KEY CONCEPTS OF AGROECOLOGY SCIENCE. A SYSTEMATIC REVIEW

[CONCEPTOS CLAVE DE LA CIENCIA DE LA AGROECOLOGÍA. UNA REVISIÓN SISTEMÁTICA]

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SUMMARY

A systematic review was conducted with the objective of determining the key concepts that are currently used in theoretical work in agroecology. They were obtained from titles and keywords of theoretical articles and books that included the term agroecology in the title. Fifteen terms with occurrences higher than three were obtained. They show that agroecology revolves around the concept of integral sustainability, and that there is agreement on neither its object of study nor goal. As a result, most key concepts concern the object of study or the goal of agroecology. Other key concepts are food sovereignty, agriculture, ecofeminism, climate change, family farming, and social movements.

Keywords: agroecosystems; sustainable agriculture; scientific concepts; sustainability.

RESUMEN

Se realizó una revisión sistemática de la literatura científica con el objetivo de determinar los conceptos clave que se están utilizando actualmente en los trabajos teóricos de agroecología. Las palabras clave fueron obtenidas de los títulos y las palabras clave de artículos teóricos y libros que incluyeron el término agroecología en el título. Se obtuvieron 15 términos con más de tres apariciones. Esto evidencia que la agroecología gira alrededor del concepto de sostenibilidad integral, y que no existe acuerdo tanto sobre su objeto de estudio como sobre su objetivo. Como resultado, muchos de los conceptos clave encontrados se relacionan con el objeto de estudio o el objetivo de la agroecología. Otros conceptos clave son soberanía alimentaria, agricultura, ecofeminismo, cambio climático, agricultura familiar y movimientos sociales.

Palabras clave: agroecosistemas; conceptos científicos; agricultura sostenible; sostenibilidad.

INTRODUCTION

Kuhn (2004) defined a mature science as one that has a theory widely shared by its practitioners. Following this criterion, recent reviews have shown that agroecology has not consolidated yet. For instance, a recent review by Wezel and Soldat (2009) showed that there are currently three widely accepted objects of study in this science -the plot or field, the agroecosystem, and the food system, and Salas-Zapata et al. (2011) have recently proposed a new one, namely the socioecological resilience of agroecosystems. Also, Dalgaard et al. (2003) have pointed out that there are two different approaches in agroecology depending on whether an agroecosystem is conceived as an ecological or a social system. Similarly, Toledo (2012) writes that scholars in Spain have distanced itself to the habitual conception of agroecology as 'the ecology of

crops or agricultural systems' or 'the application of ecology to artificial ecosystems'.

Many scholars have shown that a mature science also comprises a set of concepts that are shared by its group of practitioners (Barrington, 1997; Gerring, 1999). This is of particular importance for agroecology for three reasons. First, several authors have pointed out that agroecology diverges from conventional science (Gomes and Rosenstein, 2000; Lima, 2007; Norgaard and Sikor, 1995). This means that it requires a new terms or a resignification of old ones, so they must be explicitly laid out and discussed. Second, agroecology is a transdisciplinary science (Francis et al., 2008; Méndez et al., 2013; Ruiz-Rosado, 2006). On the one hand, this entails terms from different disciplines that need to be articulated in a coherent way. On the other hand, disciplines might use the same term to refer to different concepts, like 'development' in biology and economics, so they need to be clarified in order to avoid possible misconceptions. Third, a clear set of concepts allow scholars to determine possible paths, divisions, or schools within a discipline, like the introduction of language concepts into ethics that showed the existence of a 'linguistic turn' (Hare, 1999).

Nevertheless, agroecologists have paid a little attention to developing a clear set of the key scientific concepts of their science. For instance, renowned textbooks like Altieri (1995) or Gliessman (2007) do not include an explicit formulation of key concepts as neither do more recent texts like Altieri and Nicholls (2005) nor León (2014). For his part, Wojtkowski (2006) presents 'agricultural plants', 'agroecosystems', and 'agrotechnologies' as the fundamental "agroecological concepts", while Martin and Sauerborn (2013) mention as basic terms 'agroecology', 'ecology', 'organism', 'species', 'population', 'environment', 'abiotic factor', 'biotic factor', 'resource', 'ecological niche', 'ecosystem', 'biotype', 'habitat', 'agroecosystem', 'food crop', 'beverage', 'stimulant', 'medicinal plant', 'spice plant', 'fodder plant', and 'raw material'. From these two texts, it can be seen that there is not a consensus of what are the basic concepts of agroecology, let alone which ones constitute key scientific concepts. Furthermore, agroecology textbooks are arranged in different fashion, making it difficult to determine an unambiguous set of key concepts or terms.

Due to the above, we consider that a systematic review of the key concepts of agroecology would provide valuable information to the consolidation of this science since it would point out the terms and concepts that guide its empiric research. The objective of this study was to determine from agroecology journals, books, and global repository databases the key concepts that are currently used in theoretical work in agroecology. The results of this review could help further discussions on the present state of agrecological theory.

Theoretical frame

Most of scientific language is made of *terms*, i.e. a noun or noun phrase that is publicly regulated by the explicit introduction of a predicate. A *concept* is the meaning of a term (Seiffert, 1977). Concepts can be organized into different types. First, a scientific concept denotes a component of that portion of the world that a particular science has concurred to explain (Jones, 1990). In other words, *scientific concepts* refer to *what* a particular science observes, studies, and explains. Then there are *methodological concepts*. They denote the tools a science uses to observe, study, and explain a portion of the world. Thus, they deal with *the means* to obtain knowledge. Third, there are *epistemological concepts*. They are concerned with *how* knowledge is gathered and presented. Epistemological concepts refer to the scientific practice and not to its object of study like scientific concepts do. Last, *classifying concepts* denote divisions inside a science like analytical chemistry, organic chemistry, inorganic chemistry. They refer both to the world and the field but they highlight those concepts that a science has deemed pivotal to understand the world.

In addition, not all concepts have the same importance in a theory. For instance, Edel (1945) defines 'key concept' for philosophical theory as a notion which occupies a privileged position for it gives meaning to the whole system as well as it serves as a watchword. Similarly, in ontology learning a key concept is associated to documents. It is defined as an element that describes the text which it is associated with and conveys the primary information of it. Ontology learning asserts that key concepts are always expressed as *noun phrases*, i.e., a single noun of a group of words that work together as a noun (Kang et al., 2014). Thus, a key scientific concept can be understood as any concept that pervades a scientific theory or text and turns it unintelligible if it is unknown.

MATERIALS AND METHODS

Search strategy

A search was conducted in five databases, Academic Search Complete, Jstor, Dialnet, ScienceDirect, and SpringerLink from 2005 to May 2015. In addition, theoretical articles and conference proceedings regarding theoretical aspects were searched in two specialized journals, Revista Brasileira de Agroecologia, and Agroecologia. Since both journals were created after 2005, all volumes were surveyed.

Further searches included books with the word 'agroecology' in the titled in Amazon, Google, and local libraries. Papers, conference proceedings and books in Spanish, English, and Portuguese were included.

Inclusion criteria

Only theoretical papers, books, book chapters, and conference proceedings were considered. Papers in the databases and books had to have the word 'agroecology' in the title. For edited volumes, chapters regarding study cases or focusing on a specific region were not included.

Data extraction and analysis

For papers and conference proceedings, terms were collected from the titles and keywords. Since the objective was to determine in the importance of a concept, when a term was included both in the title and the keywords of a single paper or conference proceedings, it was counted once. For authored books, section, title and chapter titles were considered. Also terms under 'agroecology concepts', 'main concepts', or similar headings in a chapter were included. For chapters in edited books, only the titles of both the chapters and the book were taken into account. Then, the terms found were looked up in the theoretical papers to check they are recurrent.

The selection of key terms was done by occurrence, a criteria widely used in text analysis (He and Jiang, 2007; Kang et al., 2014). Since a concept can be represented by several terms, a throughout analysis of the terms found was conducted in order to determine possible synonyms and new recurrent concepts.

RESULTS AND DISCUSSION

56 theoretical articles that met the inclusion criteria were found. They were complemented with 53 chapters from eight edited books, and four authored books, totaling 113 texts. 311 noun phrases were obtained, but most of them (281) appeared once or twice. Fifteen noun phrases showed up four or more times, and there were thirteen noun phrases that appeared three times. Fourteen of the fifteen most frequent noun phrases (see table 1) refer to scientific concepts that can be sorted into three categories depending on the function they have within the scientific field: delimiting, guiding, and explicative. However, some of them may carry different functions, depending on the authors. The remaining term can be seen as a methodological concept.

Delimiting concepts set the boundaries of agroecology or what it ought to study, i.e. the object of study. Agroecosystem, food system, and socioecological resilience have an occurrence of six, four, and four, respectively. The agroecosystem is acknowledged as the object of study of agroecology by authors affiliated to The United States, Europe, and Latin America –including Brazil-. On the contrary, food system is not mentioned in any paper written in Portuguese, being embraced as object of study mainly in The United States and Europe, including Spain. Sociological resilience is included in the title of two theoretical articles, one book chapter, and one authored book. The sociological resilience of agroecosystems as object of study is accepted in two texts (Álvarez-Salas et al., 2014; Ríos-Osorio et al., 2013), restricting this sense to authors affiliated to Colombia. The other paper (Altieri and Nicholls, 2012) and chapters in the edited book give it an explicative function keeping the delimiting function to the agroecosystem concept. (Table 1).

There is not a clear concept behind the term agroecosystem. For instance, Gliessman (2007) writes "an *agroecosystem* is a site or integrated region of agricultural production –a farm, for example- understood as an ecosystem", but he defines an ecosystem as "a functional system of complementary relations between living organisms and their environment", and he adds "an ecosystem thus has physical parts with particular relationships –the *structure* of the system- that together take part in dynamic processes –the *function* of the system". Here, an agroecosystem is understood both as a processual system and a physical entity. Similarly, Ríos-Osorio et al. (2013, p. 62) point out that "an agroecosystem comprises not only the agricultural system and the physical space where production takes place, but resources, climate, soil, infrastructure, economical relations, institutions, social structure, stakeholders, and the history of the system". Regarding this, Nieto et al. (2013) assert that agroecosystem is a concept that is still epistemologically unclear since its "theoretical limits" are yet to be set.

Food system is an imprecise concept as well. Gliessman (2007), one of the most renowned supporters of this approach, gives an explicit definition of 'sustainable food system' but he does not provide one for food system. The former gives an idea what demands must be met in order to deem a food system sustainable, but it does not really express what it consists of. Gliessman writes that a food system comprises all aspects of food production, distribution, and consumption, but does not formalize it into an explicit definition. Wezel and David (2012) do not provide a clear definition either, but they point out that "it is still difficult to outline clear concepts" within the food systems approach

Table 1. Frequency of concepts found in the different kind of texts reviewed

Concept	Article Title	Chapter Title	Book Title	Key words	Total
Food sovereignty	4	5	2	1	12
Sustainable agriculture	1	3		5	9
Sustainability	6			2	8
Agriculture‡	1	5		1	7
Climate change	1	4	2		7
Agricultural system	1	4	1	1	7
Agroecosystem	1	5			6
Resilience	1	4			5
Family farming	1			3	4
Food system		3		1	4
Scientific paradigm	1			3	4
Social movement		1		3	4
Sustainable development	1			3	4
Socioecological resilience	1	2	1		4

Plot or field is not mentioned in the title or keywords of the texts studied. Although Wezel and Soldat (2009) set them as one of the objects of study of agroecology, which lead other authors to mention it as well (Martin and Sauerborn, 2013), it is unclear that either of them is still explicitly placed as object of study of agroecology. As mentioned before, farms are seen as a form of agroecosystem by Gliessman (2007). Also, León (2014) explicitly sets the agroecosystem as the object of study of agroecology while sets farm, plot, and field as types of agroecosystems or "analysis units". Furthermore, he asserts that those terms have regularly been used by agroecologists as forms of agroecosystems, contesting the idea that they designate a complete different concept from agroecosystem as does food system.

Guiding concepts establish the goal of a scientific field. Like the object of study, there is not a consensus on the goal of agroecology. Both sustainable agroecosystems and food systems have been proposed as the goal of agroecology, as well as sustainable agriculture, sustainable development, and sustainable rural development. Nonetheless, sustainability is at the core of the goal of agroecology. Indeed, it is the term with the third highest occurrence in titles and keywords, and it shows up in fifty-one out of the fifty-six theoretical articles retrieved. Sustainability is a political concept. It was introduced into the scientific world in the eighteenth century, but it became of common use after the emergence of the term sustainable development in a United Nations report in the late 1980s (Scoones, 2007). This make its regulation highly problematic, but agroecologists seem to agree that the sustainability they seek is integral, i.e. a process that comprises ecological, economical, and social variables and demands (Gliessman, 2007; Martin and Sauerborn, 2013; Videiro and Freire, 2010) (Table 1).

The most recurring guiding concept is *sustainable agriculture* with a total occurrence of nine (table 1), while sustainable development had a frequency of four. It was proposed by several scholars as the goal of agroecology (Funes-Aguilar and Monzote, 2006; Raza et al., 2012; Rocha and Siman, 2007), but there is not a clear idea of what the concept of sustainable agriculture entails. For instance, Cox (2014a) uses it as a synonym of alternative agriculture and agroecology. This might be explained by the fact that the term agroecology also refers to a practice (Wezel et al., 2009), so Cox uses it to refer not to the science of agroecology but the practice, assuming it necessarily implies sustainable ways of agriculture. Also, some authors mention the need to include variables that have usually been dismissed like 'gender equality' or 'meaningful work' (Papuccio, 2007; Timmermann and Félix, 2015). Nevertheless, there is a consensus that agroecology sees ecology and welfare of rural communities as the foundation of agricultural sustainability (Funes-Aguilar and Monzote, 2006; Gliessman, 2007; González, 2011).

Explicative concepts are those a scientific theory uses to give sense to the world. *Food sovereignty* is the most repeated single term throughout the texts studied (table 1). It showed up in the title of four papers, five chapter titles, and two book titles, as well as a keyword of one paper. Furthermore, it appears in other twenty theoretical articles (42.86% of all articles), showing it is a recurring term among agroecology texts. Like sustainability, it is more a political than a scientific concept, confirming Toledo (2012) and Dalgaard et al. (2003) observation that there is a social approach within the agroecological discourse.

Agroecology keeps the meaning of food sovereignty given by La Via Campesina, the social movement that coined the term in 1996 (Cuéllar and Sevilla, 2013; Rosset and Martínez-Torres, 2012). Though there are both broader and more concise definitions, food sovereignty has been understood by agroecology as "the right of people to produce, distribute, and consume healthy food, near to their territory in an ecologically sustainable way" (Altieri and Nicholls, 2012). Thus, food sovereignty can be seen as a concept closely tied to the kind of sustainability agroecology seeks to achieve.

Three terms had a frequency of seven, namely agriculture, agricultural system, and climate change. Agriculture is the most recurring in theoretical articles. It showed up in fifty-three out of the fifty-six papers retrieved. Most authors do not define it, but it seems there is implicit agreement among agroecologists that it is a complex socioecological system that includes both plant and animal production (Gliessman, 2007; Méndez et al., 2013; Sevilla and Woodgate, 2013). Thus, agroecology detaches itself form conventional agronomical conception that agriculture is an economic activity that does not include livestock. Nonetheless, Cox (2014b) points out that agroecology has not been able to abandon the conventional modern worldview yet. According to him, to do so, agroecology still needs to embrace a conception of agriculture that grants its dialectical interaction with the biosphere and sees it as a system that comprises religious, moral, philosophical, and practical arts.

Agriculture as a process that can be achieved in different ways is an important part of this concept within agroecology. As a result, agroecologists have indicated that there are several types of agriculture. Among them, family farming is the most mentioned in the titles and keywords, with an occurrence of four, being a key scientific concept. Closely, organic farming appears three times. Other forms of agriculture are also mentioned in titles and keywords, but with a lower frequency, such as traditional farming, conventional agriculture, and peasant agriculture.

Family farming is defined by Ricardio (2011) as "agriculture practice in small land areas by family units". As a result, it is determined by a scale and not by knowledge or technology, allowing different form of epistemologies such as conventional or agroecological. Thus, family farming does not necessarily imply sustainable agricultural practices or a traditional background. Indeed, this author writes that family farming can be capitalist, traditional, or agroecological.

There is not an explicit definition of agricultural system, but most scholars use it as a synonym of agroecosystem (Gliessman, 2013; Griffon, 2008; Rocha and Siman, 2007). Nonetheless, Ríos-Osorio et al. (2013) differentiate between them. They write "agroecosystem comprise agricultural systems and their interactions with social and ecological systems". For their part, other authors use it as a synonym of agriculture, something that makes it an unregulated predicate in agroecological discourse (Leal and Mesquita, 2008; Vandermeer, 2013).

The frequency of the term *climate change* indicates the growing concern about this issue among agroecology. Indeed, two edited books addressing this topic have been published (Lichtfouse, 2012; Nicholls et al., 2013). This concept is closely tied to sustainability of both agriculture and agroecosystems, particularly to the concept of resilience. The latter has become a key concept in agroecological literature as well (see table 1). Most authors consider it an attribute of sustainability, but León (2014) presents it as one of the key features of agroecosystems. There is a consensus that resilience is understood within agroecological theory as the ability of a system to resist external disturbances without compromising its organization, whether it refers to sustainability or to agroecosystems.

Two other scientific concepts have an occurrence of four: *social movements* and *scientific paradigm*. Authors do not provide a definition for the former but mention several examples that are of interest for agroecology. Though it can be considered a key scientific term since it appears in the title of a book chapter and as a keyword in three theoretical papers, it can also be seen as an indicator of growing concern about social aspects in agroecology. Indeed, the word 'social' appears in fifty-two out of the fifty-six theoretical articles assessed. This confirms Dalgaard et al. (2003) observation that there are two conceptions of agroecology, but refutes Toledo's (2012) who restricts a social approach to Spain. Certainly, there are still several theoretical publications like Nicholls (2006), Weiner et al. (2010), Griffons (2008), or Lemanceau et al. (2015) that show that there are theoretical works that do not span beyond ecology and agronomy.

Scientific paradigm is a concept, alongside *scientific knowledge*, that has been crucial in agroecological theory to understand conventional and industrial agriculture, and to establish the difference between agroecology and agronomy since the 1990s. There have been a couple of attempts to describe what conventional science consists of (Gomes and Rosenstein, 2000; Norgaard and Sikor, 1995), but texts assessed do not provide a thorough analysis of conventional scientific knowledge. They use it to differentiate it from other kinds of knowledge like peasant, local, and indigenous (Gliessman, 2007; Videiro and Freire, 2010), or to show some of its particularities (Pérez and Soler, 2013).

The only methodological concept with a high frequency is *ecofeminism*, which showed an occurrence of six. Zuluaga (2014) defines it as a philosophical approach and a political movement that uncovers the connections between gendered social and environmental dynamics. Thus, ecofeminism is an epistemological tool that comprises several concepts, instead of a single concept or a part of the world. For example, it comprises the concept of 'gender', which is defined as "a category of analysis that allows social sciences to interpret traits and differences between men and women as well as relations among them and them and their natural and social environments" (Papuccio, 2007).

Ecofeminism is a kind of feminism, and both concepts are found in agroecology theory. Cox (2014b) and Calle et al. (2013) who use neither ecofeminism nor feminism in title or keywords mention them in their texts. Also other ten theoretical articles deal with gender issues without mentioning the terms feminism or ecofeminism. Though gender concerns are getting attention, feminism and ecofeminism are not methodological concepts widely used in agroecology. Indeed, scholars who talk about these terms are mainly from Latin America and Spain, except Bezner (2008), whose country of affiliation is the United States.

Only *agroecosystem* had a high occurrence from the key concepts proposed by Wojtkowski (2006) and Martin and Sauerborn (2013), so they cannot be considered representative within the field. For instance, Martin and Sauerborn included 'medicinal plant', but clearly agroecology has focused on food crops, so it cannot be expected to be a recurring term in its texts. Indeed, only four articles mention medicinal plants (Funes-Aguilar and Monzote, 2006; González, 2011; Sámano, 2013; Timmermann and Félix, 2015), and they do it neither in title nor keywords. This shows that there is a strong bias towards food production, particularly in the food systems approach. Nonetheless, terms like 'ecology' or 'food crops' might appear if clustering concepts are considered, i.e. terms that are not actually used regularly, but they group under a general concept a wide range of terms.

It is important to conduct additional studies about the theory of agroecology. For instance, not all agroecological texts are labeled as such or have this word in their title, so other texts need to be included, specially original articles that can lead to determine key empirical concepts that might not be frequent in theoretical texts. Additionally, research conducted with software there that finds clouds of terms, i.e. words that frequently appear together, can be very helpful in determining the core of agroecology theory. Also, key concepts and terms need to be discussed and thought further so sound definitions that take into account current discussions and divergences can be proposed.

CONCLUSION

Most key concepts in agroecology are not regulated, so there is still a need for canonical meanings. They revolve around the concept of integral sustainability, which has social, economic, and ecological dimensions. Since there is not a single goal or object of study, agroecosystem, food system, sustainable agriculture, sustainable development, and rural development are pivotal to its theory. Other key concepts are food sovereignty, ecofeminism, climate change, social movements, family farming, and agriculture.

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