

Applying the principles of transformative innovation, strengthens agroecological transition processes

La aplicación de los principios de innovación transformadora, refuerza los procesos de transición agroecológica

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Abstract

The sustainable transformation of agri-food systems through the application of agroecological principles can help to mitigate the effects of the food crisis triggered by the health emergency and the subsequent economic recession. Accordingly, the aim of this reflection research article is to reflect on the correspondence of the principles of transformative innovation (TI) with the agroecological approach and how its application favours the processes of generation, diffusion and adoption of agroecological innovations. It is currently recognised that overcoming social and environmental challenges can contribute to economic growth and competitiveness in the long term, which becomes the basis of TI policies aimed at the generation, diffusion and adaptation of environmental and social innovations, framed within the achievement of the SDGs. At the territorial level, innovations conceived from a sectoral approach can limit the analysis of the contribution of science, technology and innovation in solving social problems. Therefore, especially in rural areas, the application of IT principles can help support agroecological transition processes, which allow addressing social, economic, political and environmental challenges.

Resumen

La transformación sustentable de los sistemas agroalimentarios, mediante la aplicación de principios agroecológicos, puede contribuir a disminuir los efectos de la crisis alimentaria, desencadenada por la emergencia sanitaria y la recesión económica subsiguiente. En este sentido, el presente artículo de reflexión, tiene por objeto realizar una reflexión en cuanto a la correspondencia de los principios de la innovación transformativa (IT) con el enfoque agroecológico y como su aplicación favorece los procesos de generación, difusión y adopción de innovaciones agroecológicas. Actualmente, se reconoce que la superación de los retos sociales y ambientales puede, en el largo plazo, contribuir al crecimiento económico y la competitividad, lo que se convierte en la base de la política de IT, que busca diseñar, difundir y apropiar innovaciones ambientales y sociales sustentables, enmarcadas en el logro de los ODS. En el ámbito territorial, la innovación concebida desde un enfoque sectorial puede limitar el análisis sobre el aporte de la Ciencia, la Tecnología y la Innovación a la solución de problemas sociales, por lo que especialmente en las zonas rurales, la aplicación de los principios de la IT puede contribuir a apoyar procesos de transición agroecológica, que permitan atender tanto los retos sociales, así como los económicos, políticos y ambientales.



Introduction

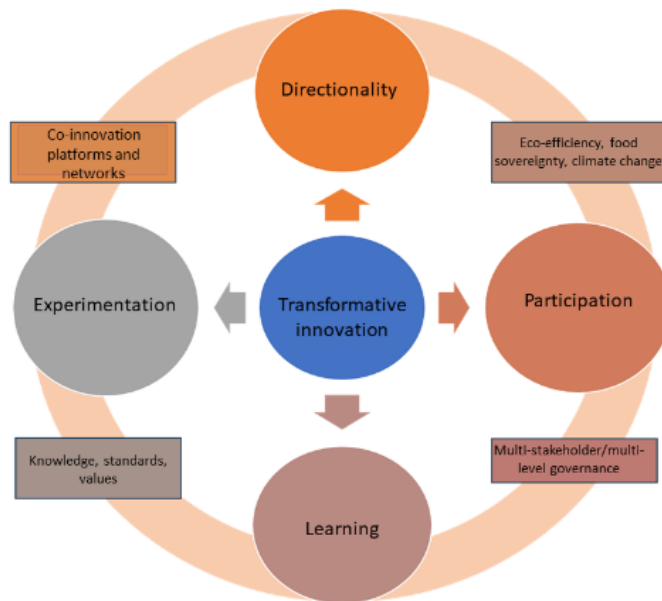
The public health emergency caused by the COVID-19 pandemic highlighted the lack of robust long-term planning processes in all socio-economic and environmental aspects of humanity, with particular emphasis on the health, food and science, technology and innovation (STI) sectors [1]. The food crisis that has arisen in this context becomes an opportunity for the recognition of the agroecological movement as an agricultural production alternative that, oriented towards the achievement of the Sustainable Development Goals (SDGs), can contribute to the design and implementation of more resilient and sustainable food systems [2].

Supporting an agroecological transition requires interaction and synergies between local and academic knowledge to produce social and institutional innovations in addition to technological ones. These innovations include the design and creation of consolidated marketing systems for agroecological food products, as well as the development of solidarity economies, institutional strengthening and the development of inclusive governance mechanisms [3,4].

The principles of IT (Directionality, Participation, Learning and Experimentation) [5] are aimed at prioritising major challenges as a new, broader policy objective aimed at defining a clear direction of change through a bottom-up approach involving a wide range of actors [6], from the point of view of the application of agroecological principles. This implies a change in the way farmers participate in the processes of knowledge generation and innovation at the local level, through processes of experimentation with techniques, practices and forms of organization [7,8], based on a transdisciplinary process of mutual learning in which the knowledge of different actors is combined, on the one hand with indigenous ancestral wisdom, traditional knowledge of farmers and marketers, and on the other with global scientific knowledge [9].

The aim of this reflection research article is to show the correspondence between the principles of IT and the application of the agroecological approach, from which processes of generation, transfer and use of technological, social and institutional innovations can be addressed, contributing to a real agroecological transition (Figure 1).

Figure 1. Alignment of IT principles with the agroecological approach



Agroecology is a holistic science that brings ecological, economic and social sustainability to the food system through research, education and action with a transdisciplinary and participatory approach [4,10]. For agroecology, theory and practice are applied synergistically through political-institutional instruments that design and build social dynamics of change [11].

The main uncertainties facing the future of agri-food systems are population growth, dietary preferences, scientific and technological advances, equitable income distribution, environmental impacts of production systems and climate change [12]. To address these global challenges, it is important to seek a transition towards sustainable agri-food systems based on innovations and technological improvements adapted to different contexts, which will increase productivity and reduce greenhouse gas (GHG) emissions, as well as address other social challenges such as poverty, inequality and unemployment [13].

The agroecological approach therefore becomes an option for sustainable agricultural development by organising agri-food systems according to an alternative set of principles that seek to maximise the positive interactions between people, agriculture and nature [11,14].

The transformation of agri-food systems is approached by agroecology from three perspectives: firstly, by

increasing knowledge of the principles governing the ecological relationships between species and the biophysical environment; secondly, through innovative agricultural practices that value the local, empirical knowledge of peasant and ethnic communities and allow for the exchange of this knowledge and its practical application; and thirdly, by the way in which socio-economic systems determine the distribution of food, ensuring food sovereignty on a permanent basis [10].

Agroecology is highly knowledge-intensive and based on techniques that are not imposed from the top down, but are built on farmers' knowledge and experimentation. Agroecological innovations are generated in situ with the participation of farmers in a horizontal (not vertical) way, and technologies are not standardised but flexible and adaptable to each specific situation. The agroecological approach emphasises the capacity of local communities to experiment, evaluate and scale up innovations through horizontal exchange of ideas, self-reliance and community empowerment, a process that starts with participatory research where farmers learn from each other by sharing not only techniques but also wisdom, creativity and knowledge [15].

Holistic approach to agroecological innovation

The technological, social, economic and institutional changes that are part of agroecological innovation processes are carried out by a network of institutions, organisations and individuals interacting in a common environment [16], where profound changes take place in the components of the agri-food system, such as technology, infrastructure, skills and capacities, standards, policies, markets and governance [17]. Its territorial basis includes elements such as systemic and complex thinking, transdisciplinarity and participatory methods of knowledge management by a broad group of stakeholders [18].

The design of an agroecological transition requires a participatory, holistic, transdisciplinary and localised design approach that, from a knowledge management perspective, facilitates interaction and synergy between local knowledge and academic science, as well as the development of social and institutional innovations, such as the creation of agroecological markets, the promotion of solidarity economies and the development of inclusive governance mechanisms [4]. These innovations must go beyond simple incremental developments at the level of agronomic technologies [19], and it is necessary to work

on the development of radical innovations that are not only technological, but also social and institutional, and whose innovation process takes place at the local level, integrating different ecological, socio-economic and institutional systems [16].

The transformation of the traditional agri-food system towards environmental, economic and social sustainability requires a redesign process that can be carried out in a variety of ways, at different levels (techno-productive, socio-ecological and political-institutional), scales (productive farm, landscape and territory) and dimensions (social, biological, economic, cultural, institutional and political) [20].

Principles of transformative innovation

Historically, S&T has played a crucial role in the progress and growth of various socio-economic sectors and activities, such as health, food, transport, communication and energy, making important contributions to the well-being and livelihoods of humanity. Nevertheless, it must be recognised that major environmental and social challenges remain, caused by the economic growth model that has generated environmental impacts through the production of goods with high energy costs, the use of fossil fuels and high levels of waste [21].

The transformative approach to innovation began to gain relevance in the first decade of the 21st century, based on the approach of social and environmental challenges as public policy objectives, which in turn can be strategic drivers of growth and competitiveness in the long term [4,22]. Transformative change requires the design and adoption of sustainable environmental and social innovations, framed within the achievement of the Sustainable Development Goals (SDGs) promulgated by the United Nations (UN), which include eradicating poverty, reducing inequality, combating climate change and promoting inclusive and sustainable consumption and production systems [22].

This new approach to innovation requires profound changes in socio-technical systems, conceived as configurations of social and technical elements that interact, evolve and reinforce each other, and that provide basic services to society such as energy, water, food, transport and health. The transformation or transition of the socio-technical system is a radical change in all elements of the system configuration, not only in technology, but also in skills, infrastructures, products,

regulations, business models, user preferences and even changes in cultural patterns [23].

TI has two central characteristics: the first is that it is a bottom-up process, which means that it is necessary to articulate participatory and inclusive processes, involving not only individuals, groups or entities that have a dominant position within the socio-technical system, but also those who may represent new alternatives, from a variety of backgrounds, such as producers, users, consumers, policy makers and civil society in general [5]. The second characteristic has to do with the diversity of possible alternatives and sustainability paths, which is why it is necessary to promote experimental spaces whose purpose is to test alternatives in order to produce demonstrative prototypes that generate deep or second-order learning and facilitate systemic change [21].

Below is a brief description of the principles of IT as defined in the "Green Paper-2030" [5], with a comparison (Table 1) with the guidelines of the agroecological approach reported in the literature, especially in relation to knowledge management and innovation.

Directionality

A collective process in which different alternatives are considered, making visible the links between them and their social and environmental consequences, in order to guide action towards necessary and desirable changes in the SDGs. It also involves creating shared visions of a sustainable long-term future [21].

Participation

Active linkage and dialogue between different actors for the generation, use and access to knowledge and innovation that contribute to sustainable development; these actors come from different backgrounds, including producers, civil society, users, consumers and policy makers [24].

Learning

Creating spaces and concrete actions that enable processes of reflection on traditional ways of understanding and addressing social, economic and environmental problems for the understanding and analysis of socio-technical systems. First-order learning focuses on improving what actors do, while second-order learning, often associated with "learning by doing", is

considered more transformative because it challenges the rules of the dominant regime and increases reflexivity, trust and the maintenance of new rules among actors [23].

Table 1. Principles of transformative innovation and their correspondence with the agroecological approach

Principles	Transformative approach	Agroecological approach	Reference
Directionality	Achieving the SDGs - in particular: ending poverty, reducing inequality, combating climate change and promoting inclusive and sustainable consumption and production systems	Increasing eco-efficiency, input substitution and system transformation to achieve food security and sovereignty, climate change adaptation and mitigation, income generation and equitable access to economic and natural resources	[5,10,18,20]
Participation	A decision-making process based on collaborative planning, participation and social learning	Establishing adaptive and accountable multi-actor and multi-level governance that supports the development of effective and innovative policies, institutions and markets for transformative change	[6,22]
Learning	First-order learning is based on the accumulation of information and knowledge to solve problems in a specific context, while second-order learning, or 'deep learning', allows one to reflect on the problem itself and challenge assumptions and perceptions about the dominant interpretative framework and worldview	"Bottom-up" process of collective learning about the impacts of practices and risks taken, involving the application of three learning loops. The first seeks incremental and standardized changes in practices to achieve a predetermined goal, the second involves rethinking the goal itself, and the third refers to a profound change in the knowledge, norms and values that underpin the existing governance structure	[5-7,20]
Experimentation	Strategic niche management, understood as small, protected spaces for experimentation and learning (both technological and social and institutional), where transformative technologies are developed to achieve environmental and social benefits	Platforms and co-innovation networks as dynamic participatory spaces, bringing together heterogeneous actors who exchange knowledge and practices (including traditional knowledge with formal scientific knowledge and practices) and work on a common problem through transdisciplinary processes	[21-23,26-28]

Experimentation

Designing and implementing strategies that enable processes of knowledge generation, transfer and acquisition, and sustainable and inclusive innovation [25].

Conclusion

The need to feed a growing world population without compromising the ecological base of rural areas requires the design and construction of socially and environmentally sustainable agri-food systems, for which the transition to production systems with less environmental impact and less dependence on non-renewable resources is an imperative, recognising that agricultural production with an agroecological approach can contribute to sustainable changes in agri-food systems through a radical transformation of production practices, through participatory processes of co-production of local knowledge.

Addressing solutions to the current and future challenges of agri-food systems, in the context of achieving the SDGs, requires a transformative approach to transition management. These transformative changes are achieved by supporting agroecological transition processes that take place in different dimensions and at different scales, in a complex process of holistic, participatory, transdisciplinary and territorialised knowledge management and innovation, based on the redesign of agricultural systems through the development, dissemination and adoption of technological, social and institutional innovations.

For the CTel policy, it is essential to give relevance to the processes of "democratisation" of knowledge and innovation, which include elements such as: the orientation of transformative innovation towards the achievement of the SDGs, the recognition of the role of social innovation in rural territorial development, the importance of the agroecological transition of production systems, and the processes of collective construction of knowledge and innovation, as they can be practical approaches that leverage this public policy approach.

Consent for publication

The author read and approved the final manuscript.

Competing interest

The author declares that he has no competing interests. This document reflects his views only and not those of the institution to which he belongs.

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