Revista Brasileira de Agroecologia

Brasília, v. 19, n. 4, p. 395-421, 2024
https://doi.org/10.33240/rba.v19i4.55450

Diversity and location: key elements to the production of agroecological technical novelties by smallholders

Diversidade e localidade: elementos chaves para a produção de novidades técnicas agroecológicas pelos/as agricultores familiares

Diversidad y localidad: elementos claves para la producción de novedades técnicas agroecológicas por parte de agricultores familiares

Pauline Hélène Cécile Marie Cuenin[1], Marcelo Leles Romarco de Oliveira[2], Maria Izabel Vieira Botelho[3], Leonardo Van den Berg[4], Irene Maria Cardoso[5]

[1] Master in Rural Extension from the Federal University of Viçosa/Brazil. Agricultural engineer, Paris, France. ORCID 0000-0002-5556-4861 and e-mail: pauline.cuenin3@gmail.com.

[2] Full Professor of the Post-Graduate Program in Rural Extension at the Department of Rural Economics; Federal University of Vicosa UFV, Viçosa, Brazil. ORCID 0000-0003-2746-8407 and e-mail: marcelo.romarco@ufv.br

[3] Former Professor at the Department of Rural Economics, Federal University of Viçosa UFV, Viçosa, Brazil. ORCID 0000-0002-8675-000X and e-mail: izabel.vieira.botelho@gmail.com.

[4] Knowledge, Transformation and Society Section at the University of Twente, Enschede, Netherlands. Orcid 0000-0003-3371-6294 and e-mail: l.vandenberg@utwente.nl

[5] Former Professor at the Soil Science Department, Federal University of Viçosa UFV, Viçosa, Brazil. ORCID 0000-0001-9819-0911and e-mail: irene@ufv.br.

Recebido em: 09 set 2024 - Aceito em: 31, out, 2024

Abstract

The institutionalization of the industrial agriculture regime weakened the potential of novelty production by smallholders. Novelties here are understood as specific types of innovations, necessary to find solutions to the current multifaceted agricultural crises and to move towards more sustainable agrifood systems. The objective of this article is to understand how the different approaches to Agroecology support the experimentation processes of technical novelties by smallholders. To reach this goal, participatory observation and semi-structured interviews were carried out with smallholders in the Zona da Mata of Minas Gerais. Biodiversity was identified as an important factor that enables experimentation and creation of agroecological technical innovations. The ability to adapt to the biophysical environment and the daily observations made by smallholders are key elements. Diversity and location, both fundamental components of Agroecology, have proved essential in stimulating the creative capacities of smallholders.
Keywords: Agroecology, experimentation processes, creativity, novelty production.

Resumo

A institucionalização do regime agrícola industrial enfraqueceu o potencial de produção de novidades pelos/as agricultores familiares. As novidades são entendidas como tipos específicos de inovações, necessárias para encontrar soluções para as crises agrícolas multifacetadas atuais e para avançar em direção a sistemas agroalimentares mais sustentáveis. O objetivo deste artigo é compreender como as diferentes abordagens da Agroecologia contribuem para apoiar os processos de experimentação de novidades técnicas pelos/as agricultores familiares. Para atingir esse objetivo, foram realizadas observação participante e entrevistas semiestruturadas com agricultores familiares da Zona da Mata mineira. A biodiversidade foi identificada como um importante fator que permite a experimentação e a criação de inovações técnicas agroecológicas. A capacidade de adaptação ao ambiente biofísico e as observações diárias feitas pelos/as agricultores familiares são elementos-chave. A diversidade e a localidade, componentes fundamentais da Agroecologia, revelaram-se essenciais para estimular as capacidades criativas dos pequenos agricultores.
Palavras-chave: Agroecologia, processos de experimentação, criatividade, produção de novidades.

Resumen

La institucionalización del régimen agrícola industrial debilitó el potencial de producción de novedades por parte de los agricultores familiares. Las novedades se entienden como tipos específicos de innovaciones, necesarias para encontrar soluciones a las multifacéticas crisis agrícolas actuales y avanzar hacia sistemas agroalimentarios más sostenibles. El objetivo de este artículo es comprender cómo los diferentes enfoques de la Agroecología ayudan a apoyar los procesos de experimentación con innovaciones técnicas por parte de los agricultores familiares. Para lograr este objetivo, se realizaron observaciones participantes y entrevistas semiestructuradas con agricultores familiares de la Zona da Mata en Minas Gerais. La biodiversidad fue identificada como un factor importante que permite la experimentación y la creación de innovaciones técnicas agroecológicas. La capacidad de adaptación al entorno biofísico y las observaciones diarias realizadas por los agricultores familiares son elementos clave. La diversidad y la localidad, componentes fundamentales de la Agroecología, resultaron esenciales para estimular las capacidades creativas de los pequeños agricultores.
Palabras-clave: Agroecología, procesos de experimentación, creatividad, producción de novedades.

INTRODUCTION

In contrast to the growing process of nature artificialization over the last 100 years, the process of sociocultural and ecological coevolution has been the basis of agriculture for more than 10,000 years (Caporal; Costabeber, 2007).

Over the centuries, ways and styles of coexistence with nature have been built by different human cultures, which have been expressed in the constitution of diverse knowledge, techniques, organizational forms and production methods (Alimonda, 2011; Costa, 2017). Generations of smallholders have developed complex farming systems, diversified and adapted to local conditions, which have improved over time (Altieri; Toledo, 2010).

However, with the institutionalization of the conventional model of industrial agriculture called “modern agriculture”, which became known as the Green Revolution in developing countries after World War II, farmers were increasingly disconnected from their agricultural "grammar" which defined the trajectories for the development of their production systems (Van der Ploeg *et al*., 2004). Oriented by modernization standards, location and diversity, both historically structural elements of agriculture, were replaced by other elements (Van der Ploeg, 1993; Van der Ploeg *et al*., 2004) such as monoculture, chemical pest control with the use of pesticides, and manipulation of the plant genome *etc*.

In fact, the current reigning sociotechnical regimes impose “capital-intensive” rules and technologies (Costa, 2017; Lacey, 2014) to be used by the farmers, depreciating their knowledge. Moreover, agricultural systems are specializing, which leads to a loss of biological and cultural diversity (Caporal; Costabeber, 2007). As a result, the creative capacities of smallholders have been weakened, which also altered the historical capacity of smallholders to produce novelty (Van der Ploeg *et al*., 2004).

Novelties are the result of territorialized and/or contextualized knowledge of smallholders that are internalized to the production unit (Van der Ploeg *et al*., 2004; Oliveira *et al.*; 2011). According to these authors, considered as a deviation and, sometimes, a break with existing routines, novelties can be considered to be a specific type of innovation, that break with the rules and standards of the dominant regime based on codified knowledge. In this way, novelty can be a useful concept for rethinking the traditional approaches of technical progress (Van der Ploeg *et al.*, 2004; Van der Ploeg *et al.*, 2014; Oliveira *et al.,* 2011). Thus, the novelty production approach allows for the consideration of new alternatives for sustainable innovation processes that honors the creative capacities of smallholders, in contrast to the diffusionist and pragmatic visions of innovation related to agricultural modernization and the agro-industrial model.

The concept of novelty production is also a useful concept for finding new solutions to the current multifaceted agricultural crises, to move towards more sustainable agrifood systems. The novelties are associated with the emergence of new forms of agriculture (Ventura; Milone, 2004) and are considered to be “the seeds of transition” (Wiskerke; Van der Ploeg, 2004) to more sustainable forms of agriculture, which can them be linked to Agroecology (Wezel *et al.*, 2009).

Agroecology is understood as a "scientific, theoretical, practical and methodological approach, based on different areas of knowledge” (ABA- ASSOCIAÇÃO BRASILEIRA DE AGROECOLOGIA, 2015) and is based on complex and specific innovation processes (Tourdonnet; Brives, 2018). In Agroecology, the conceptual and methodological approaches enhance the creative capacity of smallholders and highlight the importance of “bottom up” innovation processes initiated by farmers (Altieri; Toledo, 2010; FAO, 2015; Nodari; Guerra, 2015; Touzard, 2018). The elements of the innovation processes in Agroecology are principally based on nature, territory, diversity, knowledge and actors (Meynard, 2017; Tourdonnet; Brives, 2018). In this process, smallholders produce novelties based in nature and in their day-to-day life experience. Therefore, to produce novelties, the links between nature and human beings is of great importance.

The use of collective participation methodologies and learning (like farmer-to-farmer exchange) in different environments and in the agroecological network is essential for the production of novelties, but they were not the focus of this article. Our research focused on the processes of experimentation that leads to technical novelties produced by agroecological smallholders. We aimed to identify and characterize technical novelties and analyze how the different conceptual and methodological approaches of Agroecology support and promote experimentation with technical novelties by smallholders in agricultural systems.

METHODOLOGY

Area of study: Zona da Mata of Minas Gerais

The research was conducted in the Zona da Mata region, located in the Atlantic Forest biome, in the southeast of the State of Minas Gerais, Brazil, because of the region's tradition associated with Agroecology (Cardoso; Ferrari, 2006), which will be developed below. The Zona da Mata region was officially recognized by the State of Minas Gerais as an Agroecological and Organic Production Centre, in accordance with the State Law No. 23.207 of 2018 (Minas Gerais, 2018).

The Zona da Mata was originally completely covered by forest, which gave the region its name (Netto; Diniz, 2005), and was inhabited by indigenous peoples (Valverde, 1958). With the Portuguese colonization in the 18th century, and the intensification of mining in a region nearby, some rural properties were installed (Soares, 2009; Valverde, 1958). In the mid-19th century, with the decline of mining, large and medium-sized landowners, based mainly on slave labor, settled in the Zona da Mata when the coffee cultivation expanded from the south to the center and north of the region (Soares, 2009). After the abolition of slavery in 1888, new arrangements of using labor in the coffee plantations were established, among them, sharecrops and daily workers (Comerford, 2001; Valverde, 1958). With these new work arrangements, especially the sharecrops, the landowners allowed the consortium of other crops, such as corn and beans, with coffee plantations (Comerford, 2001; Soares, 2009) and contributed to the establishment of smaller and more diversified peasant units in the region.

The clearing of vast areas of forest for coffee production without adequate conservationist techniques or soil management, lead to the rapid decline of coffee productivity (Netto; Diniz, 2005; Soares, 2009). This caused the decline of the coffee economy in Zona da Mata at the end of the 19th century (Soares, 2009), which was accelerated in 1930, by the federal government's policy of coffee plantation eradication (Netto; Diniz, 2005).

In the years 1960-1970, with the process of agricultural "modernization", the Federal Government financially, and technically, supported the coffee sector's recovery with the reintroduction of coffee plantations, using the technological package of the so-called

Green Revolution (Cintrão, 1996). Over time, the use of these modern technologies and intensive practices, not suited to the environment, led to an even greater deterioration of the soil quality and economically weakened the smallholders who adopted the Green Revolution packages (Botelho *et al*., 2016).

The problems faced by the smallholders contributed, at the end of the 1970s, to the formation of the Boa Nova Movement (MOBON) in the eastern region of Minas Gerais. The MOBON was guided by Liberation Theology, mainly from the Catholic Church (Oliveira; Zangelmi, 2009), and supported the creation of the Basic Ecclesial Communities (CEB) (Comerford, 2001), which started nationally in 1975. That same year, the Pastoral Land Commission (CPT) was created nationally. In the early 1980s, the CPT and the CEBs started to develop, with smallholders, alternatives for agriculture in response to the economic, social and environmental impacts of the Green Revolution model (Botelho *et al*., 2016; Schmitt, 2016). CEBs and CPT also promoted political discussions that, after the re-democratization of the country (1985), allowed for the creation of Rural Workers' Unions (STRs) in some municipalities of the region (Botelho *et al.*, 2016; Comerford, 2001; Schmitt, 2016).

In 1987, in partnership with the Unions, the Center for Alternative Technologies of Zona da Mata in Minas Gerais (CTA-ZM) was created, which initially promoted alternative agriculture, and later, Agroecology (Botelho *et al*., 2016). Since the beginning, some staff of the Federal University of Viçosa (UFV) collaborated with CTA-ZM and Unions (Schmitt, 2016).

As a result of this trajectory of interactions between these different actors, in 2008, the agroecological *Intercâmbios*, similar to the peasant-to-peasant methodology (Hocdé *et al.,* 2000; Rosset; Martínez-Torres, 2012), started in the region. The agroecological *Intercâmbios* aim to create an environment of agroecological interaction and co-creation of knowledge, where smallholders, students, technicians, and teachers have the opportunity to horizontally learn from and teach each other, facilitated through participatory methodologies and popular education (Zanelli; Silva, 2017). These exchange spaces and the structures involved (STRs; CTA; UFV *etc*.) play a major role in facilitating the exchange of knowledge and the creation of innovative solutions for the families involved. This was examined in a more comprehensive study, but is not the focus of this article.

Methodological procedures

Primary and secondary data were collected and analyzed. For the collection of secondary data, a documentary analysis was carried out using available materials such as these: dissertations, academic articles, communication leaflets about agroecology techniques used in Zona da Mata, and reports from the agroecological *Intercâmbios* carried out in Zona da Mata prepared and made available by the CTA-ZM and UFV, from 2008 to 2013. This first phase identified the main innovative techniques that are developing in the region.

For the collection of primary data, the first step was to identify smallholders considered as innovators; innovators are smallholders who "develop or test new ideas without being asked by any external agent" (Gonsalves *et al.*, 2006). For this, the researchers used key informants (CTA technicians, UFV teachers, smallholders' organizations *etc*.) who have pointed to certain farmers considered as creative and who like to try new techniques.

Moreover, the researchers participated in agroecological *Intercâmbios* and decided to focus on the smallholders who are regular participants of these *Intercâmbios*. Twenty-four families were identified, which included 42 smallholders with different characteristics and origins. Most of these farmers called themselves agroecological smallholders and/or have participated actively in the agroecological movement for a long time. From 2017 to 2018, field research was conducted on farms.

For data collection, the following techniques were used:

- Semi-structured interviews: 14 semi-structured interviews were carried out with smallholders, using a simple initial script to inquire about the smallholder's perspective regarding nature, Agroecology and the reasoning behind their production of novelties. The interviews were recorded, transcribed and analyzed as qualitative data.
- Furthermore, as Triviños (1987) indicates, to complete the interviews, sometimes researchers need to prepare drawings, plans *etc*. for illustrative purposes. In this research, the interview was associated with a dynamic survey of techniques experimented by the

smallholders, similar to the dynamic created by the related researcher, in order to facilitate the survey of techniques and their characteristics without using a closed-question questionnaire. It allows us to emphasize the purpose of the experimentation, material and immaterial resources used, as well as the degree of observation involved in the experimentation process. This characterization of the technical novelties serves as a basis for quantitative analysis.

From the interviewed families, five families with a high degree of creativity and experimentation were chosen for further study via participation in their daily farming activities. For one to three days, according to the availability of the farmers, the main researcher spent time in the smallholder's farm dialoguing, sharing and helping with the work in the fields. During the time spent in each farm, a cross-sectional walk was also carried out to observe the environment (Verdejo, 2011) to complete information about the techniques and their experimentation processes, collected in the first two stages.

All this provided an opportunity for participatory observation and for a deep insight about the research subjects. As part of the participatory observation, both structured and free observation were used. Structured observation allows for the identification of practices that were already known. Forms of quantification were used, such as the presence or absence of some practices, or scales to estimate the degree of occurrence of certain uses. Free observation allowed for the observation and characterization of the biophysical environment of the farms, the activities at the farms (Alves-Mazzotti, 2002) and for the free observation of behaviors, aiming to describe and understand more fully what was occurring in the studied context (Alves-Mazzotti, 2002; Triviños, 1987). Notes were taken about dialogues, actions, physical environment, activities, reflections and feelings related to these daily activities (Triviños, 1987).

Qualitative data from the semi-structured interviews and observations was analysed, starting with content analysis using thematic categories, providing a simplified representation of the raw data. The thematic categories were identified throughout the analysis, considering the annotations, observations and information from the secondary data: within this process, which is called the "collection" procedure, the category system is a result of analogy and progressive classification of elements (Bardin, 2013). The following thematic categories were used: daily practices, observation of nature, implicit experimentation processes during the service, and adaptation of the techniques used to local conditions. For the quotes in this article, the farmers were identified by the initials of their names, age and if female (F) or male (M).

For the quantitative analysis of the information collected, a matrix was developed, listing the different identified technical novelties and their characteristics (type of technique, purpose of the technique, material resources used, degree of observation involved in the experimentation process *etc*.). The identified novelties were sorted into different categories based on the Ministry of Agriculture's agroecological brochure, which provides technical information on relevant technologies within the agroecological and organic production systems (Ministério da Agricultura Pecuária e Abastecimento, 2016). These different novelties were characterized according to the needs in the agricultural production process and the related type of technique. A quantitative analysis (descriptive statistics) of the data collection matrix was also carried out (calculations of the number of occurrences to form frequency classes).

RESULTS AND DISCUSSION

Biodiversity leads to technical diversity

In our study, 153 novelties experimented by different smallholders, were identified. This is an underestimated number, since other novelties certainly exist and were not identified. The identified novelties were related to animal-plant-forest integration; methods for maintaining and restoring soil quality using vegetative techniques; efficient recycling of plant and animal biomass; water conservation; sanitary phyto and zoo management. Over time, the process of creating novelties by the smallholders, allowed them to establish the foundations for a sustainable agriculture, because, in general, they rely on the biodiversity and resource available on or near by their agroecosystems to develop their novelties (Costa, 2017; FAO, 2014).

To categorize, we considered the main need involved in the novelty, according to the perception expressed by the smallholders (Figure 1). However, the categorization was not easy, because, in general, they are associated with various principles and needs and they are very often used in combination. Soil fertility was the category with highest number (34.6%) of identified techniques. These techniques were related to the characteristics of the soil in the region, the importance of the functions of the soil and also needs of restoration of soils whose quality has been degraded by leaching and erosion, and weakened through history. Plant production was the category with the second highest number (21.5%) of identified novelties. Novelties related to plant health, conservationist practices, production techniques, animal health and post harvesting (processing, distribution and storage), were also identified.

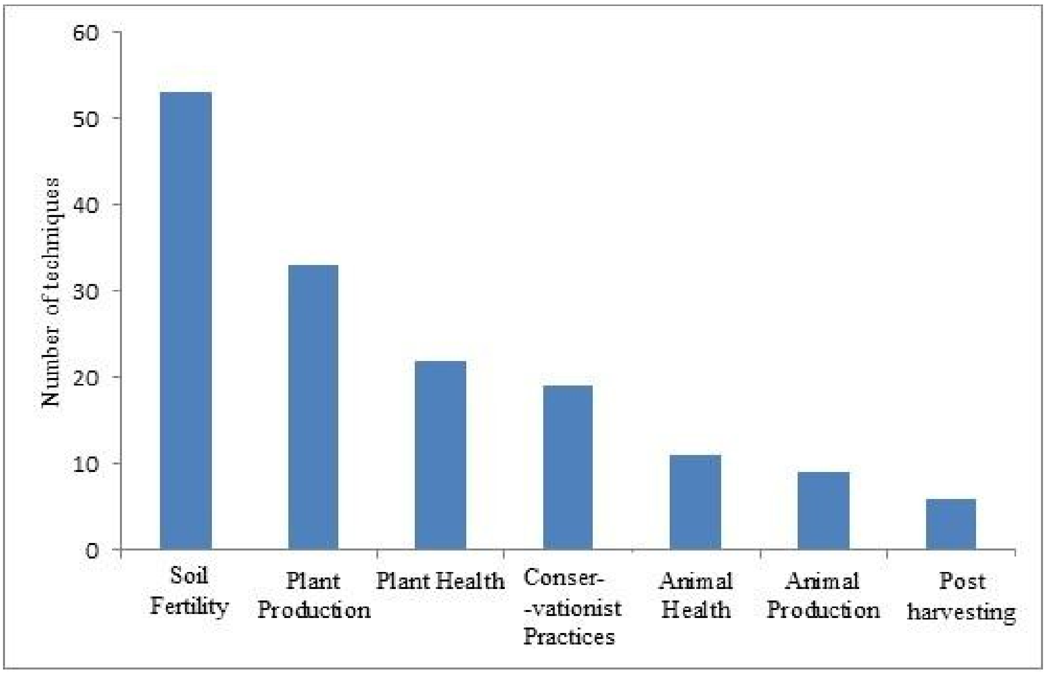

Figure 1. Main categories of novelties (n = 153) used by the smallholders, in the Zona da Mata, of Minas Gerais, Brazil. **Fonte:** elaborated by the authors.

The Figure 2 details the main techniques identified. Regarding soil fertility, many novelties related to bio fertilizers, green manure, different types of organic composts and the use of EM (Efficient Microorganism), were identified. Plant production novelties were mainly related to the diversification of species and varieties with different consortium of plants, agroforestry systems and, especially in the region, the consortium of coffee with bananas. We also identified mechanical management techniques for spontaneous plants, the use of traps to control invasive species, or repellent/attractive plants for insect control. Regarding plant and animal health, the main novelties were related to homeopathy, plant extracts and mixtures for the control of invaders / diseases. Others novelties were identified regarding unconventional feeding, biodynamics, seedling production, seed protection and grafting, and the processing, distribution and storage of products.

All identified techniques were described in a booklet (https://ctazm.org.br/bibliotecas/experiencias-dos-as-agricultores-as-na-zona-da-mata-de-minas-gerais-264.pdf) based on the results of the research subjected of this article developed in the Zona da Mata of Minas Gerais.

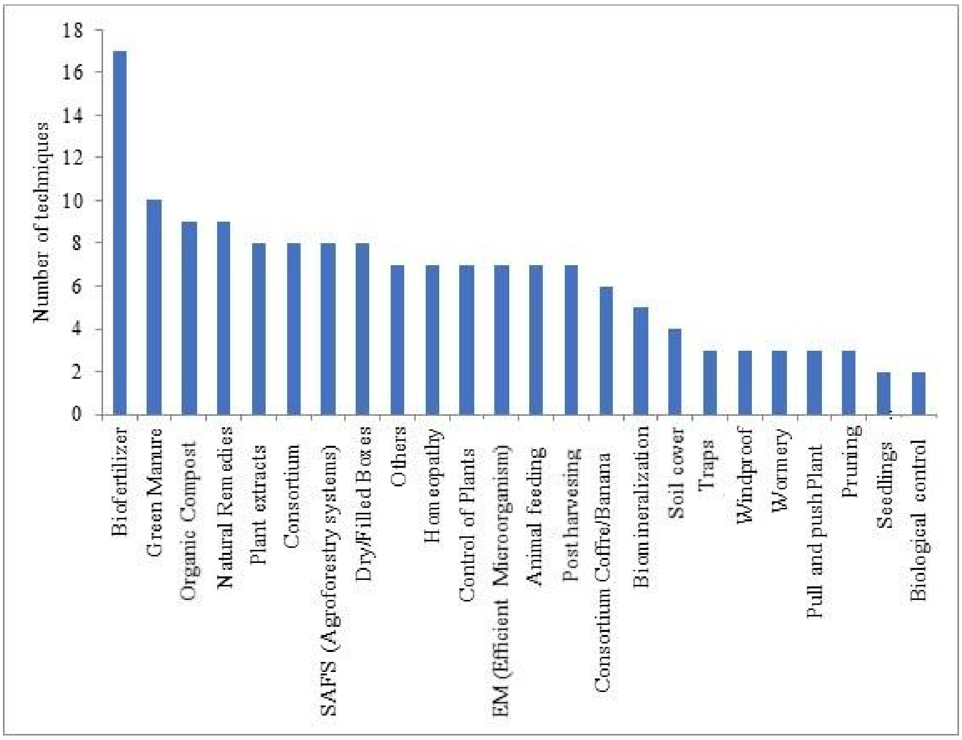

Figure 2. Main techniques experimented (n = 153).
Fonte: elaborated by the authors.

Some of these techniques are not novel in the sense that they were created by the smallholders in the Zona da Mata. Many of them have been used for generations by smallholders across the world. However, every technique identified is novel in the sense that it is re-invented by smallholders who experiment and creatively adapt them according to their specific needs, culture and environment. This is in line with the way that any novelty is developed. To develop a novelty, three processes take place: the contextualization of knowledge; the internalization regarding the types of resources used in the production of novelties (internal resources of the production unit); and the territorialization, because the production of novelties is immersed in a territory with its local ecosystem and social specificities (Oostindie; Van Broekhuizen, 2008).

Thus, some novelties, such as biofertilizer, were created by smallholders in other regions and were creatively adapted by the smallholders in Zona da Mata, others were directly created by the smallholders in Zona da Mata. For instance, the smallholders of the Zona da Mata stood out as pioneers in the use of homeopathy in agriculture, after participating in some courses called, in the region, “alternative medicine”. They practiced homeopathy for their plants, soil and water for several years and then, together with Federal University of Viçosa, started popularizing it all around Brazil (Ribeiro *et al.*, 2021). All this knowledge and experience developed by smallholders was documented in a specific booklet for the first time in 2009 (Rezende, 2009). Some recipes for plant remedies were also created by smallholders. For instance, a smallholder has developed the recipe called “calda da piteira”, a vegetable gravy, for aphids control, especially *Brevicoryne brassicae,* which is the most important pest of brassicas (Pereira *et al.*, 2018). This smallholder also created a bio fertilizer that he called "liquid compost":

> This orange is maturing and falling to the ground there, so I started to throw in the can, and I threw water inside, and it started to ferment, and then I started to throw coffee powder inside [...] cassava peel, green banana, all kinds of fruit [...] and ricinus leaf. I also add leaves of legumes [...]. And then I named it liquid compost. [...] I used it as fertilizer but also to control insects and diseases (J, 64 years old, M).

The diversity of technical novelties used by the studied smallholders are based on the different principles of Agroecology, including plant and animal diversification; nutrient recycling; the use of organic matter; the creation of optimal edaphic conditions for the growth of crops; the minimization and regulation of soil and water losses; the minimization and regulation of losses due to insects, pathogens and diseases; the exploration of synergies of plant-plant, plant-animal interactions *etc*. (Gliessman, 2015).

The natural elements most used by the smallholders are the plant or parts of the plant, such as spontaneous, leguminous and medicinal plants, and native and fruit trees; animal waste, such as manure; and microorganisms. Most of these natural elements come from their farms or from exchanges with other smallholders (88% of the total registrations), as in the example of liquid compost from the smallholder J. The external inputs taken into the farm are essentially the mineral elements such as rock dust and animal manure, especially by the ones who do not have, or who only have a few animals.

The smallholders adapt to local conditions and produce with the local resources available in the biophysical and social environment. As one smallholder said, "you have to connect your mind and embrace what you have" (JB, 68 years old, M). To give an example of this, the smallholder J uses what is available on his farm for the mulch of his vegetable garden, such as the debris from the nearby forest, the leaves of avocados, banana trees and sombrero (*Favera Espirdera*), which is a tree next to the vegetable garden that produces many leaves. They are collected and used in the fertilization process. Another farmer added, "it also is important to take advantage of everything that there is on the farm" (T, 60 years old, F).

For Agroecology, it is important that the inputs come from the farm or close to the farm. As an example, one smallholder was producing a compost to apply to the coffee crop next year, using material he has on his farm and material from his neighbours. The materials were diverse, in order to have a compost with a diversity of nutrients:

> The more variety of things you put in it, the richer it would be in nutrition, look at the diversity of things there. So, let's suppose that I compost only grass, but the grass has specific types of nutrients, [...] it's kind of like that, taking advantage of everything that appears (G, 32 years old, M).

Thus, maintaining and developing agroecological novelties from natural assets, such as biodiversity, available on or near the farm allows for greater autonomy for smallholders in relation to agricultural inputs and technological packages coming from outside, and contributes to the sustainability of the agroecosystems.

In the farms visited, biodiversity was observed both around houses (in backyards, vegetable gardens and gardens) and in coffee plantations, which is common in agroforestry systems where other crops are intercropped with the coffee lines. Biodiversity that appears in the agroecosystems is called "agricultural biological diversity" or "agrobiodiversity" (Stupino *et al*., 2014).

The maintenance, use and development of agrobiodiversity provide the foundations for innovation processes in family farming (Bragdon; Smith, 2015) and "without diversity, there is no way to innovate" (Nodari; Guerra, 2015, p. 187). The agrobiodiversity is the basis of resilience (an attribute of sustainability) of the agroecosystems, and food systems in general (Bragdon; Smith, 2015). On one hand the agrobiodiversity allows for experimenting with new techniques, and on the other hand, these techniques allow for the increase of biodiversity in the agroecosystems (Bragdon; Smith, 2015). Thus, agrobiodiversity allows creative action that, in turn, increases agrobiodiversity (Toledo; Barrera-Bassols, 2008; Bragdon; Smith, 2015), creating a virtuous cycle.

This virtuous cycle, according to Van der Ploeg (2009; 2008), refers to the co-production between living nature and human beings, which is the basis of peasant family farming. According to Van der Ploeg (2009), in a hostile environment, peasant family farming incessantly searches for autonomy, which requires the creation and development of a self-managed resource base (natural and social resources) that provides different forms of co-production. Co-production, in turn, strengthens the resource base and the coevolution process itself (Van der Ploeg, 2009). In the struggle for autonomy, smallholders seek to improve the co-production process through innovative experiences. Novelty production is simultaneously a result from, and creates co-production processes (Van Ploeg *et al.*, 2004). By modifying nature, these new experiences will maintain and develop the resource bases; that is, the socio-cultural and ecological biodiversity, which in later situations, can be used to produce more novelties.

However, the diversity of agroecosystems decreased as a consequence of the so-called "modernization" of agriculture associated with the simplification and specialization of production systems (Altieri, 1989; Gliessman, 2015; Stuvier *et al.*, 2004). The loss of diversity corresponds to a decrease of biological and cultural experiences; that is, a reduction of the creative capacity of smallholders (Toledo; Barrera-Bassols, 2008), and consequently the loss of sustainability. Agroecology, in contrast with "modernization", its rooted in diversity. In its epistemological base, Agroecology recognizes the coevolution potential of the biological and social systems within traditional systems to create innovative and sustainable experiences and techniques (Norgaard, 1989; Altieri, 2012).

Our research shows the association of biodiversity with Agroecology. In some farms, smallholders were traditionally conserving and maintaining agrobiodiversity. This diversity was increasing thanks to the active participation in agroecological movements, as expressed by the young smallholder farm:

> I think that a lot of this concept of Agroecology, this diversity thing, I think we already did it without giving it a name, because since we bought our land, we never planted just one thing, [...] we started to diversify a lot the production, afterwards we learned that this was Agroecology (J, 18 years old, M).

The diversification of the agroecosystem of this young farmer is closely associated with his and his family's participation in the agroecological *Intercâmbios* and access to the seed bank of the Agricultural Family School of Araponga (Escola Agrícola de Araponga). In general, the role of *Intercâmbios* was essential to maintain and expand the biodiversity that already existed in family farms (Elteto, 2019). For most of the smallholders who participate in the agroecological movement, diversity is associated with Agroecology. This perception is clear in the records found in the *Intercâmbios* reports (19/08 and 26/11/2011) that sought to characterize what it means to be agroecological. The need to have diversity in the farm is one of the main elements pointed out by the smallholders participating in these *Intercâmbios*.

By emphasizing the importance of biodiversity, Agroecology favors its increase on the farms of smallholders who participate in the agroecological movement and thereby, expands co-production processes. The changes promoted by Agroecology in the technical, social and epistemological dimensions allowed for innovations that guaranteed, among other results, the conservation and regeneration of agrobiodiversity (Altieri; Toledo, 2010). The smallholders who participated in this research developed processes of experimentation with agroecological techniques, based mainly on biodiversity (Figure 2).

Local adaptations for the production of new knowledge and techniques

The knowledge developed by farmers comes from the need to adapt to changing local conditions, which requires tests and observations acquired via the repetition of the productive cycle, enriched by variations and unforeseen events (Toledo; Barrera-Bassols, 2009), as exemplified by a young smallholder: “What worked for one is not what’s gonna work for yours because there are differences. There are different places, land, soil, everything is different” (L, 25 years old, F). Another farmer associated these adaptation processes to local conditions with Agroecology, because he believes that there are no ready-made packages, as recommended by industrial agriculture: “In Agroecology, what’s good for me here, there in the other places, is not so good. That's why you can't have a ready-made package” (G, 31 years old, M).

This emphasizes the ability of smallholders to adapt their actions according to the disturbance perceived in their environment; that is, they have a coupling between perception and action (Ingold, 2011). This skill does not come ready made, it is acquired through the interactions of a smallholder with their environment, their experiences and the observation of their surroundings. According to one agroecological smallholder who needed to adapt the SAF to his local conditions, adaptation is necessary, because the responses of the coffee crops vary according to the soil and the sun exposure of the land.

These local variations are important to generate novelties in one place and at a certain time, that may not arise or be relevant in another place at another time. In some cases, the novelty may have the opposite effects, because it can be highly localized (Van der Ploeg *et al*., 2004). Therefore, the search for adaptation to local conditions leads to the production of numerous novelties.

Some smallholders pointed out that the adaptation to local conditions is not a priority for conventional farmers, because they use ready-made and standardized packages. These packages need to be standardized, to be sold in markets and used in any environment without the need for adaptation. In fact, using these standardized packages and practices, industrial agriculture seeks to maximize profits and productivity in the short term (Gliessman, 2002; Van der Ploeg, 2009).

In contrast, in the production systems of smallholders, “there is no pattern”, as reported by a young smallholder when referring to his diverse coffee crop and the agroforestry systems:

> Agroecolgogy forces you to observe a little, to observe what is happening there. In the conventional way of doing things, there is no such concern. [...] In the conventional way, the farmer goes to spray, he goes to weed and he goes to harvest, the number of times he goes in the fields is less. [...] We go more, sometimes, the visiting [observing] ends up giving more results than spraying (Q, 25 years old, F).

Understanding the principles of Agroecology helps the farmers to adapt their practices anywhere, as explained:

> Something that my neighbour does sometimes, it is right for him, sometimes here on my farm it will not work, so adaptations have to be made. So, if you understand what the principles of Agroecology are, [...], you will arrive at a place and you will be able to adapt and apply them in a given reality (A, 33 years old, M).

Agroecology, unlike industrial agriculture, does not propose universal technological packages that are ready to manage agricultural systems, but principles that are essential for smallholders to be able to adapt their practices to local conditions. Among the principles of Agroecology are diversification, nutrient recycling, energy flows *etc.*, based on the processes and characteristics of natural ecosystems (Gliessman, 2015). These agroecological principles provide frameworks for designing and basing sustainable production systems on (Gliessman, 2015).

As expressed by the farmers, the daily observation of nature plays a fundamental role in the adaptation and adjustment processes to the local environment and, therefore, in the production of knowledge and novelties (Altieri, 2012, Van der Ploeg *et al.*, 2004).

Daily observations: bases of experiments for the novelties production

Observation occurs at all times in the cycle of building knowledge and improving techniques (Altieri, 1991; Sevilla Guzman; Molina, 1996; Van Der Ploeg *et al*., 2004). According to two smallholders who manage SAFs, although they have learned the benefits of *Solanum argentum* (capoeira branca), they observed that a specific type of the tree does not do well with coffee; it “burns” the surrounding coffee leaves because of a product released by the leaves of *S. argentum*. From these observations, smallholders were able to select species variations, or perhaps even another species of the same genus, for the benefit of their SAFs.

Another smallholder noted that the wasp "houses" were full of a certain kind of dead "bug" (insect considered to be a coffee pest); that is, the wasps were taking the bug to serve as food for the larvae. Upon discovering this, the smallholder understood the importance of the wasps in the natural control of the other insects and stopped killing the wasps, as he said: "avoid killing the wasps, who catch the larvae? Before I discovered this I used to burn the wasps [...] it's an experience that I saw for myself" (S, 40 years old, M). These new understandings about how biodiversity functions are incorporated and transformed into knowledge and, therefore, into production management techniques (Van Der Ploeg *et al*., 2004).

According to Toledo and Barrera-Bassols (2009), the learning process of the smallholders themselves, from their local experiences, develops due to variations and unforeseen events of the previous cycle. In the case of the smallholder S, he learned to use the wasps as a biological control in the next cycle. Another smallholder reported that he observed that when he removed the sick leaves from the lower branches of the avocado tree, it produced more fruit, a learning process that he planned to use the following year:

> Like this avocado tree, it produced much better than last year [...]. Last year it had a fungus that pierced it all. This year [my wife] removed all the leaves from the bottom and took it to the compost. I see that these leaves were causing the fungus. That's it, we remember this for the next year (J, 64 years old, M).

These examples illustrate how smallholders incorporate new information by observing nature, its phenomena and its transformation observed in time and space. The new information is incorporated and transformed into knowledge and, therefore, into new production system management techniques. From an experience combined with complex cycles of careful observation, interpretation and evaluation, smallholders create and develop novelties (Van Der Ploeg *et al.*, 2004).

In these cycles, smallholders observe nature in the processes of improving and maintaining a technical novelty. This was the case of a smallholder who used scattered rock powder for the first time, in the lines of the coffee plantation. He observed a very big difference in weed growth, since before it grew a lot of "weeds" typical of "weak land" (such as *Sida sp*). After having used the rock powder, he observed the emergence of "weeds" typical of "good land" (such as *Bidens Pilosa* and *Commelina sp*), which, for him, meant the rock dust was effective as it was used. In fact, the presence or absence of native plants are generally identified by the smallholders as indicators of soil quality, supportive of their good management (Barrios *et al*., 2011).

The importance of observation in innovation processes was particularly pointed out by the smallholders who consider themselves agroecological or who actively participate in the agroecological movement. For them, the daily and detailed observation of the ecosystem is a prerequisite for doing Agroecology. For instance: “if you can't observe this, the dynamism there is, you don't do Agroecology anymore. So, it’s to observe these small details, but that has very large meanings” (I, 21 years old, M). The daily observations made by the farms about the phenomena that occur in their farm is an important step to build knowledge necessary for the construction of agroecological production systems (Feiden, 2005). It is another way of working. It is indispensable to develop locally appropriate practices and sustainable techniques to manage the production systems.

The need for observation is related to the need for local adaptation, so that a series of experiments and tests are done from nature observation. In our study, the testimonies and examples of novelties developed by testing, experimenting and observing nature by smallholders were diverse and varied. In their daily activities, the smallholders use the empirical process of trial and error to create and adapt their different techniques, as the example of a smallholder with his homeopathy tests: “there are some things I didn’t get right, but you get right with experience [...] what we see that works, continues, what doesn't work, starts again” (S, 40 years old, M). This agrees with Altieri (2012, p. 166) who says: “the strength of the knowledge of the rural population resides on what it is based on sharp observation and also on empirical learning”.

This type of adaptation, carried out by smallholders on a daily basis through tests and observations, can be called “creative adaptation” because it is not passive and natural, but requires action and understanding of the properties of bodies and of the interactions of phenomena. That is, understanding the world for the creation and realization of new techniques (Vieira Pinto, 2005). Out the 153 novelties identified, 64% required a high level of observation from the smallholder. Therefore, they were not simply a replication of an experience from another place on their farm, but a "creative adaptation" or an invention of the smallholder.

This creativity, according to Ingold (2012), corresponds to forward movement, because the idea is not to replicate or reproduce, but to shape things following the flows of materials, because matter is always in motion. However, a smallholder gathers the materials to combine and redirect their flows with a certain intentionality, but not with complete control of the processes. For example, a smallholder did an experiment with the intention of making a biofertilizer that actually became a desiccant.

Such examples also reveal the importance of everyday life in the production of novelties. According to Bifano (2015), regarding the nature of everyday life, a daily activity, even when it looks similar from one day to the other, is different in each situation, because there is an open process of unfolding daily activity. This is especially true for smallholders because they work in open spaces, with nature. The interaction developed between processes, products, persons and environments are diverse and results of an activity inserted in daily life, which makes the transformation possible (Bifano, 2015) and, therefore, allows for novelty production. In fact, according to Van der Ploeg *et al.* (2014), a novelty is a deviation and, sometimes, a break with existing routines.

The examples provided show the continuous monitoring and evaluation by the smallholders of their experimental practices, which allow them to acquire new knowledge and adjust it to their experiences, because a smallholder learns by doing and does by learning. This knowledge is based on daily experience, observations, experimentation through trial-and-error process, and the synthesis of facts and phenomena (Toledo; Barrera-Bassols, 2008). Therefore, smallholders' experiential and practical knowledge generally remains implicit (Stuvier *et al.*, 2004). The potential for building the knowledge of smallholders through the trial-and-error process, adaptations, observations, and experiments is an epistemological premise of Agroecology (Norgaard, 1989) and allow smallholders to create and expand new techniques for sustainable management of their environments (Altieri, 2012).

Besides the daily practices (*praxis*), to innovate and produce their knowledge (*corpus*) (Toledo, 2000), peasants also incorporate belief systems and representation of nature (*kosmos*). This was evidenced by more subtle situations in the daily life of the smallholders, such as a smallholder who has the habit of talking to the ants instead of killing them. A female smallholder stated that her husband, when making syrup, mentions the importance of intention in the actions carried out. According to her: “when you make it, do it with the intention that it will work and it works” (Q, 25 years old, F).

Belief systems and representations of nature (*kosmos*), daily practices (*praxis*), and the production of knowledge (*corpus*) are the inseparable bases upon which the smallholder relies day-to-day in order to experiment with new ideas and techniques; that is, to produce novelties (Toledo; Barrera-Bassols, 2009). This holistic understanding is one of the epistemological bases of Agroecology (Norgaard, 1989), but it is not well accepted by science. This holistic vision comes, on one hand, from the influence of Southern Epistemologies, from the cosmovision of traditional populations (Altieri; Toledo, 2010) and, on the other hand, from ecological thinking and principles (Gliessman, 2015). In many societies, local models of nature are represented by a continuity between the biophysical, human and supernatural world, corresponding to a bio-centric worldview that takes root in harmony with nature (Acosta, 2012; Escobar, 2005).

This holistic worldview of traditional communities, which involves the interdependent relationship between the social and ecological systems, operates in the processes of formation of traditional and local knowledge. Thus, the recognition of traditional, empirical and local knowledge is one of the epistemological foundations of Agroecology (Altieri; Toledo, 2010; Gomes, 2005; Norgaard, 1989).

When considering the local empirical knowledge and the learning mechanisms of smallholders or peasants as important, Agroecology questions the paradigms that underlie current agriculture practices, which destroys the creative processes of smallholders (Gliessman, 2002; Toledo, 2016). Agroecology proposes new bases for building knowledge with: the recognition of traditional peasant knowledge, the integration of this knowledge and articulation with scientific knowledge, and a holistic and co-evolutive view of the world (Altieri; Toledo, 2010; Norgaard, 1989). Because of that, unlike the

Green Revolution model, Agroecology encourages the creation of novelties, since it is based on the valorization of the local empirical knowledge and experimentation processes of smallholders (Altieri; Toledo, 2010; FAO, 2015).

Agroecology considers relationships between the natural and social world. These relationships are composed of constant exchanges and interactions between the smallholder and living nature, daily observations of the cycles of nature and improvements of the available resources, which promote adaptation and allow the smallholder to learn new ways of doing things (Van Der Ploeg, 2008). Figure 3 illustrates the relationships between the biological and social systems which include the key factors for novelty production by smallholders. These novelties guarantee the technical autonomy and sovereignty of smallholders (Altieri; Toledo, 2010; Van Der Ploeg, 2008), and are an essential part of the creation of new strategies towards a more sustainable agrifood system.

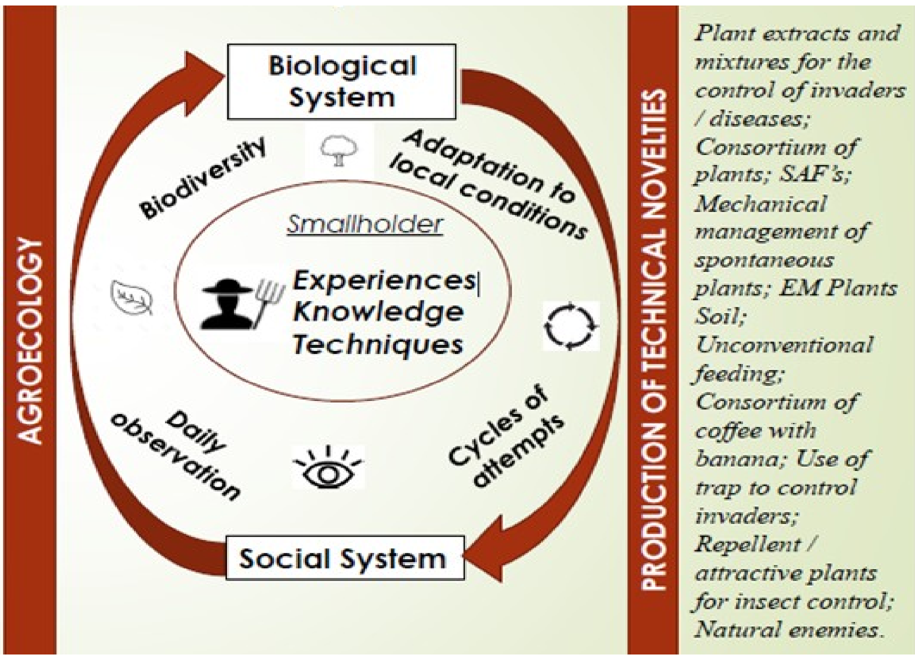

Figure 3. Key elements of the novelties production by smallholders.
Fonte: elaborated by the authors

Although important, agroecological innovation processes have risks and limits. Among them, there is the time and dedication that novelties production requires, because they are based on trial-and-error process and systematic observation. Another limit is that expected results are not always achieved, especially in the time needed. In order to overcome these limits and to limit the risks, public policies of different scope would be, among other elements, necessary to support these transition processes.

FINAL CONSIDERATIONS

We found 153 novelties, developed or adapted by 42 smallholders, most of them agroecological, who experiment and creatively adapt novelties according to their specific needs, culture and environment. The diversity of technical novelties used by the studied smallholders are based on the different principles of Agroecology.

The autonomous production of technical novelties by smallholders involves several elements, such as the daily observation of the biophysical environment, cycles of attempts and adaptation to local conditions, biodiversity and cosmovision. Agroecology promotes the creative potential of smallholders, bringing new epistemological bases that differ from those of modern science, such as the recognition of the importance of biodiversity and local empirical learning processes, and the respect of the farmer's cosmovision. Besides technical novelties, Agroecology also supports organizational, methodological, and epistemological novelties.

The production of technical novelties by smallholders generates a variety of technical solutions that are necessary for the transition towards more sustainable agrifood systems. However, theses agroecological innovation processes have limits, for example, regarding the time and dedication that novelty production requires. For this reason, public policies are necessary for enhancing the innovation capacity of smallholders, for supporting the realization of new experiments, for the conservation and development of biodiversity and cultural diversity, and for supporting participative activities to build agroecological knowledge. In some cases, public policies are also important for the promotion of the industrialization and commercialization of some of the farmers' innovations, to make them easily available for other farmers. It is also interesting to search for partnership with scientists that are engaged in promoting Agroecology and in supporting smallholders.

ACKNOWLEDGEMENTS

To the smallholders for the welcome and rich exchanges that made this study possible; to the smallholders' organizations (SINTRAF) and the CTA (Viçosa Alternative Technology Center) for the exchanges and organizational support; to the Federal University of Viçosa (UFV), to the Postgraduate Program in Rural Extension for the construction of scientific knowledge for the development of this study; to the National Council for Scientific and Technological Development (CNPq) for the financial support.

REFERENCES

ABA- ASSOCIAÇÃO BRASILEIRA DE AGROECOLOGIA. **Estatuto da Associação Brasileira Agroecologia.** s.l.: ABA-Agroecologia 2015. Disponível em: https://aba-agroecologia.org.br/wp-content/uploads/2018/05/Estatuto_ABA_2015.pdf Acesso em: 8 de julho de 2022.

ACOSTA, Alberto. O Buen Vivir : uma oportunidade de imaginar outro mundo. *In*: BARTELT, D. D. (Ed.). **Um campeão visto de perto.** Uma Análise do Modelo de Desenvolvimento Brasileiro. Rio de Janeiro : Heinrich-B ed., 2012. p. 94–105.

ALIMONDA, Héctor. La colonialidad de la natureza. Uma aproximación a la Ecología Política LatinoAmericana. *In*: ALIMONDA, H. (Ed.). **La natureza colonizada**. Buenos Aires: Ediciones Ciccus, 2011. p. 21–60.

ALTIERI, Miguel A. **Agroecologia:** as bases científicas da agricultura alternativa. Rio de Janeiro: PTA/FASE, 1989.

______. Por qué estudiar la agricultura tradicional. **Agroecologia y Desarrollo**, [s. l.], n. 1, p. 16–24, 1991.

______. **Agroecologia:** bases científicas para uma agricultura sustentável. São Paulo: Expressão Popular; Rio de Janeiro: AS-PTA, 2012.

______; TOLEDO, V. M. La revolución agroecológica de América Latina : Rescatar la naturaleza, asegurar la soberanía alimentaria y empoderar al campesino. **El Otro Derecho**, n. 42, p. 163–202, 2010. Disponível em: <http://biblioteca.clacso.org.ar/Colombia/ilsa/20130711054327/5.pdf> Acesso em: 8 de julho de 2022.

ALVES-MAZZOTTI, Alda J. O método nas Ciências Sociais. *In*: GEWANDSZNAJDER, F.; ALVES-MAZZOTTI, A. J. (Eds.). **O método nas Ciência Naturais e Sociais**. 2. ed. São Paulo: Pioneira Thomson Learning, 2002. p. 109–203.

BARDIN, Laurence. **L'analyse de contenu**. Paris: PUF ed., 2013.

BARRIOS, Edmundo., COUTINHO Heitor L.C., MEDEIROS Carlos A.B. **InPaC-S:** Integração Participativa de Conhecimentos sobre Indicadores de Qualidade do Solo – Guia Metodológico. Nairobi: World Agroforestery Centre (ICRAF), Embrapa, CIAT, 2011. 178 p.

BIFANO, Amelia C. S. Vida cotidiana e tecnologias: diálogos possíveis. *In*: BIFANO, A. C. S.; ROSADO, M. S.; TEIXEIRA, T. S. (Eds.). **Entre Estratégias e Técticas: diálogos com o cotidiano.** Viçosa: UNIEDHS, 2015. p. 15–38.

BOTELHO, Maria I. V.; CARDOSO, Irene M.; OTSUKI, Kei. "I made a pact with God, with nature, and with myself": exploring deep agroecology. **Agroecology and Sustainable Food Systems**, v. 40, n. 2, p. 116–131, 2016.

BRAGDON, Susan H.; SMITH, Chelsea. **Small-scale farmer innovation**. Geneva: Quaker United Nations Office., 2015.

CARDOSO, Irene. M.; FERRARI, Eugênio. A. Construindo o conhecimento agroecológico: trajetória de interação entre ONG, universidade e organizações de agricultores. **Revista Agriculturas**, v. 3, n. 4, p. 28–32, 2006

CAPORAL, Francisco. R.; COSTABEBER, José A. Segurança alimentar e agricultura sustentável: uma perspectiva agroecológica. *In*: CAPORAL, F. R. (Ed.). **Extensão Rural e Agroecologia:** temas sobre um novo desenvolvimento rural, necessário e possível. Brasília: MDA, 2007. p. 275–290.

CINTRÃO, Rosângela P. **Ongs, tecnologias alternativas e representação política do campesinato:** uma análise da relação entre o Centro de Tecnologias Alternativas e os Sindicatos de trabalhadores Rurais na zona da mata mineira. 1996. Dissertação (Mestrado em Desenvolvimento, Agricultura e Sociedade) – Universidade Federal Rural do Rio de Janeiro. 1996.

COMERFORD, John C. **"Como uma família":** sociabilidade, reputações e territories de parentesco na construção do sindicalismo rural na Zona da Mata de Minas Gerais. 2001. Tese (Doutorado em Antropologia Social) - Universidade Federal do Rio de Janeiro. Rio de Janeiro, 2001.

COSTA, Manoel B. B. **Agroecologia no Brasil:** História, Princípios e Práticas. São Paulo: Expressão Popular, 1 ed., 2017.

ELTETO, Yolanda. M. **As sementes crioulas e as estratégias de conservação da agro biodiversidade**. 2019. Dissertação (Mestrado em Agroecologia) - Universidade Federal de Viçosa, Viçosa, 2019.

ESCOBAR, Arturo. **Sentipensar con la tierra:** nuevas lecturas sobre desarrollo, territorio y diferencia. Medellín: Universidad Autónoma Latinoamericana , 2005.

Food and Agriculture Organization. **The State of Food and Agriculture:** Innovation in family farming. Rome: FAO, 2014.

______. **Agroecology for Food Security and Nutrition Proceedings of the FAO International Symposium.** Rome: FAO, 2015.

FEIDEN, Alberto. Agroecologia: introdução e conceitos. *In*: AQUINO, A. M. de; ASSIS, R. L. de. (Ed.). **Agroecologia:** princípios e técnicas para uma agricultura orgânica sustentável. Brasília, DF: Embrapa Informação Tecnológica; Seropédica: Embrapa Agrobiologia, 2005.

GLIESSMAN, Stephen R. **Agroecologia:** procesos ecológicos en Agricultura Sostenible. Turrialba: CATIE, 2002.

______. **Agroecology:** The Ecology of Sustainable Food Systems. Third Edit ed. [s.l.]: Taylor & Francis Group, 2015.

GOMES, João C. C. Bases epistemológicas da Agroecologia. *In*: DE AQUINO, A. M.; DE ASSIS, R. L. (Eds.). **Agroecologia:** princípios e técnicas para uma agricultura orgânica sustentável. EMBRAPA ed., 2005. p. 517.

GONSALVES, Julian *et al.* **Investigación y desarrollo participativo para la agricultura y el manejo sostenible de recursos naturales**: libro de consulta. Volumen 1: Comprendiendo. Investigación y el desarrollo participativo. Laguna : Perspectivas de los Usuarios con la Investigación y el Desarrollo agrícola. Centro Internacional de la Papa. Ottawa : Centro Internacional de investigaciones para el desarrollo, 2006.

HOCDÉ, Henri *et al*. Hacia un movimiento de innovacion de agricultores: Campesino a Campesino. **LEISA**, [s. l.], v. 16, n. 2, 2000.

INGOLD, Tim. Trazendo as coisas de volta à vida: emaranhados criativos num mundo de materiais. **Horizontes Antropológicos**, [s. l.], v. 18, n. 37, p. 25–44, 2012. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0104-71832012000100002&lng=pt&tlng=pt Acesso em: 8 de julho de 2022.

INGOLD, Tim. **Estar vivo:** ensaios sobre movimento, conhecimento e descrição. Petrópolis: Vozes, 2011.

LACEY, Hugh. Scientific research, technological innovation and the agenda of social justice, democratic participation and sustainability. **Scientiae Studia**, [s. l.], v. 12, n. spe, p. 37–55, 2014. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1678-31662014000500003&lng=en&nrm=iso&tlng=en Acesso em: 8 de julho de 2022.

MEYNARD, Jean-Marc. L'agroécologie, un nouveau rapport aux savoirs et à l'innovation. **Ocl**, [s. l.], v. 24, n. 3, 2017. Disponível em: http://www.ocl-journal.org/10.1051/ocl/2017021 Acesso em: 8 de julho de 2022.

MINAS GERAIS (Legislação mineira). **Lei nº 23.207, de 27 de dezembro de 2018**. Institui o Polo Agroecológico e de Produção Orgânica na região da Zona da Mata. Assembleia Legislativa de Minas Gerais, 2018.

MINISTÉRIO DA AGRICULTURA PECUÁRIA E ABASTECIMENTO. **Fichas Agroecológicas**. Brasília: MAPA. 2016. Disponível em: <http://www.agricultura.gov.br/assuntos/sustentabilidade/organicos/fichas-agroecologicas>. Acesso em: 15 abr. 2018.

NETTO, Marcos M.; DINIZ, Alexandre M. A. A Estagnação Sócio-Econômica Da Zona Da Mata De Minas Gerais: Uma Abordagem Geohistórica. X Encontro de Geógrafos da América Latina – 20 a 26 de março de 2005. **Anais** …. – São Paulo: Universidade de São Paulo p. 9342–9367, 2005.

NODARI, Rubens O.; GUERRA, Miguel P. A agroecologia: estratégias de pesquisa e valores. **Estudos Avançados**, [s. l.], v. 29, n. 83, p. 183–207, 2015. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-40142015000100183&lng=pt&tlng=pt Acesso em: 8 de julho de 2022.

NORGAARD, Richard B. A base epistemológica da agroecologia. *In*: ALTEIRI, M. A. (Ed.). **Agroecologia:** as bases científicas da agricultura alternativa. Rio de Janeiro: PTA/FASE, 1989. p. 42–48.

OLIVEIRA, Daniela *et al.* A produção de novidades: como os agricultores fazem para fazer diferente? *In*: SCHNEIDER, S.; GAZOLLA, M. (Eds.). **Os atores de desenvolvimento rural:** práticas produtivas e processos sociais emergentes. Porto Alegre: Editora da UFRGS, 2011. p. 91–113.

OLIVEIRA, Fabrício. R. C.; ZANGELMI, Arnaldo J. O MOBON, a política e a imprensa: notas sobre religião e política em Minas Gerais. **Horizonte**, [s. l.], v. 7, n. 14, p. 170–186, 2009.

OOSTINDIE, Henk; VAN BROEKHUIZEN, Rudolf. The Dynamics of Novelty Production. *In*: VAN DER PLOEG, J. D.; MARSDEN, T. (Eds.). **Unfolding webs**. Assen: van Gorcun. p. 68–86, 2008.

PEREIRA, Adalgisa *et al.* Control of *Brevicoryne brassicae* (Hemiptera: Aphididae) with extracts of *Agave americana* var. *Marginata* Trel. in *Brassica oleracea* crops. **Annals of Applied Biology**, v. 174, n. 1, p. 14-19, 2018.

REZENDE, Jesus M. **Instruções práticas geradas por agricultores sobre o uso da homeopatia no meio rural**. Viçosa: UFV, 2009.

RIBEIRO, Alessandra P.; COELHO, France M. G.; CRISCUOLO, Myriam R. A Incrível história da homeopatia na zona da mata mineira e sua aplicação na agropecuária. *In*: CARMO, Davi L. *et al.* (Org.). **Diálogos transdisciplinares em Agroecologia**: Projeto Café com Agroecologia. Viçosa: FACEV, 2021. cap. 16, p. 228-249.

ROSSET, Peter M.; MARTÍNEZ-TORRES, Maria E. Rural social movements and agroecology: Context, theory, and process. **Ecology and Society**, [s. l.], v. 17, n. 3, 2012.

SCHMITT, Claudia J. **Agroecologia, políticas públicas e transições sociotécnicas:** ampliação de escala de redes territoriais voltadas à promoção de uma agricultura de base ecológica. Relatório de pesquisa CNPq. Mimeo. 2016.

SEVILLA GUZMAN, Eduardo; MOLINA, González. De. Sobre la Agroecologia: Algunas reflexiones en torno a la agricultura familiar en España. *In*: GARCIA DE LEON, M. A. (Ed.). **El campo y la ciudad.** Madrid: MAPA, 1996.

SOARES, Josarlete M. **Das Minas às Gerais: um estudo sobre as origens do processo de formação.** 2009. Universidade Federal de Minas Gerais, 2009. Dissertação (Mestrado em Arquitetura e Urbanismo) Universidade Federal de Minas Gerais. Belo Horizonte, 2009.

STUPINO, Susana A. *et al.* La biodiversidad en los agroecosistemas. *In*: SARADON, S. J. *et al.* **Agroecologia:** bases teóricas para el diseño y manejo de Agroecosistemas sustentables, La Plata: Universidad Nacional de la Plata, 2014. p. 132-158.

STUVIER, Marian; LEEUWIS, Cees; VAN DER PLOEG, Jan D. The Power of Experience: Farmers' Knowledge and Sustainable Innovation in Agriculture. *In*: WISKERKE, J. S. C.; VAN DER PLOEG, J. D. (Eds.). **Seeds of Transition:** Essays on novelty production, niches and regimes in agriculture. Assen: van Gorcun. 2004. p. 93–118.

TOLEDO, Victor M. Indigenous knowledge of soils: an ethnoecological conceptualization. *In*: BARRERA-BASSOLS, N.; ZINCK, J.A. **Ethnopedology in a worldwide perspective.** An annotated bibliography. The Netherlands: ITC Publication, 2000. 632p.

______. A agroecologia é uma revolução epistemológica. **Agriculturas**, [s. l.], v. 13, n. 1, p. 42–45, 2016.

TOLEDO, Victor M.; BARRERA-BASSOLS, Narciso. **La memoria biocultural.** La importancia de las sabidurías tradicionales, Barcelona: Icaria Editorial. 2008.

______. A etnoecologia: uma ciência pós-normal que estuda as sabedorias tradicionais. **Desenvolvimento e Meio Ambiente**, [s. l.], v. 20, p. 31–45, 2009. Disponível em: http://revistas.ufpr.br/made/article/view/14519 Acesso em: 8 de julho de 2022.

TOURDONNET, Stéphane de; BRIVES, Hélène. Innovation agro-écologique : comment mobiliser des processus écologiques dans les agrosystèmes? *In*: FAURE, G. *et al.* (Eds.). **Innovation et développement dans les systèmes agricoles et alimentaires.** Versailles: Quae ed., 2018. p. 71–80.

TOUZARD, Jean-Marc. L'innovation agricole et agroalimentaire au XXIème siècle : maintien, effacement ou renouvellement de ses spécifités? *In*: FAURE, G. *et al.* (Eds.). **Innovation et développement dans les systèmes agricoles et alimentaires**. Versailles: Quae ed., 2018. p. 39–56.

TRIVIÑOS, Augusto N. S. **Introdução à Pesquisa em Ciências Sociais:** a Pesquisa Qualitativa em Educação - O Positivismo, A Fenomenologia, O Marxismo. São Paulo: Atlas ed. 1987.

VALVERDE, Orlando. Estudo Regional da Zona da Mata, de Minas Gerais. **Revista Brasileira de Geografia Física**, [s. l.], v. 1, p. 3–82, 1958.

VAN DER PLOEG, Jan D. El proceso de trabajo agrícola y la mercantilización. In: GUZMAN, E. S. (Ed.). **Ecología, Campesinado e História**. Madrid: La Piqueta, 1993. p. 163–195.

______. **Camponeses e Impérios Alimentares: lutas por autonomia e sustentabilidade na era da globalização**. Porto Alegre: UFRGS Editora, 2008.

______. Sete teses sobre a agricultura camponesa. **Revistas Agriculturas: Experiências em Agroecologia**, [s. l.], n. Especial, p. 17–32, 2009.

______. Cadernos de debate : Dez qualidades da agricultura familiar. **Agriculturas,** [s. l.], n. 1, p. 1–16, 2014.

______. *et al.* On regimes, novelties, niches and co-production. In: WISKERKE, J. S. C.; PLOEG, J. (Eds.). **Seeds of Transition.** Essays on novelty production, niches and regimes in agriculture. Assen: van Gorcun. 2004.

VENTURA, Flaminia; MILONE, Pierluigi. Novelty as Redefinition of Farm Boundaries. *In*: WISKERKE, J. S. C.; VAN DER PLOEG, J. D. (Eds.). **Seeds of Transition.** Essays on novelty production, niches and regimes in agriculture. Assen: van Gorcun. 2004. p. 57–92.

VERDEJO, Miguel E. **Guia Prático - Diagnóstico Rural Participativo**. Brasília: MDA/Secretaria da Agricultura Familiar, 2011.

VIEIRA PINTO, Alvaro. **O conceito de tecnologia**. Rio de Janeiro: Contraponto ed. 2005.

WEZEL, Alexander *et al.* Agroecology as a science, a movement and a practice. **Sustainable Agriculture**, [s. l.], v. 2, p. 27–43, 2009.

WISKERKE, Johannes S. C.; VAN DER PLOEG, Jan D. **Seeds of Transition:** Essays on novelty production, niches and regimes in agriculture. Assen: van Gorcun. 2004.

ZANELLI, Fabrício; SILVA, Lourdes. Intercâmbios agroecológicos: processos e práticas de construção da agroecologia e da educação do campo na zona da mata mineira. **Perspectiva**, v. 35, n. 2, p. 638-657, 2017.