soil cover on paths or uncultivated areas). In turn, each specific practice involves planning. For example, incorporating green manures requires foreseeing the tillage for installation, defining the species and cycle to achieve adequate biomass and cover, and foreseeing the time and manner of cutting and/or incorporating in advance of the next crop. It also involves decisions beyond green manure, such as considering the necessary work and foreseeing overlap with other activities.

Rethinking the farm as a whole forces us to change the focus of analysis, focusing on the objectives set by those who carry out the production, their needs, and aspirations. It also leads us to set

short, medium, and long-term objectives and select indicators that allow us to monitor changes according to the objectives set to make better decisions.

There is a need to move towards more sustainable systems, and agroecology is a viable alternative. How and where to initiate the change process will depend on each situation. However, we must transcend the idea of exchanging one input for another and embark on a global rethinking of systems, taking short and medium-term actions framed within a long-term strategy. This transition in how we produce cannot occur in isolation or independently; it also implies changes in the link with the market, what we do as consumers, and how we generate knowledge or train professionals. In this context, collective strategies are crucial, and public policies and institutions are responsible for enabling (or not) these processes.

Keywords: agroecology, horticulture, sustainability, transition

Palabras clave: agroecología, horticultura, sustentabilidad, transición

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Transparency of data

Available data: The entire data set that supports this study was published in the article itself.

Author contribution statement

Both authors wrote the paper and contributed equally to the content.

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