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Agroecological Strategies for Reactivating the Agrarian Sector: The Case of Agrolab in Madrid

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Abstract: Considering the social and ecological obsolescence of the conventional agricultural model and the crisis faced by rural areas, innovative models based on collective initiatives and agroecological practices are emerging. Here, we present the use of a participatory farming lab as a space to reactivate the agrarian sector in rural and periurban areas of Madrid. The specific objectives of this study are: (1) to describe the project; (2) to identify participants' profiles and motivations and (3) to identify the most socially valued ecosystem services and the actions collectively taken to enhance them. To do so, we have used the living lab conceptual approach and the ecosystem service lens. Data gathering included a combination of qualitative and quantitative techniques, including participant observation, informal and formal meetings, interviews, workshops and surveys. We found a diversity of motivations for enrolling in the program and 20 ecosystem services were selected as socially important. We also describe how the project has contributed to adopting agroecological practices to sustain those ecosystem services. Finally, we discuss the contribution of the project towards new and integrated rural development strategies, including its potential to promote cooperative solutions that enhance farming activity by also providing ecosystem services.

Keywords: agricultural landscape; agroecology; ecosystem service; living lab; open farming laboratory; participatory approach; people-nature bond; rural-urban interaction; social innovation

1. Introduction

The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) promoted by the Food and Agriculture Organization of the United Nations (FAO) and the World Bank for a period of three years (2005–2008) recognized how, despite the scientific and technological achievements to improve agricultural productivity, insufficient attention has been paid to the environmental and social consequences of the prevailing agrifood model [1]. According to the International Millennium Ecosystems Assessment, agroecosystems are in a vulnerable situation, especially because of the decline of cultural values and regulating ecosystem services (ESs; [2]). The intensification and globalization of food systems has created detrimental impacts related to the following: (1) abandonment of rural areas due to the low profitability for smallholders and relocation of production; (2) aging and masculinization of rural populations, lack of generational replacement and loss of cultural memory; (3) high dependence on fossil fuels and changes in demand in international

markets; (4) climate change and greater vulnerability to environmental changes and (5) slowing down of the food system due to the degradation of the basic ESs responsible for food production in terms of soil fertility, water availability and regulation, pollination and so forth [3–8].

In addition to these impacts, in the case of the Madrid region (centre Spain), there has been a reduced economic weight of the agrarian sector in the territorial economy, together with a discredit of the profession, difficulties in land access for new farmers, a lack of training programs or education opportunities, a lack of a culture of innovation, an individualistic mindset, a disconnect among agents in the food value chain and a lack of integration with other sectors (e.g., tourism, health, environment and education) [9,10]. Madrid is one of the most densely populated regions of Europe; at the same time, it has considerable agrarian potential that has deteriorated (agrarian land, institutions and infrastructure) over the years. There has been a replacement of vegetable crops as orchards and fruit trees, especially in irrigated areas, by extensions of arable crops [9,11]. It has been favoured by the fact that arable crops are easily mechanizable requiring smaller workforces. Following the data reported by Madrid Statistical Institute, in the last 30 years, agricultural lands have decreased an 18% (from 276,100 ha in 1985 to 226,792 ha in 2015); where orchards have suffered a significant decreased of a 76% (from 8901 ha in 1985 to 2130 ha in 2015), while cereals have decreased a 22% (from 103.605 ha in 1985 to 81.098 ha in 2015) and grain legumes have increased a 38% (from 5175 ha in 1985 to 7154 ha in 2015). In ten years (from 1999 to 2009), Madrid has lost 15% of its utilised agricultural area [12]. In contrast, urban areas have almost double its surface during the last four decades (from 42,510 ha in 1981 to 81,499 ha in 2017), together with a population increase from 4,686,895 inhabitants in 1981 to 6,436,996 in 2015. Following this pattern, for decades, agrarian activity has declined and many rural and periurban areas have been reduced to dormitory towns, weekend leisure spaces for urban people or, simply, depressed, isolated and abandoned territories. It is essential to rebalance territorial relations between the countryside and the city and between local communities and their surrounding agricultural landscapes, with farming activities following agroecological principles being a potential connector.

Agroecology was developed to address the problems generated by industrial agriculture following basic principles of sustainability, integrity, equity, productivity and stability [13]. The concept of agroecology has undergone scientific and technical development since the early 1990s [14]. It is presented as a practice, scientific discipline and socio-political movement that applies ecological concepts in the management of agrarian systems [15]. From a socioecological perspective, agroecology requires a break with reductionist visions. A holistic point of view is needed to envision the complex relationships that are generated among ecological functioning, human wellbeing, economic profitability, models of governance and territorial policies. Agroecology considers that the problems of the agrarian system cannot be studied isolated of the human communities that depend on it [13]. Thus, it has as one of its principles the inclusion of all the actors involved [16]. Agroecosystems are one of the ecosystem types most directly managed by humans. For this reason, farmers assume special importance and responsibility through the practices they carry out, which can contribute to the custody or deterioration of ESs [17]. Currently, there is an interest in studying collective action as a way to enhance ESs at agricultural landscapes [18]. Therefore, agroecology works towards action and participation to enhance a transition from the current models [15].

In this regard, living labs are a new research area and phenomenon in which human ideas and needs, from a multi-actor and participatory perspective (usually including a public-private partnerships), are established as a starting point in innovation and transition towards new productive, governance, consuming and living models. Living labs have the purpose of creating, validating and testing new products, services, business ideas, markets and technologies in the real world. The concept emerged in the context of information technology development in the beginning of 2000 to test modern technologies in a real-life context [19,20]. Since then, the concept has been extended towards many other sectors, such as health, mobility, energy, rural development, education and so forth; this diversity could be found in the European Network of Living Labs (ENoLL). Others

have adapted the concept to the context of sustainability, especially in urban areas, through the development of urban living labs [21]. Here, we operationalize the living lab approach with the aim of exploring ways to reactivate the agrarian sector in rural and periurban areas in Madrid following sustainable agroecological practices by engaging local communities in participatory farming labs (hereafter Agrolabs). The initiative was born in 2015 by a Madrid Regional Government's commitment on Agriculture and the Environment regarding "the creation of agricultural laboratories for training and entrepreneurship in rural areas" (commitment No. 248). Agrolabs seek to recover the relations between rural, periurban and urban areas with economic, environmental and sociocultural solutions based on agrarian activity. Principally, Agrolabs are focused on: (1) designing a practical training program including land access to promote professionalization in the agrarian sector; (2) enhancing social inclusion and local communities' cooperation to strengthen rural-urban bonds and agrarian sector networks and (3) promoting sustainability through agroecological practices that enhance ESs and opportunities to interact with agricultural landscapes.

The principal aim of this study is to introduce the Agrolab project as a living lab to reactive the agrarian sector in rural and periurban areas in the Madrid region through the embracement of socioecological and agroecological principles. The specific objectives of this manuscript are: (1) to describe Agrolab principles and Agrolab pathway development, articulating the steps given during the period 2015–2018; (2) to identify and characterize participants in terms of their profiles and motivations and (3) to identify the most socially valued ESs (and non-ES benefits) and the actions collectively taken to enhance them. Finally, we discuss the contribution of the project towards new integrated rural development strategies, including its potential to support innovative policies that promote agroecological transitions.

2. Materials and Methods

2.1. Study Area Description

The program is run at two municipalities within the Madrid region, Spain. It first started in 2015 in Perales de Tajuña, a municipality located in the Las Vegas agrarian district (southeast Madrid); then, in 2018, a second Agrolab program was initiated in El Escorial, a municipality located in the Guadarrama water basin (central-west Madrid; Figure 1).

Las Vegas agrarian district is a semiarid territory located in the Tajo water basin, its landscapes are crossed by the Tajo River and two of its tributaries, Jarama and Tajuña and are composed of fluvial terraces. The agriculture includes horticultural crops and cereals (mainly corn, wheat and barley), olive groves and vineyards interspersed with thyme, rockrose, lavender, rosemary or esparto and dry cereals, legumes and other annual crops [22]. Regarding the socioeconomic aspects, the Las Vegas agrarian district includes 23 municipalities, with a total area of 1378 km^2. The area has a population density of 112.3 inhabitants/km^2, which provides its rural character (Table 1). During the last few years, financial and global crises have battered this region, with an unemployment rate of 26.85% (13.8% in the Madrid region according to the Spanish National Statistics Institute-INE for 2017). Traditionally, its economy has been based mainly on the farming sector and related agri-food industries. Due to Perales de Tajuña agrarian character and suitable distance to Madrid city (38 km), it is possible to distribute and sell the products produced in Perales de Tajuña in Madrid [10]. In recent decades, several projects with an agroecological emphasis have been initiated (ex. Under the Asphalt is the Orchard, or, in its Spanish acronym, BAH or Meplanto), with the aim of producing quality organic food with a minimum distribution distance. These projects have served to connect farmers in the area to exchange expertise and seeds and to conserve and maintain traditional irrigation channels and horticultural production.

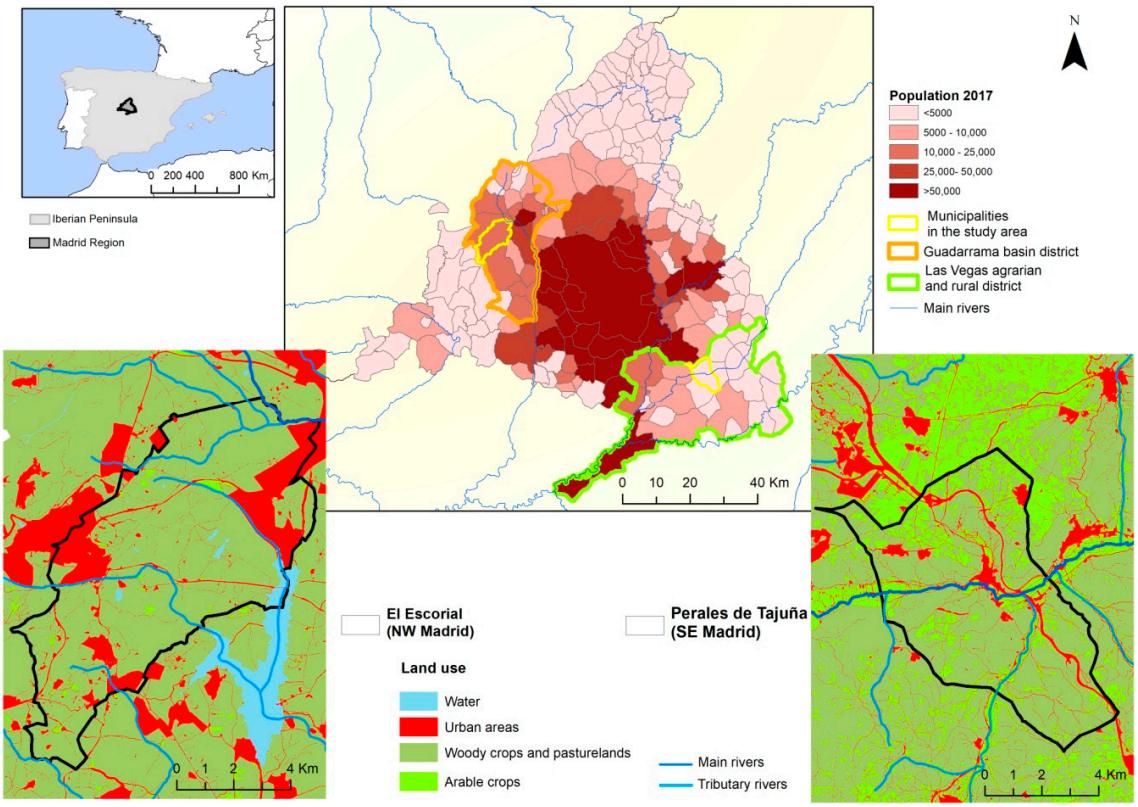

Figure 1. Agrolab locations in the Madrid region, in SE Madrid (Perales de Tajuña in Las Vegas agrarian district) and NW Madrid (El Escorial in Guadarrama basin district). Madrid region map (central map), differentiated municipalities in terms of their population, including rural (with <5000 inhabitants or <10,000 inhabitants), intermediate or periurban (10,000–25,000 inhabitants and 25,000–50,0000 inhabitants, respectively) and urban municipalities (>50,000 inhabitants). Side images represent the most representative land use of each municipality; El Escorial (**left**) has a greater representation of woody crops and pasturelands, while Perales de Tajuña (**right**) has a mixture of the woody crops, pasturelands and arable crops.

Agrolab-El Escorial is in the Guadarrama water basin (central-west Madrid, Figure 1). There are several legally recognized areas of habitat and species protection, with Sierra de Guadarrama National Park (declared in 2013) being worth mentioning. Regarding its vegetation, in the northernmost area (highest elevations), there are perennial vegetation formations and high mountain pastures, below which pine forests dominate. In the area of the middle course of the Guadarrama river, we can distinguish the plain areas (with a clear dominance of rainfed crops) and the mountain plate (with important extensions of holm oaks, accompanied by juniper and some reforested pine groves), as well as the presence of important gallery forest formations linked to the main river ecosystems (fluvial, ash, willow and poplar). Regarding the socioeconomic aspects, the Guadarrama basin district includes 19 municipalities with a total area of 764 km^2. The area has a population density of 358.8 inhabitants/km^2, which provides its periurban character (Table 1). El Escorial is located within a transition zone between the mountains and the plain. Traditionally, its economy has been based mainly on forestry and livestock, with meat production in the mountain areas and agriculture in the flat areas of the piedmont. Currently, the economic activity in El Escorial is based in the service sector and agriculture has remained a symbolic activity, while livestock farming still maintains a certain importance thanks to good-quality pastures that favour the breeding of livestock, including fighting bulls and cattle of different autochthonous breeds. A few projects have been initiated with an agroecological emphasis (Community Supported Agriculture Zarzalejo, Sierra Oeste Agroecologica).

Table 1. Environmental, socio-economic and farming characteristics of both study areas.

Characteristics	Descriptors	Las Vegas Agrarian District	Guadarrama Water Basin
Climatic and physical characteristics	**Location**	**SE Madrid**	**NW Madrid**
	Water basin and main rivers	Tajo water basing, including Tajo River and two of its tributaries (Jarama and Tajuña) and its fluvial terraces.	Guadarrama water basin, including Guadarrama River and it tributary (Aulencia)
	Surface [1] (Km^2)	1378 (49 corresponds to Perales de Tajuña)	764 (68 corresponds to El Escorial)
	Climate	Semiarid	Mountain climate to continental Mediterranean
	Average yearly temperature [2] (°C)	15	7.8
	Average yearly rainfall [2] (mm)	365	1325
	Altitude range (m.a.s.l)	500 to 840	600 to 2000
Socio-economic characteristics	Municipalities	23 municipalities (3 urban and 20 rural)	19 municipalities (11 urban and 8 rural)
	Population [3]	154,801 (2817 inhabitants in Perales de Tajuña)	274,223 (15,562 inhabitants correspond to El Escorial)
	Percentage (%) of Madrid Region (6,507,184 inhabitants)	2.4	4.2
	Population density [1] (inhabitants/km^2)	112.3 (57.1 in Perales de Tajuña)	358.8 (226.1 in El Escorial)
Farming surface [2] of each crop type (Km^2)	Pasturelands (pasture and pasture with scrub or woods)	404 (29%)	418 (54%)
	Arable crops (cultivated lands with orchards and cereals)	519 (37%)	79 (10%)
	Forest areas	80 (6%)	101 (13%)
	Olive groves	189 (14%)	0.3 (0.04%)
	Vineyards	37 (3%)	0.5 (0.1%)
	Fruit crops	13 (0.9%)	0.4 (0.05%)

[1] Geographical Information System of agricultural plots of the Government of Spain; [2] State Meteorological Agency; [3] Madrid Statistics Institute-Almudena (according to data from 2017).

2.2. Data Collection Procedure and Analysis

To address specific objective 1, we used our own experience and knowledge to describe the main project principles and the training itinerary considering the viewpoints of the various stakeholders involved, mainly local authorities, rural development organizations operating in the area and the farmers working on the project as agroecological trainers (Figure 2). The agroecological trainers are local farmers with experience on organic farming and collaborative processes contract by the project to provide technical support and practical advice. The data have been systematized following the principles that are commonly used to assess the impact of living labs [19,23]. Then, we described the project in terms of the specific principles derived from applying the living lab concept to the context of the promotion of agroecological practices by engaging local communities. The training itinerary was described following its main stages and the number of participants and organizations involved each year.

The information used to cover specific objective 2 is based on an application form that is submitted individually by people interested in enrolling in the project. The call for new participants is announced at the beginning of every year on different platforms, mainly the Regional Government of Madrid website, municipality websites, project websites and social media. The application form includes information regarding three main sections: sociodemographic characteristics, motivations to participate

and previous relationships with the farming sector. To indicate their motivations to become involved in the project, participants provided spontaneous responses to an open-format question that was later codified.

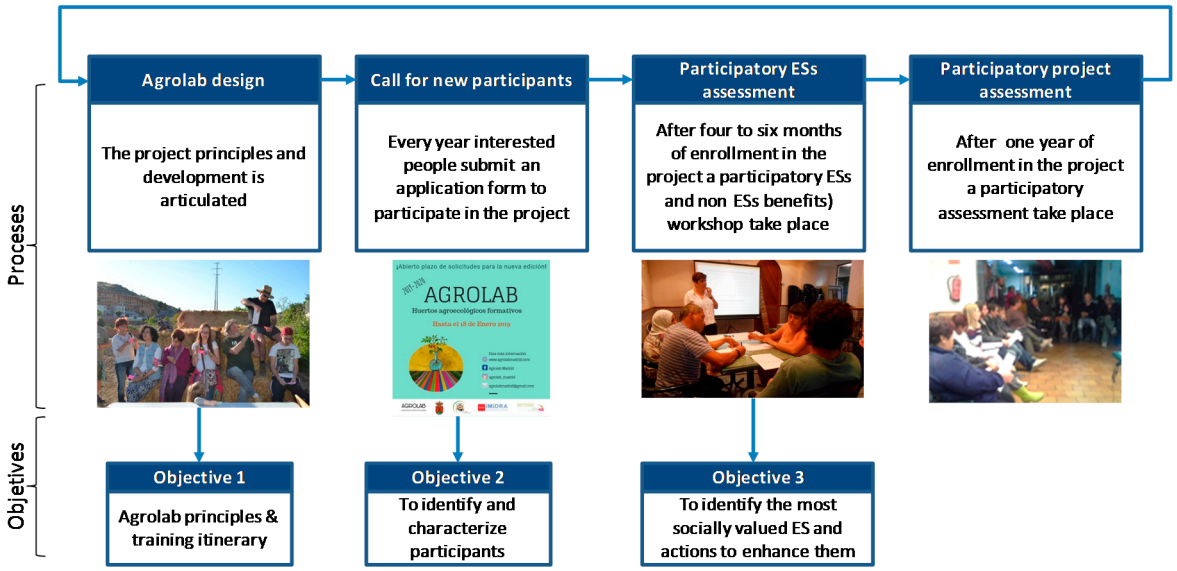

Figure 2. Description of the methodological process of the data collection based on Agrolab process and study objectives.

To cover objective 3, we present the results of an ES participatory assessment workshop that is conducted annually after four to six months of enrollment in the project, in which participants select the most socially relevant ESs that they perceive from their engagement in the project. These workshops serve to identify common representations of the provision of key ESs by agroecosystems [24]. Participants completed individual questionnaires on ES preferences including a list of a wide array of provisioning, regulating and cultural ESs provided by agroecosystems. The idea of this first exercise is to give participants time to think individually on the topic. Then, they are split into groups to choose by consensus the top five ESs provided by Agrolab to social wellbeing, discussing the rationale for their relevance. In total, the workshop was conducted 12 times (twice per year during the first three years and four workshops during the fourth year) with 91 participants who were split into 17 small discussion groups. In addition, we provide a description of the collective actions that are being conducted in association with the project to enhance agrarian ESs. During the participatory workshops, in addition to the ES exercise, we also provide participants with a list of other potential benefits of being involved in the project. All of these were ranked following a Likert scale from 1 to 5. Differences in perceived importance among all these benefits were tested using a non-parametric Kruskal Wallis test, then Dunn's test was used to test for differences between categories.

3. Results

3.1. Agrolab Principles

The project follows the common principles of living labs:

Continuity: The project has a long-term orientation period, which enhances cooperation and trust among actors. To guarantee continuity, the project should be approved and supported by local municipalities during a council plenary session. A key aspect has also been to build on trust with external stakeholders, such as landowners, who progressively are more willing to make their lands available to new farmers who have been part of the project. In addition, this continuity provides the opportunity to assess the project periodically and improve it in an iterative way.

Openness: The project welcomes people of multiple backgrounds for the exchange of knowledge and experiences. The training itinerary and the plot design and distribution are open to innovative ideas and changes every year. The training program also has an open format in which any interested person can attend the sessions and participants could propose new content or act as trainers at suggested sessions.

Realism: Participants learn from real market data regarding project cost (materials, machinery, irrigation system, etc.). Participants also have a field notebook to regularly record data (ex. harvest, crop calendars, etc.). Participants (in the second training year) also participate in local markets to learn about the most demanded products, prices or market strategies. Finally, participants design cultivated surfaces on the basis of consumer demand.

Empowerment: Participants' needs, suggestions and priorities are considered through multiple channels of communication, including day-by-day interactions, periodic assemblies, discussions in small groups and so forth. In addition, participants organize working groups according to their interest, which are mainly focused on organizing irrigation turns, the custody of local varieties, assistance attending visits, knowledge documentation and project communication.

Spontaneity: The project is a dynamic process open to new creative and innovative ideas over time.

In addition to the common principles of living labs, Agrolab holds principles related to the promotion of agroecological transitions in agrarian socioecological systems, which has been mainly based on:

Participatory: Agrolab is codesigned and coproduced based on technical and experiential knowledge, promoting collaborative and experiential learning between rural communities and urban dwellers. All stakeholders participate according to their level of interest or competence in the development of a project, responding to a collective demand or proposing solutions to problems that affect the community. This principle rests on the idea of enhancing agroenvironmental benefits through collective action; defining collective action as the voluntary involvement of a group of people with a shared interest and with common action that works in pursuit of that shared interest (based on [25]).

Inclusive social agriculture: The project is based on the promotion of social inclusion and equal opportunities. Here, we understand that interacting with agrarian landscapes produces physical, psychological, emotional, social, cognitive-educational and social and labour integration benefits [26,27]. The project prioritizes the inclusion of vulnerable participants, such as those who are unemployed or have a low income. In addition, some plots are reserved for organizations following environmental, sociocultural or health goals.

Hybrid governance system: A hybrid model promotes dialogue and facilitates shared visions and innovative solutions. The project is run thanks to the collaboration among local authorities, a research institute, the Intermunicipal Association Red Terrae for Local Development and Employment Policies through Agroecology in Spain, the agroecological trainers and the participants themselves.

Experimental: The epistemology of the word involves controlled conditions but a living laboratory provides the possibility of examining and experimenting in both real life and uncontrolled contexts as a key to enhancing innovation [28].

Modern technologies and technical knowledge: Two of the principal technologies are the development of a drop irrigation system that works through solar energy panels and the design of a weather station to measure meteorological conditions in the area. In this way, Agrolab acts as a demonstrative space or showroom for participants and for farmers and students who visit the project of how technologies are used to find solutions to limitations in the agrarian sector.

Circular economy and low carbon food: the products cultivated are seasonal products, which are sold in local markets, optimizing the materials and energy used for its production and distribution. In addition, agrocomposting activities are conducted.

Scientific and scalable: Instruments such as scales, surveys and workshops are used to evaluate participants' preferences and progress. This project is intended to facilitate (in a gradual and

documented way) the creation of a model that can be extended and applied to other municipalities in the Madrid region, with an emphasis on internal coherence and collaboration.

3.2. Agrolab Pathway Development

In the case of individual participants, a training method was designed based on the guidelines provided by the Intermunicipal Association Red Terrae for Local Development and Employment Policies Through Agroecology in Spain [29] and adapted following participants' suggestions (ex. ensuring the existence of plots for local varieties, meeting and resting areas or agrocomposting zones). One of the main pillars of this approach is the development of a practical training itinerary in agroecology made up of several stages of technical, socioeconomic and environmental accompaniment (in contrast to more intensive and time-bound training). Each phase is undertaken for one year to complete an annual crop cycle. During phase I (total surface between 3000–4000 m^2), participants work collectively at community orchards and then apply the lessons they have learned at self-consumption (not for sale) and individual orchards of 50 m^2 (N = 24/25 individual orchards available). During this first stage, participants receive weekly training regarding land planning, sowing, planting, harvesting and other complementary skills (Figure 3). In phase II (total surface between 4000–5000 m^2), participants aiming to professionalize move to larger orchards (between 200 m^2 and 1000 m^2) and initiate small-scale marketing activities. At this stage, the training is also focused on recruiting consumers, participating in local markets organized at the municipality level, developing business ideas, business plans and communication and complementary training, such as product transformation through the canning of vegetables. At this stage, there is an effort to enhance the benefits of collective and cooperative strategies for crop production and commercialization. At a third year, the incorporation of new agents into the agrarian sector takes place through the establishment of small businesses or cooperatives. During the stage, local authorities mediate between participants who want to acquire (by sale or lease) land at an affordable price and landowners. Other participants could opt to establish their own productive orchard with a self-consumption purpose. In the case of entities, they follow and remain at phase I.

Figure 3. Agrolab training. (**A**). Participants of Agrolab-Perales de Tajuña carrying out soil preparation work for spring planting. (**B**). Association of potato (*Solanum tuberosum* L.) and chives (*Allium schoenoprasum* L.) crops. (**C**). Pre-Columbian polyculture formed by corn (*Zea mays* L.), beans (*Phaseolus vulgaris* L.), pumpkin (*Cucurbita moschata* Duchesne) and cayenne (*Capsicum annuum* L.) at Agrolab-El Escorial; at the picture corn (*Zea mays* L.) and beans (*Phaseolus vulgaris* L.) are seen.

Since February 2015, the initiative has held four annual implementations, four in Perales de Tajuña and one in El Escorial (Table 2). It has involved 126 individual participants and six entities, together with agroecological trainers, local authorities, the local action group operating in this region and an agrarian research institute (IMIDRA) as mentors.

In total, 27 people and one socioeducative entity working toward the integration of children and young people were registered in 2015 (first edition). Of these participants, 10 began the second stage and then four opted to grow their own vegetables for self-consumption purposes in the third year (Table 2). During the second edition (2016), 20 people started the project together with the same socioeducative entity. Of these participants, four began the second stage. Overall, three participants established their own business; two of them focus on productive initiatives of organic products sold at short-supply chains and a third focuses on the dynamization of abandoned lands and the integration of displaced people. At least three of the participants from the second edition are running self-consumption plots.

Table 2. Participants' engagement in different program stages for four years. P: Perales de Tajuña, E: El Escorial.

Project Edition	First training Stage (First Year)	Second Training Stage (Second Year)	Professionalization (Third Year)	Life Style Change (Third Year)
2015	27 individuals 1 entity	10	0	4
2016	20 individuals 1 entity	4	3	3
2017	31 individuals 2 entities	7	2	0
2018	48 individuals (18-P and 30-E) 4 entities	13 (6-P and 7-E)		

In 2017 (third edition), 31 participants joined the project together with two entities. One of the entities included the staff and residents of an elderly people rest home. The purpose was to create opportunities to interact with society (going beyond other residents or the family of the residents); at the same time, it created opportunities for young participants to learn from elder participants about traditional methods for growing crops, different varieties of crops and the agrarian sector in the past decades. It was also a training opportunity for the residence staff, who had created an occupational orchard at the residence. Finally, it was an incentive to introduce new products and vegetables into the residents' diet. The second entity was an environmental organization enhancing environmental activities in Madrid city. Among their activities, they offer a training program in collective home gardening to urban dwellers for one year. Those who want to continue have the possibility to join the Agrolab horticulture plots, which provides them with an opportunity for continuity and the option to engage in horticultural activities in a productive agrarian and rural environment. During the third iteration, 7 participants continued in the program to reach the second training stage, of whom two began productive initiatives.

Finally, in 2018 (fourth edition), 48 participants joined the program (18 of them at Perales de Tajuña and 30 of them at El Escorial), together with two entities at each site (Table 2). At Perales de Tajuña, one of the entities was the environmental organization operating in Madrid city mentioned above and the other was the municipality school. In El Escorial, one entity works on the preservation of the natural and cultural history of El Escorial through the organization of environmental activities, the planting of native trees and the promotion of organic farming and so forth. The other one is a parents' association for the integration of people with functional diversity into society through leisure activities and training workshops (gardening, cooking, crafts, etc.) in El Escorial and its surroundings. Of these participants, 13 expressed their interest in starting the second stage in 2019 (six of them at Perales de Tajuña and seven of them at El Escorial).

3.3. Characterization of Participant Profiles and Motivations to Become Involved

The individual participants ranged in age from 18 to 70 years, with an average age of 41 years and 45% of participants under 40 years. A total of 55% of the participants were women, facing the increasing rates of masculinization in rural areas (Table 3). Overall, 44% of the enrolled participants were unemployed and this percentage was higher in Perales de Tajuña (47%) than in El Escorial (33%; see Table 3). Regarding their municipality of origin, in the case of Perales de Tajuña, the participants were from the same municipality (45%), other municipalities in the Las Vegas agrarian district (11%) or Madrid city and other urban areas in Madrid (44%).

Table 3. Participant sociodemographic characterization (N = 126 respondents). * Refers to 2016–2018 (N = 99 respondents), as this question was not included during the first edition (2015). Dk/Da: Do not know/Do not answer.

Variable		Pool (%)	Perales de Tajuña (%)	El Escorial (%)
Age	<30	14	15	10
	30–40	32	32	33
	40–65	52	52	54
	>65	2	1	3
Gender	Women	55	60	40
	Men	45	40	60
Unemployed		44	47	33
Residence	Same municipality	51	45	70
	District	15	11	30
	Madrid city	34	44	0
Level of formal education	Non formal studies	3	3	4
	Primary	9	9	11
	Secondary	39	36	48
	University	49	52	37
Available time * (h/week)	<2 h	1	2	0
	2-4- h	19	24	7
	4–6 h	21	23	19
	6–8 h	21	26	11
	>8 h	38	25	63
Professionalization interest *	Dk/Da	13	13	11
	None	5	0	15
	Low	6	4	11
	Medium	26	25	30
	High	50	58	33

In the case of El Escorial, they were from El Escorial (70%) or other municipalities in the northwest district (30%). Almost half of the participants had undertaken university studies (49%) or secondary studies (39%). Almost 60% of the participants were willing to dedicate more than 6 h per week to the project. Finally, 76% of the participants expressed a high or medium interest in becoming professionalized in the agrarian sector. In this regard, 51% of the participants had previous experience, 10% of them had undertaken studies in this field (including degrees in agronomy, gardening, organic farming, etc.), 8% had their own orchard, 6% had family orchards, 5% had participated in community orchards and 3% had been employed in this sector.

The motivations for joining the project were highly diverse, including to improve work opportunities and skills thanks to the practical training (50% of responses), to obtain quality food products to enhance self-sufficiency (20%) and to learn and promote organic farming (13%). Other reasons were related to be in contact with natural landscapes (9%), instilling family values (9%), being part of a collective action (8%), maintaining traditional knowledge and practices (8%) and

preserving agrarian landscapes and enhancing alternatives to conventional farming (4%, Figure 4). Considering the differences between individual participants (men and women) and entities, the indicated motivations of the latter related to practical training to improve work opportunities and skills, the interest to learn and promote organic farming, the interest to be part of a collective action, the use of horticultural resources as educational tools and the promotion of inclusion, occupation and rehabilitation. As can be seen in Figure 4, differences exist between men and women but the significance of the differences was not tested because there were not enough data for all the motivations. It can be observed that while practical training to improve work opportunities and skills was the most mentioned by men and women, men were more interested in learning and promoting organic farming and instilling traditional knowledge and practices. In contrast, women showed a higher interest in obtaining quality food products, being in contact with natural landscapes and instilling family values.

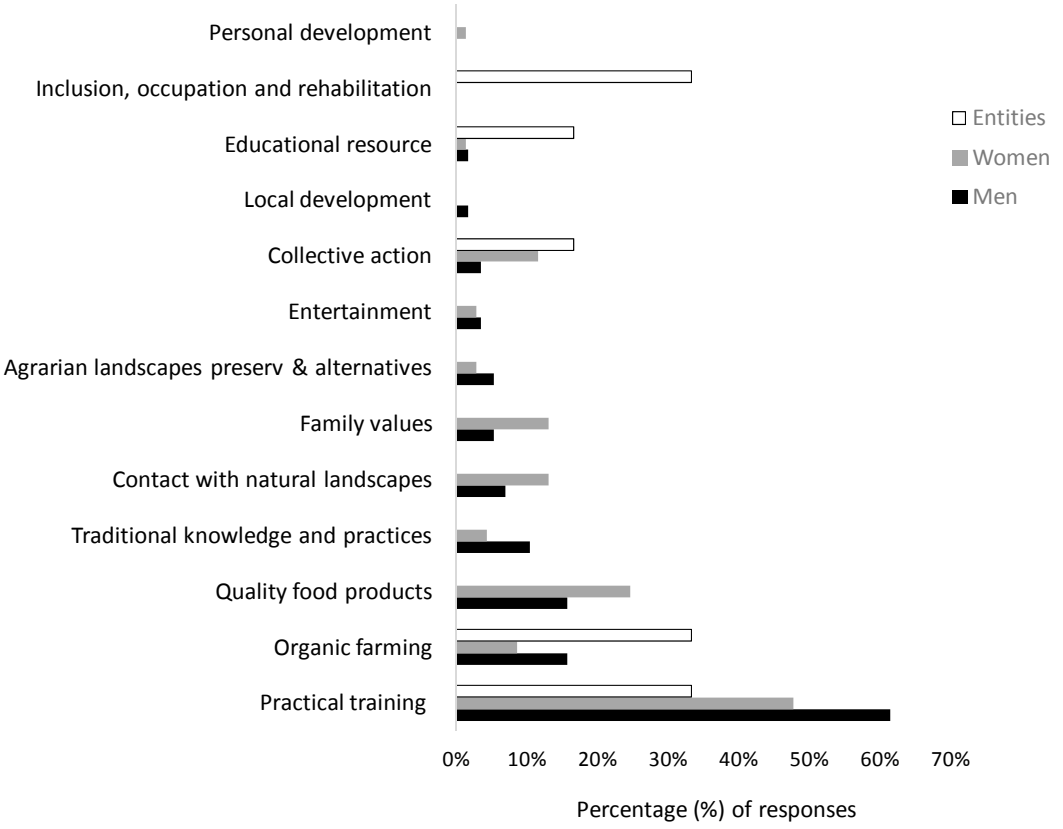

Figure 4. Motivations (in terms of number of responses) expressed by participants (distinguishing men, women and entities) to become involved in Agrolab.

3.4. Identification of ESs and Other Benefits from Agrolab

During the workshops conducted with project participants, 20 ESs were selected by at least one group because of their importance (Table 4).

Two of the most noted were provisioning ESs: obtaining quality food products (selected by 16/17 groups) and improving agrobiodiversity by growing local varieties (8/17). There is a correspondence between ESs and Agrolab actions, as the key activity is the production of agroecological horticulture products. In addition, there is custodial motivation, as varieties from the region are being grown for reproductive purposes.

Table 4. Ecosystem services (ESs) selected during participatory workshops because of their delivery importance (expressed as number of groups (N) that selected them), their rationale (following workshop discussions) and a description of the collective activities conducted to enhance them.

Ecosystem Services	N	Rationale	Collective Actions at Agrolab to Enhance Them
Provisioning ESs			
Obtaining quality food products	16	*"To grow quality, tasty and healthy products. Growing our own products provides the opportunity to know where the product comes from and to follow its whole production process".*	The project is based on producing vegetables for self-consumption and short food supply chains following agroecological principles. More than 30 vegetables are produced during the different seasons.
Conserving local varieties	8	*"In the local economy, local varieties improve self-sufficiency and the gene pool. It is a way to preserve cultural heritage and local identity and to value local knowledge regarding seed selection processes, the way to grow them and the characteristics of each variety".*	An initiative of traditional seed custody is being conducted. Eight landrace varieties (*Solanum lycopersicum (3), Phaseolus vulgaris (2), Spinacia oleracea, Pisum sativum, Brassica rapa*) are being grown for reproductive purposes and in situ conservation. Data are being taken to characterize them.
Regulating ESs			
Soil fertility	5	*"It is key to maintain fertile valleys and sustainable agriculture. Large areas of monoculture and pesticides are of concern".*	Use of deep-root plants to provide soil structure. Other practices include growing green manure (fall cover crops) and crop associations. Green waste composting is conducted to improve soil organic matter.
Pollination	3	*"Essential for good harvests".*	To attract wild pollinators, together with other beneficial insects and natural predator, nest sites have been built and installed in the plot. Annual and perennial plants with melliferous flowers are grown at the field margins (lavender, pennyroyal basil, mint, thyme, sage, rosemary, calendula).
Air quality	2	*"Essential for health, to maintain healthy environments".*	The cultivation of abandoned or underutilized land has a beneficial effect on carbon sequestration, reducing emissions and improving air quality.
Healthy outdoor spaces availability	2		Plots are located at the margins of the two municipalities, surrounded by a natural and agrarian environment.
Habitat for species	1	*"To maintain life".*	Soil biodiversity, field margins, crop diversification and wild biodiversity
Water flow regulation	1	*"Drip irrigation is saving water compared to conventional systems. It is also saving time".*	Drip irrigation is used. Irrigation channels are cleaned collectively (with other farmers) upstream to avoid clogging. Soil mulching is done to reduce water evapotranspiration and to provide soil moisture.
Cultural ESs			
Knowledge exchange	11	*"Obtaining collective enrichment, learning from other experiences and knowledge".*	Training days and work in collective plots provide spaces for dialogue and practice. Public participation principles and behaviours are introduced (effective communication, active listening, respect of speakers, etc.).
Satisfaction for agrarian landscape preservation	8	*"To recover a space that was abandoned or occupied. It is a way to beautify the municipality. The landscape has to be maintained, as it supports food production. We are working in a circular process, growing life and being fed with quality organic products".*	An agrarian land inventory should be conducted. Contact between landowners and interested new farmers should occur to reactivate abandoned lands.
Sense of belonging within a community	6	*"We feel supported (do not feel lonely) during the learning process. Participation in the project is a way to be integrated into the village. It is a meeting point in an individualistic society".*	Participatory ESs mapping has been done to identify the locations associated with a sense of belonging. During the project, indicators are being measured, such as the perceived social support indicator.
Maintain traditional and cultural knowledge and practices	4	*"Actively using traditional knowledge and practices".*	Tutorials and a special seminar regarding the traditional uses of wild plants were conducted. Local varieties are maintained.

Table 4. *Cont.*

Ecosystem Services	N	Rationale	Collective Actions at Agrolab to Enhance Them
Self-esteem	4	*"It is rewarding to participate in this activity and to recover agrarian lands and local varieties. It is a way to feel useful in a community that pursues a meaningful goal".*	During the project, indicators are being measured, such as the perceived life satisfaction scale.
Nature respect and environmental education	3	*"Projects of this type are contagious and encourage an increasing number of them to be executed".*	The project is open to visits from other farmers acting as a demonstrative plot and for field studies (ex. for university students attending agroecology courses).
Patience and understanding the rhythm of nature	2		During the project, indicators such as the connectedness to nature scale are being measured.
Maintain local identity	2	*"This is the essence of the project, allowing the municipality to recover part of its identity. This is important because it allows us to feel part of a community".*	
Entertainment	1	(rationale not provided)	
Empathy	1	(rationale not provided)	
Forget problems	1	(rationale not provided)	
Physical exercise	1	(rationale not provided)	

Six regulating ESs were highlighted; of these, soil fertility (5/17) and pollination (3/17) stand out, followed by expending time in healthy outdoor spaces (2/17), air quality (2/17), habitat for species (1/17) and water flow regulation (1/17). Those ESs are being collectively managed at the farm level through actions such as cultivating deep-root plants, as artichokes, to provide soil structure, growing green manure as a soil amendment to fix nitrogen, creating nesting sites and field margins to provide suitable habitat for wild pollinators or soil mulching with straw to reduce water evapotranspiration and increase soil moisture (a detailed description of practices is given in Table 4).

Finally, cultural ESs were the most diverse category, with 12 ESs selected. Some of them were intellectual, cultural and representative interactions with nature, such as knowledge exchange, that stand out, being noted in 11 of 17 groups: satisfaction with preserving agrarian landscapes (8/17), maintenance of traditional and cultural knowledge and practices (4/17) and maintenance of local identity associated with agrarian practices (2/17). Others were related to the spiritual and symbolic interactions established with nature, such as the sense of belonging within a community (6/17), self-esteem (4/17), respect for nature and environmental education (3/17), patience and understanding the rhythm of nature (2/17), empathy (1/17) or forgetting problems (1/17). Aspects associated with physical interactions with nature that were mentioned were entertainment (1/17) and physical exercise (1/17). These ESs relevance corresponds with Agrolab goals regarding public participation, collective action and connectedness to nature.

When we asked about the impact of Agrolab on agricultural activities, the idea of enhancing the image of agriculture in society had the highest support, with statistically significant differences, followed by building new networks between producers and consumers, the establishment of connections between rural and urban citizens, work opportunities and skills and carrying out alternative services to broaden and diversify farming activities in the municipality. Saving money on groceries and the involvement of more stakeholders in agricultural activities were less supported (Table 5).

Table 5. Impacts of the project on personal wellbeing and the agricultural sector (n = 91). SD, standard deviation. Differences in perceived importance among them were calculated by the Kruskal Wallis test (statistical significance at $p < 0.05$) and letters represent significant differences between groups following Dunn's test.

Item	Average	SD	Dunn Groups
Enhance the image of agriculture in society	4.146	0.818	A
Build new networks between producers and consumers	3.848	0.949	AB
Establish new connections between rural and urban citizens	3.817	1.020	AB
Work opportunities, work skills	3.810	0.975	AB
Carry out alternative services to broaden and diversify farming activities in the municipality	3.797	0.979	AB
Involve more stakeholders in agricultural activities	3.638	1.009	B
Save money on groceries	3.349	1.064	B

4. Discussion

Historically, extension services have played a key role in the accumulation and validation of technical knowledge; for decades, this service has been mainly privatized and therefore free and accessible extension services for farmers have decreased [30]. Many of the innovations do not reach family farmers and far fewer reach nonprofessional farmers or those still trying to become established as farmers. One of the main difficulties of technical support in agriculture is the lack of sufficient interaction and cooperation between farmers and advisory services [31]. In addition, not all advice should focus on technical knowledge but on social, cultural, legal, economic or environmental aspects. Farming knowledge produced, accumulated and translated in a linear way from knowledge centers, such as universities or research institutes, to farmers are disconnected from real-life problems of the farming sector and from societal goals and needs; additionally administrations and extension services usually react too slowly to new challenges [32]. To address these challenges, this project has created a living lab experience to enhance participation and collective action within the agrarian sector. In association with the project, participants find support through permanent communication with the group and with the agroecological trainer and through continuous meetings and assemblies. These meetings serve as spaces for discussions about agroecological topics, experiences, training topics for future sessions and ideas for new action in the plot and organization. As argued by previous authors for the case of organic farmer networks, such interactions provide opportunities for the diffusion of experiences and innovations and also help to minimize the need to conduct experiments on one's own [33]. To offer practical and supervised knowledge and work opportunities thanks to the availability of a permanent and practical project has been one of the main motivations to become involved in the project. Nevertheless, motivations to enroll have been highly diverse. We have found that the project has increased trust and land tenure dynamics to reactivate abandoned or underused lands, which are significant in the Madrid region (Madrid lost 33.5% of agricultural farms in the period 1999–2009 [12]). In fact, participants point out as some of the main contributions of the project the possibility to enhance the image of agriculture in society, build new networks between producers and consumers, establish connections between rural and urban citizens and carry out alternative services to broaden and diversify farming activities in the municipality. According to previous studies, the proximity of farms to urban areas, linked to urban demand for good quality and services, could encourage farmers to carry out innovative activities beyond commodity production such as including touristic, social and didactic services [34]. At agroecological transitions, there are farmers looking for innovative ways to relate with agricultural land and the provision of food and non-food services. Simultaneously, the environmental and social concerns of consumers increase and new organizational models are needed (ex. community supported agriculture, agroecological farmers' markets, etc.) to organize the provision of goods and services in innovative ways [32]. Here, we propose an empirical experience for landscape planning in rural and periurban areas where a new

organizational structure is created among established farmers, new farmers, landowners, rural-urban inhabitants, local governments and researchers.

However, the project has also encountered limitations that should be considered, with one of the most relevant being the difficulty of connecting with the local inhabitants (those not involved in the project as participants) and with other existent (mainly agroecological) farming initiatives at the local level. The project has actively involved new farmers but is still not completely connected with local farmer groups, which in some cases do not feel that they have received the same level of support from local authorities. At Agrolab, we as researchers have been part of the action arena, acting as facilitators, documentarists and voices to disseminate information about the project at academic forums and to interact with local authorities. As a project supported by the Madrid regional government and driven by a research institute, we have played a role in interacting with local authorities in a way that could be less possible for other actors. We are concerned with the implications of this fact in terms of power asymmetries that exist; however, it has helped create a space of dialogue with local authorities to study and prioritize the reactivation of the farming sector. Over the long term, the project is designed to be sustained by local networks, placing the research center as a supporter (giving a step backwards), research observer and nexus between initiatives. The project has created social capital within the group but still has the challenge of amplifying its dissemination to other farmers in the municipality and the private sector related to the agrifood chain (restaurants, school cafeterias, etc.). Another challenge would be to extend beyond individual projects to regional initiatives and to create suitable farm conditions that could be reached or economically afforded by participants who decide to establish themselves showing economically viable options and alternatives. It is also worth mentioning the shortcomings related to data gathering in a long-term project whose own nature is characterized by a living and dynamic space, being difficult to perform follow-ups with participants, which is a limitation stated in previous studies [25]. To have such dynamics, changes and heterogeneity within the group could reduce the effectiveness of the processes [35]. Nevertheless, this study constitutes an empirical study bringing into practice the different approaches related to sustainable agroecosystems and shows how to empirically enhance socioecological system stewardship [36].

Previous studies have suggested the capacity of participatory approaches and collective action to promote agroecological transitions and agroenvironmental public goods in terms of ESs [37–40]. Collective action has been highlighted as a solution to be combined with markets and government regulations to guarantee the supply of non-food products in agricultural landscapes [35]. In fact, agroenvironmental schemes, one of the key measures developed under the Rural Development Programme in Europe, are investigating new formulas where the incentives are applied to farmers' collectives instead of individual farmers [18]. Non-food products (and nonmarketable outputs) refer to ESs such as pollination, pest control, soil conservation and fertility or water regulation, are usually public or quasi-public goods that benefit society beyond farmer economic profitability. Most farmers face market incentives to manage their land for the short-term production of food, leaving behind agroenvironmental benefits that require expanding management from food production to the stewardship of agricultural landscapes. However, only through cooperation can farmers gain a collective benefit that could not be achieved by individual efforts; this is especially relevant for specific ESs that are provided at the landscape level such as pest control, habitat for species, flood control or pollination. For those cases, one farmer decisions and practices could impact on another nearby farmer [35]. In addition, effective collaboration requires knowledge on how ecosystem components interact across various geographical and jurisdictional boundaries and a precise analysis of the actors that should be engaged [41]. The degree to which stakeholders perceive themselves as interdependent with other stakeholders could increase people's interest in collective action [24]. A way to encourage farmers to participate in cooperative solutions is to uncover the interactions among different ESs, highlighting practices that ensure the maintenance of one of the ESs while also having an impact on another ES (ex. field margins would increase the presence of beneficial resources for both pollination and disease control [35]). In this study, we used the ES approach to assess the main benefits perceived

by participants and to create a space to discuss their importance and interactions and ways to enhance them. Overall, 20 ESs were mentioned, with obtaining quality food products, conserving local varieties, knowledge exchange, satisfaction for agricultural landscape preservation and sense of belonging within a community being the top five ESs. In the project, participants are encouraged to work in a cooperative way and to dedicate an important amount of time to managing the plot, introducing agroecological practices that will affect ESs improvement, such as enhancing crop associations, growing green manure, leaving areas with aromatic flowers and field margins to attract pollinators and other beneficial insects and so forth. Nevertheless, some of the main barriers of collective actions are related to the free-rider effect (associated with those members who benefit without contributing) or the related high transaction cost (derived from negotiating and reaching agreements), skeptical members and the uncertainty of the future direction of government support or policy instruments [37]. To guarantee the permanence of these practices once participants have become established, a combination of collective actions, supported by market and government incentives, will be necessary.

In this case, Agrolab aims to contribute to the renaissance of the farming sector in the Madrid region. Its activities are part of the local and regional priority measures for sustainability and rural development. At the regional level, Agrolab contributes to the objective of promoting "intelligent, sustainable and inclusive growth" of the Community of Madrid's Rural Development Programme 2014/2020 (CM-RDP 2014/2020), approved by the European Commission in 2015. In this sense, Agrolab promotes knowledge transfer and innovation; improve the viability of agroecological farms, the promotion of short food supply chains and low carbon economy, the preservation of agroecosystems and the economic development in rural areas. The regional government has supported the project by providing research guidelines, technical assistance, facilitation and financial assistance to partially cover the cost. In parallel, other strategies to ensure agricultural landscape sustainability are being developed. One of them is the Strategy to Revitalize Rural Municipalities of Madrid region [42]. This strategy, approved in 2018, was designed for 78 municipalities with less than 2500 inhabitants to encourage population growth in rural municipalities and seeks to reduce dependence on nearby urban areas with different measures, some of them focused on the promotion of traditional crops and organic production. Another example is the Strategy of Air Quality and Climate Change of Madrid region for the period 2013–2020, with measures related with the application of sustainable tillage practices, incentives towards organic farming, promotion of organic food products and training programs for farmers [43]. Finally, in 2018, 26 regional operational groups has been established in Madrid region as instruments of the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) programmed at the Rural Development Programmes (CM-RDP 2014/2020, measures 16.1 and 16.2 [44]) during the period 2014–2020. Finally, at the local level, Agrolab lines up with the Milan Urban Food Policy Pact objectives, which have been signed by more than 120 cities around the world committed to advancing food system development based on the principles of sustainability and social justice. At this stage, it is key to reinforce policies and fix institutional arrangements to guarantee the establishment of this project or others looking for agroecological transitions. At the time of writing this manuscript, three new local authorities have stated their interest in beginning the project in their municipalities.

5. Conclusions

In this article, we have described and analyzed living lab principles in the context of agriculture with the purpose of reactivating the agrarian sector in rural and periurban areas of Madrid with agroecological practices enhanced by collective action and cooperation. Based on our findings, the Agrolab project follows the common principles of living labs in relation to continuity, openness, realism, empowerment and spontaneity together with the promotion of an agroecological transition following socioecological system thinking by enhancing participation, social inclusion, circular economy and a combination of knowledge systems by using an experimental and scientific design that ensures monitoring. Since February 2015, the initiative has held four annual implementations and has

involved 126 individual participants and six entities working in the promotion of environmental, sociocultural and health goals together with the technical support and advice of agroecological trainers, local authorities and an agrarian research institute as mentors. The project constitutes an empirical experience for agricultural landscapes reactivation in rural and periurban areas, enhancing innovative organizational models among actors related to the agrarian sector, researchers and managers. The participatory approach and collective action followed in the project have affect ESs social recognition and improvement and could be conceived as a viable alternative towards agroecological transitions. To ensure agricultural landscape sustainability and to guarantee projects in this direction, we appeal for a solid integration of these types of initiatives in landscape planning and agrarian development strategies.

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