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Agroecology in Mediterranean Europe: Genesis, State and Perspectives

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Abstract: The Mediterranean agro-food systems need to be properly managed. A promising pathway is the transition towards more sustainable food systems through agroecology, which represents the ecology of food systems. In this paper, the state-of-the-art of agroecology is described for three representative euro-Mediterranean countries: Italy, Greece, and Spain. The analysis has been partly based on results of a dedicated literature search and partly on grey literature and expert knowledge. After an overview of the history of agroecology, targeted research and education, collective action (political and social), and some agroecological practices in the three countries are presented. These countries share a rather similar use of the term "agroecology", but they differ regarding (i) the existence/extent of strong civil and social movements; (ii) the type of study/educational programmes, and the relative importance of different scientific disciplines and their evolution; (iii) the development of political support and legal frameworks; and (iv) the elaboration of concepts to rediscover traditional practices and apply new ones, often taken from the organic agriculture sector. Agroecology is an emerging concept for the Mediterranean agricultural sector, with huge potential due to the peculiar socio-cultural, bio-physical, and political-economic features of the region. To boost agroecology in Mediterranean Europe, better networking and engagement of different actors within a coherent institutional framework supporting the transition is strongly needed.

Keywords: science; practice; movement; Italy; Greece; Spain

1. Introduction: Agroecology in the Mediterranean Context

Although the green revolution provided a significant increase in food production, the intensification and industrialization of food systems resulted in negative externalities and pressures, both in terms of environmental and socio-economic aspects. Specifically, biodiversity loss; soil fertility decreases due to soil erosion; salinization and acidification; pollution of water, soil, and air; and greenhouse gases (GHG) emissions, as well as abandonment of rural territories, social injustice, and low quality food and diets, became apparent and well described [1–4]. In order to limit the above mentioned negative externalities, several directives and plans, such as the European Union (EU) Common Agricultural Policy (CAP), the EU Nitrate or Water Framework Directives,

and nature conservation policies such as the NATURA 2000 network of protected natural areas, have been approved and promoted in Europe [5,6]. Anyhow, these directives do not address the redesign of whole food systems and their provisions are not aimed at substantially modifying the monoculture nature of dominant agroecosystems. Hence, negative impacts of industrial agriculture could only be temporarily moderated [7]. In terms of agricultural and food systems present in the Mediterranean basin, there are specific strengths and weaknesses, which affect and are strictly connected with sustainable rural development. Among the strengths, the following can be mentioned:

(i) The Mediterranean bioclimatic region is considered a biodiversity hotspot; it possesses an outstanding flora diversity of 15 to 25 thousand species, of which 60% are unique to the region, and 1912 species of amphibians, birds, fishes, mammals, arthropods, and reptiles, almost half of which are considered threatened, endangered, or vulnerable [8]. The Mediterranean also possesses the highest level of "refugia" in Europe [9,10], which represent climatically stable areas resulting from complex historical and environmental factors. Refugia constitute a high conservation priority, being key areas for the long-term persistence of species and genetic diversity, especially given the threats posed by extensive environmental changes operating in the Mediterranean region.

(ii) The existence of traditional ecological and agricultural knowledge in the Mediterranean area, characterised by a strict link between agriculture and society. This was developed due to historical and geographical features and a land-sharing approach, which seek to develop a synergistic interaction between human land uses and nature conservation areas [11], governed by collective norms, for example, shared grazing and shared woodland exploitation [12,13].

(iii) The Mediterranean diet, which was recognized in 2013 by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as an intangible cultural heritage of Cyprus, Croatia, Spain, Greece, Italy, Morocco, and Portugal. Conviviality, that is, the pleasure of eating together, was recognized as the cornerstone of food culture in the region [14]. The Mediterranean diet is an assemblage of local ecological knowledge, practices, and traditions ranging from the landscape to the table, including crops, harvesting, fishing, food conservation, processing, preparation, and particularly consumption. It is considered an important example of sustainable diet, as defined by Food and Agriculture Organization (FAO) [15], including high quality food products linked with positive health effect (e.g., olive oil, nuts, whole grain cereals, fruit and vegetables, legumes, fish, and honey) and low presence of unhealthy food (e.g., red and processed meat, butter and margarine, and sugar). It is also rich in traditional gastronomic specialties often shared in conviviality, drives sensitivity to local food value chains and entrepreneurial rural vitality, and raises interest of younger people for ecological agriculture and biodiversity [16]. Furthermore, a sustainable diet also features characteristics such as cultural acceptability, accessibility, economic fairness, and affordability [17]. The Mediterranean diet emphasizes the development of bio-cultural diversity; a co-evolution in which humans have interacted with their natural surroundings.

Among weaknesses of Mediterranean areas, the following can be mentioned:

(i) The environmental vulnerability to climate change effects, including water scarcity, soil erosion, desertification, and biodiversity loss. The Mediterranean is considered to be one of the areas at higher risk of damage for agriculture due to climate change. The latest projections from the Intergovernmental Panel on Climate Change estimate that crop yields in southern Europe are very likely to decrease due to increase in temperature, drought risk, and heat stress, and decrease in annual rainfall and water availability [18], which is often already limited between 300 mm and 600 mm. Similarly, climate change may adversely affect dairy production because of heat stress in lactating cows and increased occurrence of vector-borne diseases in ruminants. Irrigation needs are expected to increase, but will be constrained by increasing demand from other sectors and high economic costs [18]. Any measures aimed to foster mitigation and adaptation to climate

change become of utmost importance to preserve agricultural productivity and so to increase resilience of Mediterranean agroecosystems and rural societies.

(ii) A considerable increase in agricultural land abandonment, as the Mediterranean region has been highlighted as one of the areas at higher risk in Europe [19]. This is due to the poor performance of southern European countries in most of the eight related risk indicators: weak land market, low farm income, lack of investment in the farm, high share of farm holders older than 65 years, high share of farm holders with low qualification, low farm size, remoteness and low population density, and low share of farms committed to specific schemes linked to continue farming. For example, in the whole territory of Greece, Italy, Portugal, and Spain, the share of farmers older than 65 years is above 30% [19]. Van der Zanden [20] confirms that agricultural abandonment can have both negative and positive consequences, for instance, while abandonment of certain areas has increased carbon sequestration and habitats for large mammals as a positive consequence, in other areas, this can cause a considerable loss in cultural heritage landscapes. Agricultural land abandonment is both a socio-economic and environmental problem because it increases loss of biodiversity and ecosystem services; risk of fire, floods, and landslides; and marginalisation of rural areas and people, besides diminishing territorial food self-sufficiency.

(iii) Despite the well-documented health and environmental benefits of the Mediterranean diet, current data show a decline in adherence in many Mediterranean countries, because of manifold influences, including life style changes, globalization of food markets, and economic and socio-cultural factors [21,22].

From what has been said above, it becomes evident that these important challenges for Mediterranean agro-food systems should be properly managed. A promising pathway is the transition towards more sustainable food systems with agroecology, which appears to have the potential to solve several of these problems [23,24].

As seen nowadays, agroecology represents the ecology of food systems [25] and includes (i) scientific and educational approaches, (ii) social and political movements, and (iii) a set of practices [26]. A recent definition of agroecology [27] is the following: "*the integration of research, education, action, and change that brings sustainability to all parts of the food system: ecological, economic, and social. It is transdisciplinary in that it values all forms of knowledge and experience in food system change. It is participatory in that it requires the involvement of all stakeholders from the farm to the table and everyone in between. And it is action-oriented because it confronts the economic and political power structures of the current industrial food system with alternative social structures and policy action. The approach is grounded in ecological thinking where a holistic, systems-level understanding of food system sustainability is required*."

In this paper, we have used these three major themes to confront and discuss the status of agroecology in Italy, Greece, and Spain as representative examples of Mediterranean countries. For each country, we have structured our analysis into the following parts: history of agroecology, research and education, collective action (political and social), and a set of most important related practices. The final aim of the paper is to understand the dynamic of agroecology in the Mediterranean in order to find a suggestion on how to sustainably manage this area relevant for cultural, natural, social, and economic capital.

2. Methods

We started our analysis by conducting a review of the published literature on the Scopus™ database (last accessed: 3 June 2018). We used the following search strategy: "Agroecolog*" AND "Mediterranean" OR "country name" (in title, keywords or abstract).

As our focus was on Mediterranean Europe, we included only the names of countries geographically located in Europe or belonging to the European Union (Cyprus). Turkey was excluded as the majority of its territory is part of Asia. France was eventually excluded, because most of the French studies on agroecology do not refer to its Mediterranean part (Only one record included both

"agroecolog*" and "Mediterranean" in title, keywords or abstract. The search term "Mediterranean" yielded 69 records.). We also excluded papers referring to Mediterranean climates outside Europe (e.g., Chile, northern Africa, near East, Western Australia, South Africa). After reading the abstracts, papers referring only to geo-pedoclimatic features (e.g., "agroecological zones") and those using the keyword "agroecology" clearly in an equivocal context (e.g., papers dealing with herbicide-resistant or conventionally-managed crops) were then deleted.

Spain and Italy emerged as the Mediterranean countries (excluding France) with the highest number of papers published on agroecology (Table 1). Despite the low number of published studies, Greece was included because there is momentum for agroecology, also driven by the recent economic crisis (Gkisakis, pers. comm.), and in order to focus our analysis on three representative countries of western (Spain), central (Italy), and eastern (Greece) Mediterranean Europe.

Table 1. Number of papers dealing with agroecology in European Mediterranean countries retrieved from the Scopus™ literature database (accessed 3 June 2018).

Country [1]	Records (No.)
France	128
Spain	58
Italy	43
Croatia	21
Greece	9
Portugal	5
Montenegro	3
Former Yugoslav Republic of Macedonia (FYROM)	2
Slovenia	2
Albania	1
Cyprus	0
Malta	0
Total	272

[1] Sorted by decreasing number of records.

Interestingly, out of the initial 110 papers retrieved that focused on these three countries, after applying our refining criteria, we retained only 70 studies, that is, 63.6% (Table 2). Although most of the excluded studies are relatively old (1990s or early 2000s), this is an indication that the usage of the word 'agroecology' is still to be adjusted to its current meaning [26] in the target countries. Nevertheless, there is an increasing trend of studies dealing with agroecology in this geographical area (Figure 1). To ensure consistency with the current vision on agroecology, we then grouped these 70 papers by agroecological theme (science, practices, movements) within country (Table 2). For papers dealing with more than one theme, the attribution was done by considering the prevailing theme in the paper. Papers attributed to the 'science' theme included either theoretical advancements or use of models or other advanced research methods. Papers mostly focusing on agroecological practices (also including those related to the development of agricultural policies, e.g., CAP's Regional Development Programme) were attributed to the 'practices' theme. The 'movements' theme includes papers mostly referring to people's motivation in embracing a way of farming or life in line with agroecological principles.

As we are aware that the analysis of the published literature is not sufficient to fully capture the dynamics of agroecology in the three target countries, we complemented the study by including papers (reports and others) belonging to grey literature and expert knowledge.

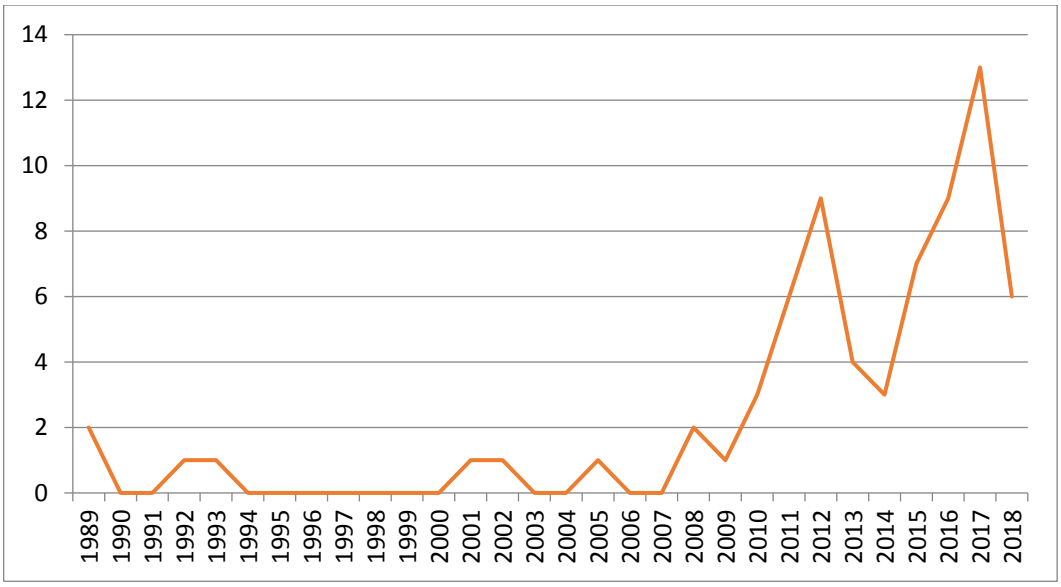

Figure 1. Number of papers dealing with agroecology in Spain, Italy, and Greece retrieved from the Scopus™ literature database (accessed 3 June 2018) and their evolution over time from 1989 to 2018 (data of 2018 are obviously partial).

Table 2. Number of papers dealing with agroecology in Spain, Italy, and Greece retrieved from the Scopus™ literature database (accessed 3 June 2018) and their partitioning among science, practices, and movements themes.

Country	Records [2] (No.)	Science	Practices	Movements
Spain	39	16	6	17
Italy	28	13	14	1
Greece	3	0	2	1
Total	70	29	22	19

[2] See text for details on the search strategy and subsequent refining.

Our literature review revealed a clear difference in the partitioning of papers among the three themes in the target countries. In Spain, there is a prevalence of papers belonging to the "movements" and "science" themes (84.6% of total), whereas in Italy, the "science" "practices" themes prevail (96.4%). The Greek papers are too few (total: 3) to draw any meaningful conclusions. These outcomes will be commented on in the country sections below and in the discussion section.

3. Case Study: Italy

The term "agroecology" is not yet frequently encountered in different discourses in Italy. Nevertheless, several activities and policies dealing with agricultural and food systems, as well as examples of farming, enterprises, and research/education activities based upon an agroecological approach, exist since the late 1970s. A first attempt to trace the history of agroecology in the country in a systematic way, by taking into account the developments in research, education/training, and policy, has been carried out in the literature [28]. Although this report does not explicitly focus on the movement approach of agroecology, it provides a good starting point to develop a national case study for Italy.

3.1. History of Agroecology

The genesis of agroecology in Italy has its main foundations in academia. The precursor of agroecology is considered to be the agronomist professor of the University of Pisa, Pietro Cuppari

(1816–1870), who thoroughly studied the farm as an agroecosystem [29]. In the early 20th century, his steps were followed by Girolamo Azzi (1885–1969), professor at the University of Perugia, who is considered the founder of agricultural ecology [30]. Soon after World War II, the work of Cuppari was re-elaborated and expanded by Alfonso Draghetti in his book "Principles of farm physiology" [31]. During the times of the green revolution, agroecology was nearly neglected until its approaches and values were rediscovered and brought forward in the late 1970s by Fabio Caporali (University of Tuscia, Viterbo), Concetta Vazzana (University of Florence), and Maurizio Paoletti (University of Padova). In the mainstream view of national academies, agroecology and organic farming were marginalised until the late 1990s, when the development of organic farming in Italy finally raised the interest of the national research community [32].

In fact, the development of agroecology has in Italy largely coincided with that of organic farming [33]. Some remarkable pioneers of this approach were already present since the 1970s, that is, well before the first EU regulation on organic agriculture was established (Reg. EC 2092/91). Among these, one of the most influential was Gino Girolomoni, who established the cooperative 'Alce Nero' (Black elk) in 1977 in the central region of Marche based on clear principles of ecological production, environmental sustainability and conservation of peasant knowledge. In early eighties, the regional aggregations that promoted organic farming give life to the commission "What is Organic?" with the purpose of discussing the technical aspects of the organic method and arriving at the first unitary standards by Associazione Italiana Agricoltura Biologica (AIAB) and Mediterranean Association for Organic Farming (AMAB), which was founded by Girolomoni and remained a cornerstone of this approach, until organic farming boomed in the late 1990s, putting Italy as one of the countries with the largest share of organic production in Europe and beyond. Since 1997, IFOAM AgriBioMediterraneo (the first Regional group of International Federation of Organic Agricultural Movement) have raised this issue at Mediterranean level within IFOAM, strongly advocating for the development of organic agriculture based on agroecology [34,35].

In the late 2000s, it became evident that, in some cases, the success and development of organic farming could make farmers downplay the fundamental role of agroecological principles and practices in organic management [36] and let them focus only on an input substitution approach, hence following the pathway of "conventionalization" [37]. In Italy, this risk was raised in 2009 during the final conference of the Ministry of Agriculture's project 'States General of Organic Farming', when the importance to refocus organic production on agroecological approaches was stressed [38]. In July 2015, during the International Expo in Milan, a conference on agroecology was organised by the Joint Research Centre of the European Commission, which gathered several key persons who promoted agroecology in Europe and beyond. On one hand, this event fostered the foundation of Agroecology Europe (www.agroecology-europe.org), a European association for the promotion of agroecology, which was then formally established in January 2016. On the other, it gave impetus to the establishment of an Italian Observatory on Agroecology (OPERA), launched in 2017, in Milan [39].

3.2. Research and Education

3.2.1. Research Institution and Research Topics

In Italian universities and research centres, there is increasing interest in agroecology, but research activities are still limited. However, in Italy, long-term experiments (LTEs) for organic farming and agroecological practices have been established by both universities and research councils. At the Universities of Florence, Perugia, Pisa, and Tuscia, there are LTEs, established since 1992, 1998, 2000, and 2001, respectively, comparing organic versus conventional arable crop management, soil fertility, tillage and weed management, and yield assessment [40,41]. Some of the LTEs were also designed to assess the comprehensive evaluation of agro-environmental sustainability. The need to support and to promote LTEs as pre-condition to empower the potential of the organic farming research/innovation communities was acknowledged by the RETIBIO project, funded in Italy by the Organic Farming

Office of the Ministry of Agriculture (MipAAF) and coordinated by the CREA (Italian Council for Research in Agriculture and analysis of agricultural economy).

The Scuola Superiore Sant'Anna in Pisa (SSSA) has a research group of agroecology strongly engaged in agroecological research through regional, national, and international projects.

CREA have developed several studies on agroecology, mainly on innovations for agronomic management in organic farming, for example, on (i) agronomic systems and technologies for adaptation to climate change in organic farming systems, (ii) improving soil conservation and resource use in organic systems, and (iii) sustainable techno-economic solutions for agricultural value chains. In addition, some scientific societies are developing Agroecology as an internal section (e.g., SOI, Italian Society for Horticulture).

At food systems level, the University of Gastronomic Sciences at Pollenzo-Bra (UNISG) conduct several research activities to support bio-cultural diversity (i.e., on local varieties of winter cereals [42]) and on sustainability assessment of agri-food systems [43,44].

3.2.2. Academia

Courses on Agronomy at Italian university have a base in Agricultural Ecology, but only few explicit on agroecology. At the University of Florence, a course on agroecology of 6 ECTS (European Credit Transfer and Accumulation System (ECTS) within the postgraduate programme in sustainable management of agroecosystem is offered in Italian [45]. This is the heritage of Prof. Concetta Vazzana, who also coordinated the first Italian post-graduate course in 'ecological agriculture' (2000–2005). At University Mediterranea of Reggio Calabria, a course on agroecology (6 ETCs) within the Postgraduate Programme in Agricultural Sciences and Technologies has been taught in Italian since 2011.

Other Italian universities are engaged in MSc programmes and postgraduate courses on organic farming (Padova and Udine University), some of which were paused or have been refocused (e.g., at the University of Florence, Pisa, Napoli, Torino, Bologna). At several Italian universities, agroecology is taught by individual lecturers, without these courses being yet part of overall BSc/MSc programmes, aiming to offer higher education opportunities to students interested in agroecological subjects.

At UNISG, an action oriented, phenomenon based, participatory, and experiential learning approach is put in place, according to the agroecological educational theory and practice [46,47]. At the same university, many courses offer several didactic journeys and food tasting sessions [48]. The goal of this experiential learning process is to develop knowledge, skills, and attitudes enabling students to deal with complex situations in agricultural and food systems development. This approach has been already developed at MSc level since 2011 [49].

As to PhD programmes, the Scuola Superiore Sant'Anna's International PhD Programme in Agrobiodiversity [50] is largely based on the application of agroecological research approaches.

3.2.3. Farm Schools and Vocational Training

An initial example of long-lasting farm school and vocational training experience in agroecology is the Scuola Esperienziale Itinerante in Agricoltura Biologica (Experiential Itinerary Learning School on Organic Farming, SE) established in the northeastern region of Veneto by a group of farmers and technicians [51]. They offer hands-on courses reprising the 19th century approach of 'cattedre ambulanti' (walking lectures), where the main focus is on learning by seeing and doing, and where theories are introduced only as complement to the illustration and discussion on practices. SE experts have educated several young persons who later developed their own agroecological farm, mainly in organic vegetable cropping.

3.3. Collective Action

3.3.1. Political Action

There are a number of ongoing activities somehow related to the political side of agroecology taking place in various Italian regions, but a census of them is difficult because of their fragmentation and heterogeneity. However, they share the above-mentioned history of the agroecological movement in the country, that is, their close affinity with organic farming. One of the main fields of agroecological political action in Italy is the quest for food sovereignty as driven by the saving, reuse, and sharing of seeds. In 1996, a national seed savers association ("Civiltà Contadina" or Farming Civilization) was established with the purpose of protecting agricultural biodiversity through in situ conservation of seeds of underutilized local species and varieties [52]. Regional associations of seed savers are also present and are particularly active in central Italy (e.g., Marche and Tuscany), where local germplasm is maintained in regional genebanks. Civiltà Contadina, together with other seven co-founding associations, established the Italian Rural Seed Network (Rete Semi Rurali) [53] in 2007. This organisation soon became a reference organization in the country for agrobiodiversity conservation through use, connecting with corresponding institutions in other parts of Europe and globally. More recently, relevant national NGOs (Non-governmental organizations) engaged in international cooperation, for example, COSPE and Mani Tese [54,55] have embraced agroecology as their reference model for their sustainable agriculture projects around the world. Interest on agroecology by Italian NGOs and other politically-oriented movements is expected to grow in the near future, following similar trends elsewhere. Activities by organizations working closely with agroecological Italian farmers are expected to be fostered by CAP's regional Rural Development Plans, in which some recently introduced measures (e.g., local projects taking the spirit of EU's European Innovation Partnerships, EIPs) are well in line with the participatory approach supported by agroecology.

The FAO database on legislation [56] has identified the following laws in Italy:

- National Strategic Plan for the Development of the Organic System. The Plan, deployed in 2015, has a general objective (to develop the national organic system as a whole) and defines three specific objectives: (a) strengthening of the production phase; (b) strengthening of supply chains; and (c) strengthening of the biological system. Ten strategic actions have been identified. FAO have so far identified organic agriculture as crucial for agroecology development with the vision that they are more converging than diverging [36].
- National Biodiversity Strategy. Pursuant to the obligations deriving from the United Nation's Convention on Biological Diversity, this document lays down the National Strategy on Biodiversity, whose overall goal is to ensure the preservation of biodiversity, the rational and sustainable exploitation of natural resources, and the fair and equitable sharing of benefits arising from their utilization.
- Act No. 194 of 2015 on the protection and promotion of biodiversity for food and agriculture. This law sets out measures to protect and improve biodiversity for food and agriculture. The aim is to protect local genetic resources under threat of extinction or facing genetic erosion. It establishes the National System for the Protection and Promotion of Biodiversity for Food and Agriculture.

Moreover, the Future Policy Award nominated in 2018 for World Championship in Agroecology, the following Policies in Italy:

- The Legislative Decrees No. 226, 227, and 228, known as "Orientation and modernisation of agriculture, forestry, and fisheries decrees", 2001. Ministerial Decree, 2nd Energy Account, 2007 (II Conto Energia). Ministerial Decree, Uniform minimum criteria for the definition of conservation measures related to special areas of conservation (SACs) and special protection areas (SPAs), 2007.
- Liguria: Regional Law No. 66 on Organic Agriculture, 2009. Guidelines Article 8 on Biodistrict.

- Mals: Referendum for a Pesticide-Free Future in the Municipality of Mals, 2014. Ordinances for a Pesticide-Free Future in the Municipality of Mals, 2016.

3.3.2. Social Movements, Networks, Territories and Food Systems

Besides the NGOs and national/regional organizations cited in the previous paragraph, others that have recently embraced agroecology in their visions and action plans are also listed below. The Slow Food association, both at Italian and International level, promotes the use of "slow agriculture", which is their novel name for agroecology [57]. AgriBioMediterraneo (ABM) was the first regional Group of the International Federation of Organic Agricultural Movement (IFOAM) to be established. The history of IFOAM–ABM goes back to 1990 with the first meeting held in Vignola (Mo), Italy, to foster the agroecological approach into organic movements. After 25 years of activities, ABM organised a first International Conference "Agroecology for organic agriculture in the Mediterranean" in 2015, with the aim to improve interdisciplinary scientific dialogue, and to implement information exchange and dissemination of knowledge and innovation strategies on organic agriculture for the Mediterranean area [35].

3.4. Practice

In Italy, agroecological practices are not officially defined; however, they are well in place, linking traditional agricultural knowledge with modern and technologically advanced practices. Both of them are already experimented and applied in the organic agriculture sector. Among these practices, we have identified the following:

I. Mixed farming systems. This practice has been discouraged since decades through the promotion of specialization in the agricultural sector. In Italy, 60% of the national agricultural area is under specialized crop farming, 28% is under specialized livestock farming, and only 12% is under mixed farming [58]. However, 78% of total Italian farms are family based and there is space for improvement, towards mixed farming systems.

II. Locally adapted crops and local animal breeds. Italy has a very rich agricultural and food biodiversity and the use of locally adapted varieties is still a common practice because of the variety of pedo-climates and culture. In quality production, Italy confirms its leadership in Europe, being the country with the highest number of geographical origin food product labels awarded by the EU: 250 products in 2014 shared by Protected Designation of Origin (PDO), Protected Geographical Indication (PGI) and Traditional Specialities Guaranteed (TSG).

III. Despite the negative effects of green revolution on the agri-food system, plant and animal genetic resources have survived in the field primarily as a result of the activity of farmers and associations (Organic movement, Rete Semi Rurali, Slow Food) who continued to cultivate uncompetitive local varieties and animal breeds as part of local agricultural and gastronomic traditions. After an initial emphasis on germplasm conservation, the current approach is to focus on participatory and evolutionary plant breeding [59] to develop new resilient populations able to face climate change effects at local level.

IV. Soil fertility enhancement and climate change mitigation. There is a slow but steady increasing trend in the use of longer crop rotations, cover crops and green manures, crop residue management, and conservation tillage [60]. Factors beyond the plot scale may outweigh mitigation measures, thus training to farmers on the application of conservation practices is crucial to overcome barriers to implementation [61].

V. Landscape conservation and terracing. Italy has 41% hills and 35% mountainous territory and terraces, which were very diffuse since late Medieval time and are still used today in olive and vineyard cultivation along the coastal areas of Campania (Amalfi) and Liguria, as well as in Alpine and Apennine territories. Typical features like farming terraces, olive yards, and highland meadows and pastures have been decreasing over the past 50 years.

This resulted in a declining biodiversity and loss of traditional Mediterranean landscapes [62]; however, these practices are being rediscovered, for example, through their support in CAP's Regional Development Programmes.

VI. Agroforestry and agrosylvopastoral systems. These practices were once traditional in Italy, but nowadays are still far from being applied at farm level. However, there are very interesting pioneer research activities in central Italy [63,64], for example, combining extensive free-range systems of poultry production in olive orchards intercropped with asparagus cultivation.

4. Case Study Greece

4.1. History of Agroecology

Similar to Italy, the history of agroecology in Greece is strictly related with the development of organic agriculture, with roots in the environmental movement at the beginning of the 1980s. The first organic farmers were mostly amateurs who experimented with different organic cultivation methods, for example, according to the principles of biodynamic agriculture and natural farming [65]. Commercial agricultural production of organic products initiated in 1982 with demand from abroad on certain products, such as raisins, olives, and olive oil, with no official data available until 1992. Although the concept of ecological/organic farming was frequently used and applied by associations, NGOs, and farmer organizations in Greece since the early 1980s, the term "agroecology" has only been broadly used in very recent years, at academic or farming level.

4.2. Research and Education

Academic courses and curricula and research initiatives referring to the agroecological approach in agriculture have been scarce in Greece. Research institutes and universities started focusing on research projects and educational programmes related mostly to organic farming and environment-friendly practices over the last two decades, following the global trends in agricultural academia.

4.2.1. Research Institutions

The sole research body with a clearly stated focus on agroecology is the Institute of Viticulture, Floriculture, and Vegetable Crops, located in Heraklion, Crete, of the Hellenic Agricultural organization (ELGO—Demeter), formerly known as National Agricultural Research Foundation (NAGREF). The institute includes an ecological production systems unit working on ecological production, food and sustainable rural development, consisting of a team of agronomists, agroecologists, ecologists, economists, and sociologists, and has experience in national and international projects related to the above topics [66].

One of the first applied research projects considering agroecological principles and the related framework was the development of a prototype and the dissemination of ecological olive productions systems in Crete [67,68]. The project aimed at the design, development, evaluation, and dissemination of ecological olive production considering the regional agricultural, ecological, and socio-economic context. It involved the formation of agroecological networks including the foundation of an agri-environmental group, for conversion to ecological production and for transition to an ecological knowledge system, and a pilot group of olive growers, for interactive prototyping. The main result was the set up of a local organic farmers' cooperative, launched in 1998 aiming at cooperatively marketing certified organic products. A later study on olive fruit fly infestation conducted in Crete [69] mentioned an agroecological approach in establishing environmental background conditions and "agroecological balances" via appropriate cultural practices. In the same region, a private-funded project on the "environmental impacts of olive production systems" followed an agroecological approach in order to study different management systems (organic, integrated, and conventional) and different agroecological zones (hilly and plain) in terms of soil and olive canopy arthropod diversity [70,71], as well as flora diversity, greenhouse gases emissions, and irrigation. The aim of the

project was to provide data and recommendations related to the improvement of the sustainability and best management strategies for olive production systems.

4.2.2. Academia

Following the global trend in agricultural academia, development of bachelor and master curricula on the topics of "organic farming" and "sustainable agriculture" was also prioritised by the main Greek agricultural universities, faculties, and technological education institutes. Notably, an "applied agroecology" elective study programme was developed and run by the University of Ioannina from 1998 to 2007. The study programme had an objective to educate agroecology scientists at university level conceiving agroecology as applied ecology, aiming to protect agricultural ecosystems for production of high quality agricultural and animal products [72]. The fellow Technological Education Institute of Ionian islands also ran a curriculum on organic farming technology until 2013, including courses on agro-ecology, before it was integrated in the food technology department. Currently, there are two master programmes in the two majour agricultural schools in Athens (Agricultural University of Athens) and Thessaloniki (Aristotle University, School of agriculture) focusing on organic farming.

4.2.3. Farm Schools and Vocational Training

Agroecology-related training by farm schools and vocational training institutes is mostly focusing on organic farming, delivered by Vocational Educational Centres, both private and public. Specifically, such centres are located in rural areas and agriculturally-oriented and provide sporadic training programmes related to organic farming [73]. Agricultural adult education on organic farming and organic livestock training is also by ELGO—Demeter, in some of its vocational training centres and practical agricultural schools, located in several rural areas in Greece. Notably, a volunteer, free of charge, farm school on "ecological agriculture" has been organised by organic farmers in the region of Attiki over the last eight years, with courses provided by organic farmers themselves, plus university professors and NGO representatives. These courses cover a wide range of issues, from farming practices and certification procedures to food product distribution methods and CAP policies.

4.3. Collective Action

4.3.1. Political Actions

To date, there is neither a clear reference to agroecology in the regulations of the Greek state nor collective political actions which prioritise agroecology in their agenda. Additionally, in the FAO database on legislation [56], no data about Greece are included. Previous collective actions considered to be related to the broader context of the agroecological approach included (i) initiatives opposing the use of genetically modified organisms in agriculture, initiated by larges NGOs like Greenpeace, the Greek Green Party and organic farmers since 1999 [74]; (ii) a permanent representation, active for several years during the last decade, of groups and organisations working on agricultural biodiversity and organic farming in a consultative group on plant genetic resources of the Greek Ministry of Agriculture, promoting interests in terms of farmers rights and use of biodiversity [75].

4.3.2. Social Movements, Networks, Territories, and Food Systems

The terms "organic" or "ecological" agriculture were frequently utilized by a number of entities when describing an agroecological approach for Greek agriculture, starting from the "Association for Organic Agriculture in Greece" (SOGE); the "Ecological Practice Lab" (Ergastiri Oikologikis Praktikis) in the 1980s and the "Rea—Scientific Society for Organic Agriculture"; and certifications bodies initiated in the 1990s, like DIO, Biohellas, and Fysiologiki [65]. Additionally, organisations working on the conservation of local and traditional agricultural varieties like the "Peliti—alternative community", initiated in 1995, and "Aegilops—Network for biodiversity and

ecology in agriculture", initiated in 2005, clearly refer to "ecological agriculture" in their activities [75]. The "Natural Farming Centre", established in Greece in 1999, works on promoting the concepts and principles of natural farming by Masanobu Fukuoka, organizing meetings and training programmes. Moreover, the Agribiomediterraneo regional group of IFOAM have had several initiatives and events in Greece, linking organic agriculture and agroecology [76]. Other related initiatives have also appeared over the last decade among the Greek permaculture movement, although without explicitly referring to agroecological principles and methods.

The term and concept of agroecology were initially used among Greek NGOs and civil society entities by the organisation "BiotechWatch" in informative seminars on alternative paradigms to industrial agriculture in 2011 and by the NGOs "Nea Guinea" and "Peliti", hosting agroecology courses of the French organisation "Terre & Humanisme" in Athens (2015) and Crete (2016), respectively. A clear shift towards the adaptation of the agroecological terminology and framework appeared with the foundation of the "Agroecological Network of Greece" (Agroecology Greece), in 2016. Agroecology Greece's official aim is to promote agroecology as a science, practice, and movement in Greece by connecting primarily agricultural scientists and trainers. Its main goal is to exchange information, knowledge, and research that will familiarize stakeholders with the principles and framework of agroecology in Greece and promote the transition of food production systems towards a truly sustainable form. Agroecology Greece has so far delivered technical reports on agroecological topics; organization of events promoting the agroecological concept, while its members participate through private SMEs, NGOs and research and academic institutes in research and training projects related to agroecology. Another newly founded NGO focusing on the agroecological approach is Agroecopolis (Hellenic network for Agroecology Food Sovereignty and Access to Land), a grassroots organisation founded in 2017, acting as formal representative for Greece in the European Food Sovereignty Movement and the Nyeleni Forum. Agroecopolis participates in the European Community Supported Agriculture (CSA) movement and is member of the URGENCI organization and the European CSA research group. The main activities of Agroecopolis are stated to be, among others, the promotion of alternative models of connecting consumers and producers; the promotion of participatory action research; advocating for policy change on local, national, and international levels; the creation of food policy councils; and the promotion of ethical consumption and a change of consumer habits, especially regarding food.

4.4. Practice

The main body of agroecological practices identified in Greece stems from the traditional agricultural knowledge developed in mountainous islands or hinterland. The Greek peninsula and islands are characterised by isolated and traditional agricultural areas, common in the Mediterranean area, where local agricultural traditions, along with genetic diversity [75], were preserved until recently, as an important adaptation strategy to harsh environments. The most important practices within the agroecological framework encountered in Greek traditional agricultural systems are the following:

(i) Conservation and use of locally adapted crops. The use of locally adapted varieties in the Greek geographical area has been a common practice for centuries. However, transformation of the countryside started in the 1950s, followed by the expansion of intensive agriculture and rural exodus, resulted in genetic erosion and the anthropogenic degradation of traditional rural landscapes [75]. Nevertheless, these plant genetic resources have survived in the field primarily because of farmers and gardeners, who continued to cultivate low productive local varieties as part of their local agricultural tradition and culture.

(ii) Dry farming and rain harvesting. Dry farming has been regarded as a dominant cultivation method, especially for vegetable and grapevines in isolated islands of Greece, until the mid-20th century [77]. It consisted of a sophisticated method of seasonal soil management and use of local, drought resistant varieties aiming to utilize the residual soil moisture from the rainy season, by trapping moisture using a roller and compacting the soil, which forms a dry crust reducing

evaporation. The most important example of dry farming is the cultivation of a tomato landrace and local grapevine varieties in the island of Santorini. The correspondent technique of rain harvesting through traditional roof collectors and underground tanks is also a main practice in the Greek islands, as a result of local water scarcity and arid/semi-arid conditions.

(iii) Terracing. Cultivation of trees, mainly olive and grapevine, and cereals in terraces in Greece goes back to the bronze age [78] and is found all over the insular region and coasts. The majority of terraces nowadays are abandoned and very few of them are still used for olive cultivation [79] or for livestock grazing [80].

(iv) Agroforestry. Agroforestry systems are considered to be widely distributed all over Greece as important elements of the rural landscape. Three types of systems are mainly encountered: (a) silvoarable, involving trees and crops grown on arable land; (b) sylvopastoral, involving trees and pasture/animals grown on forest and arable land; and (c) agrosylvopastoral, involving trees, crops, and grazing animals grown on arable land [81]. Greece, being the country with the highest goat density in Europe, coupled with long periods of water shortage, explains why livestock farms are based on woody vegetation. The area covered by these systems is estimated to be more than 3 million ha, that is, 23% of the country's agriculturally used area [81]. Most of these traditional agroforestry systems are being under threat over the latest decades either through abandonment or intensification, consequent of socio-economic changes.

5. Case Study: Spain

5.1. History of Agroecology

Use of the term agroecology emerged in Spain, linked to the agrarian social movement with strong academic contribution by the Institute of Sociology and Peasant Studies (ISEC), of the High School of Agronomy Engineers (ETSIA), University of Córdoba, in the 1980s. There, landless peasant and environmental movements, together with a group of social scientists [82,83], gave a robust social transformative and committed profile to agroecology, influencing its further development. The ISEC academic group contributed strongly to enhance agroecology from a more socio-political approach under the rural sustainable development framework, rather than from the viewpoint of agronomic techniques [84,85], involving consumers' collectives and other short supply chain and proximity local agri-food systems initiatives.

The first reported experiences of agroecological transition in Spain fully adopting organic farming methods were reported in the 1990s in Andalusia, at the Cooperative "La Verde", where farmers belonging to Landless Peasants Union (SOC) recovered traditional vegetables varieties, with support of the ISEC researchers, using participatory approaches. This work was extended to the marketing of organic products in short supply chains, to close the gap between farmers and consumers, establishing some CSA-based local consumer groups in most of the cities of Andalusia region and elsewhere.

From the Spanish academic community and prior to the above, researchers had already reported on the conventional agriculture crisis, suggesting several actions to improve the national agricultural sector by sustaining certain cropping systems [86] or preserving "agroecological" practices, like crop rotation in cereals and use of different local legumes. On the above position, it was clear that the serious sustainability problems of the industrial agricultural model could not be solved only by reducing the environmental impact, but by addressing the agri-food system as a whole.

In this sense, organic farming was the first and clearest implementation of an agroecological approach in Spain. In this respect, two phases can be distinguished: one more focused on ecologically-based agricultural science (focused on technologies and certification solutions), and a second with a more systemic vision and holistic approach, clearly including social and cultural processes.

The first phase was more agronomically-oriented and has produced a relevant growth of farms [87], increased the complexity of agroecosystems, and reinforced biological processes (nutrients

recycling, pest and disease control, etc.), as a response to conventional farming. Under this point of view, agroecology has evolved together with (certified) organic farming, which was regulated in Spain for the first time in 1989. The second phase of agroecology started approximately in the beginning of the 21st century, to become a more social phenomenon, involving environmental and other social movements' issues on responsible consumption and food sovereignty, among others, in a more proactive way [88].

Some authors [89] identify the initial development phase of agroecology with the first generation of organic farmers associations, like the Coordinadora de Agricultura Ecológica (CAE), founded at the end of the 1980s, most of which were later co-founders of the Spanish Society of Organic Farming (SEAE) in 1992. SEAE joined the efforts of researchers, educators, operators, advisors, and farmers, aiming to support and improve knowledge on organic farming methods. This phase centred efforts in discussing and defining the organic farming name and baseline: fundamentals, principles, aims, and standards.

One consequence of the socio-politically oriented approach of the Spanish organic farming movement was the adoption of a public organic certification system in organic farming.

One bottleneck in the development of agroecology in Spain was the fact that agricultural modernisation and the decline of yields in agriculture was quickly eroding traditional peasant knowledge and culture on natural resource management [90], as it became more and more economically unviable. Therefore, one priority of agroecological activists in this phase was the conservation and retrieval of this peasant knowledge.

Some authors [91], like in the Italian case, called for the risk of "conventionalization" of organic farming in Andalusia, undermining the fundamental role of agroecological principles and practices, and bringing forward only on an input substitution approach.

5.2. Research and Education

5.2.1. Research Institutions

Research on agroecology is not widespread in Spain. The first research teams studying agroecology working on the topic were established within ISEC and concentrated mostly on agroecological tools for analysing (and designing) sustainability actions for rural development in Spain [91,92]. A good deal of Spanish research done on agroecology and organic production is presented at biannual SEAE Congresses, which started in 1994. These events serve to promote a culture of innovation and cooperation between researchers and organic operators. In the Congress proceeding series, 96 papers containing the term agroecology in the title were found out of >2000 entries, most of which (70) were presented by Spanish research groups or authors.

5.2.2. Academia

To develop agroecology as a scientific discipline, ISEC of the University of Córdoba (UCO), in 1997, established the first (non-official), Master and PhD in Agroecology in Spain. Some teachers of this initial endeavour later contributed to develop an interuniversity program at the International University of Andalusia (UNIA), and subsequently at the University Pablo Olavide (UPO) and the University of Sevilla (US). Most of the external associated Professors and students from the UNIA programme came from the Latin American agroecological movement.

Students in these university programmes made several studies related to Andalusia and to Spain, using participatory methodologies to interact with (organic) farmers, producing an important amount of agroecological research on the analysis of peasant practices and the use of traditional seeds.

A list of the final study projects containing the term "agroecology" in their title can be found in the website of these pioneer universities [93], showing that a low percentage of them are related to Spanish cases. To this list we can add the Master's Final Research Studies (TFM) and PhD thesis supported by the History Laboratory of Agroecosystems [94] at UPO dealing with agroecological

economic aspects (e.g., social metabolism). Despite the recent increasing trend of the final research projects tackling Spain in the latest years [95], the amount of final studies or PhD theses on agroecology in Spanish universities is still low.

5.2.3. Farm Schools and Vocational Training

At the levels of vocational schools, a curriculum named "Agroecological production" was developed by the Ministry for Education in 2010. This study plan was adopted in 12 different regions (Autonomous Communities) and 34 schools. The learning content is based mainly on the EU Organic Regulation.

5.3. Collective Action

5.3.1. Political Actions

A process to reinforce the agroecological approach is provided by the network of agroecological municipalities, "TERRAE" (started in 2010). The network later constituted an inter-municipal association in 2012, the "DILAS" Agroecological Initiative for Local Initiatives, launching an online (agroecological) land bank and a training process of local technicians and elected council members to design and implement local agroecological policies.

5.3.2. Social Movements, Networks, Territories, and Food Systems

Since 2000, agroecological transition processes were promoted in the context of the fight against speculation that especially threatened the areas surrounding large cities. Historical examples in this sense are the Horta of Valencia City, where the "*Per l'Horta*" initiative was developed. Another similar initiative was carried out by an association promoting organic farming in the Vega de Granada (GRAECO), composed of different organic consumers and producers in Granada, southern Spain. Later on, some local platforms emerged in Catalonia, such as Delta Viu or more recently the Agroecology Association of Gallecs, working upon the agroecological approach in areas surrounding the metropolitan area of Barcelona, and in Huerta Zaragozana. Their aim is the protection of traditional vegetable gardens in urban territories, preserving agricultural use, and the promotion of agroecology, as a way to restore life and the ability to promote social and ecological wealth. The work carried out in Catalonia since 2006 by L'Espai Recursos Agroecològics (L'ERA), an association of teachers and students of the Agricultural Training Centre of Manresa (Barcelona), is also worth emphasising because it promotes a generalised agroecology approach in agrarian vocational education. In all these experiences, SEAE members were involved, embracing agroecology as a central action in their agendas, realizing its potential to initiate new social models. On the basis of regional initiatives and organizations, an Alliance for Food Sovereignty was created in 2008 at state level [96], merging several processes and experiences of production and agroecological consumption. To date, there are many different environmental social and movements, like the Spanish Rural Platform, and some other general farmers Unions, active especially in Basque country.

Examples of adapted agroecological approaches exist also in the cases of the initiatives of (i) the "Shared Responsibility Agriculture" (ARCO), supported by the Spanish Coordination of Rangers (COAG), a general farmers' organisation belonging to La Via Campesina; (ii) the "Andalusian Federation of Cooperatives of Organic Producers and Consumers" (FACPE); and (iii) the "Xarxa de Consum Solidari" of Catalonia. These are the most recent examples trying to build alternatives to mainstream agri-food systems [96,97], but there is a lack of information about their real impacts.

In Spain, agroecology is being promoted through consumer groups, organic farming fairs, public procurement programmes for organic food consumption, and agroecological associations at local level. Several projects and initiatives have nominally adopted the agroecological approach to upgrade integrated actions in organic agriculture [88] and reinforce organizational capacity to

support sustainable rural development at local or regional scale, nearby medium-sized or large cities, where farmers groups (associations or cooperatives) and consumers can get in contact.

Recently, an agroecological technological platform (PTA) was created at national scale by the Spanish members of the International Federation of Organic Farming Movements (IFOAM), to influence research policies and to mobilize resources towards agroecological research.

Additionally, after the regional elections held in 2015, a number of new regional governments (e.g., Valencia and Balearic Islands) and municipal authorities (e.g., Barcelona, Madrid, Valencia, and Cádiz) seem willing to promote agroecological policies. This new trend in the context of decreasing budget availability is strongly focused on the co-production of public policies [98] between local or regional agro-ecological social movements and local or regional administrations. Some small farmers and consumers initiatives have grounded the so-called participatory guarantee systems (PGS), fostering direct relationships between producers and consumers, avoiding the usual third part organic certification in Andalucia, Murcia, Valencia, and other regions. Currently, the PGS tool is being used in several areas surrounding cities, but not much information is available on its impacts and possibility of expansion.

5.4. Practices

Upon a recent SEAE study, the vast majority of agroecological practices are used by small and medium certified organic farmers in all 17 Spanish regions [99]. Most of these practices are linked to soil fertilization and the use of organic materials, like compost. Cover crops and green manure use are steadily scaling up, being used by organic farmers, especially in the climate of northern Spain. Pruning residues incorporated into the soil is a common practice in vineyards, fruit tree crops, and vegetables. Reduced or minimum tillage is less practiced as specific machinery is not easily available. Use of longer crop rotations in arable and vegetable crops is common within organic farmers, but there are constraints for greenhouse production, where fallows are more frequently used.

Local and traditional varieties conservation and use is also practiced, especially through the work of the seed exchange network "reseeding and exchanging", working at national level on the recovering; conservation (in situ or ex situ); and promotion of the use of old, local, and traditional varieties. Local animal breeds are also being preserved by breeders' associations in their original territories, and include all common livestock species (cattle, sheep, goats, poultry, and pigs).

Water-saving systems, like drip irrigation is common in dry areas, as well as the construction of small and large water reservoirs reinforced with plastics, most of which aim to accumulate water.

Traditional old terraces are also being protected in some territories, where almond or olive trees are cultivated in mountain areas, but agroforestry is only being promoted in northern regions of the country, like Asturias, Cantabria, or Galicia, and in Central Spain "dehesa", referring to the multifunctional, agrosylvopastoral system (agroforestry) and cultural landscape of southern and central Spain and southern Portugal (known as "Montado") on either private or communal property (belonging to the municipality).

6. Discussion

Agroecology in these three Mediterranean countries presents several similarities as well as differences, as shown in Tables 1 and 3. A main common element among countries is the origin and evolution of agroecology, which mainly linked traditional agricultural knowledge with the organic farming movement, emphasising social and political aspects. Specifically, in Italy, the genesis of agroecology has its main foundations in academia, but its recent development is strongly linked to civil society, NGO, and consumers. At the moment, the Italian research community has still not captured the momentum, but it can be assumed that the raising interest on agroecology in Europe will raise interest. In Greece, a gradual shift towards recognising the necessity of adopting a holistic, agroecological approach can be identified, by incorporating practices and techniques, and recognising as well socio-economic dimensions and bottlenecks. The Greek organic farming sector appears as the

main stakeholder to primarily adopt such an integrated approach. In Spain, a theoretical framework was developed by research groups accompanying the environmental and landless movements in Andalusia. Its development came from the consolidation of organic farming, although one idea that has excelled in Spain is that agroecology goes beyond other goals that integrate the socio-political aspects (fair marketing for consumers and producers) with environmental (management of biodiversity), without neglecting the social dimension.

Table 3. Main aspects of agroecology in Italy, Greece, and Spain.

	Country		
Aspect	**Italy**	**Greece**	**Spain**
Origins	Academia	Organic (ecological) farming movement	Academia and social movements
Academic/training/research	Limited, under development	Limited, under development	Limited, under development
Socio-economic	Certified organic farming, neo-rural movement	Ecological and certified organic farming movement, civil society organisations	civil society and rural movements
Practice	Mixed farming, locally adapted crops and animals, soil management, landscape management, agroforestry	Locally adapted crops and animals, dry farming and rain-harvest, terracing, agroforestry	Organic fertilization, composting, cover crops, green manure, crop rotation, locally adapted crops and animals, water saving, terracing

Agroecological training and research, although it has recently advanced, still has many challenges to overcome in Mediterranean Europe. A common point is that new academic transdisciplinary approaches in agroecology are still under development and are difficult to identify and incorporate for the time being. Nevertheless, several experiences of organic production in the Mediterranean with local actors suggest that agroecology is in a position to offer concrete solutions to the crisis of the rural and wider society. In this sense, agroecology is called to play an important role in the design of food production alternatives and to strengthen the processes of sustainability in rural areas.

At the socio-economic level, despite being sporadically criticized, certified organic farming has already become a real agroecological alternative for thousands of small and medium farmers, and for a new generation of producers emerged from urban environments that can repopulate the rural environment constituting a new profile, the agroecological neo-peasants.

The civil society, consumers', and neo-rural movements appear as main actors for developing and promoting viable and fair models of production and have considered, up to a certain point, the agroecological concept as a main alternative solution to the environmental and social problems linked with industrialised agriculture.

Undoubtedly, the conversion to agroecological management has also brought more complexity to agroecosystems, strengthening ecological processes (e.g., recycling of nutrients, soil fertility and biodiversity enhancement, natural and/or biological control of pests with ecological infrastructures) and providing more resilience to the production systems. More resource efficient techniques such as dry farming and rain harvesting, could also provide viable solutions and alternatives. Similarly, agroecological livestock systems and especially mixed farming systems can contribute to improved environmental performances, because of the use of local animal breeds, which are fed with grass or other feedstuff produced on-farm or in the farm territory [100]. The existence of livestock makes it necessary to have grasslands that, where permanent, increase biodiversity at field level. Crop/livestock integration is especially effective in promoting resilience of farming systems and contributes partially to system productivity in Latin America [101]. Mediterranean farms are characterized by forage availability across the year mainly linked to woody vegetation or costly irrigated systems to overcome water shortage. As a result of climatic constraints, trees can be utilised to modify water regime and

extend the growing season, thanks to the shade they provide to herbaceous vegetation. Animal movement at long distances (transhumance) or short distances (from lowlands to highlands) has traditionally be used to overcome feed shortage periods across Mediterranean regions characterised by mountain areas and could be revitalised [12]. In Mediterranean areas, the connection between cropland and grazing land is also part of traditional land management. Sheep graze crop residues once crops are harvested. Permanent grasslands based on annual self-reseeded species is another ecological trait that nature has to overcome dry summer periods in Mediterranean environments where herbaceous perennials are not able to survive [102,103]. This fact has been adequately included in the definition of permanent grasslands for the CAP 2014–2020 [104]. However, from our literature review, this connection clearly emerged only in Spain and mostly in the papers dealing with the "movements" theme.

It becomes apparent that, despite the differences of agroecology in all three countries, there is a common strong necessity for incentives towards of (i) widespread implementation of sustainable practices, (ii) favourable policy measures, and (iii) educational opportunities, in order to facilitate the transition towards sustainable food systems, based on the agroecological approach.

7. Conclusions

This paper describes the history of agroecology, as well as aspects related to research and education, collective actions (political and social), and practices for three euro-Mediterranean countries; Italy, Greece, and Spain. A rather similar use of the term "agroecology" appears in these countries, although there are country-based differences, with regards to (i) the existence of civil and social movements; (ii) the presence of study and educational programmes and the importance of different scientific disciplines and their evolution; (iii) the development of political support and legal frameworks; and (iv) the elaboration of concepts to rediscover traditional practices and apply new ones, often inspired from the organic agriculture sector.

The history of agroecology is linked in all case studies with environmental movements, ecological research approaches, and the development of organic agriculture. Training and agroecological research still has many challenges to overcome, in particular to develop collaboration around transdisciplinary approaches. The civil society, consumers, and rural movements are presently the main actors trying to foster the developments of agroecological concepts, as a main alternative to the environmental and social problems of industrialised agriculture. Institutions and policy are almost absent and the legal framework in agroecology is still weak. At the production level, organic agricultural practices are used with focus on diversification and integration at all levels; field, farms, region, and food systems.

Agroecology is an emerging concept for the Mediterranean agricultural sector, with huge potential because of the peculiar socio-cultural, bio-physical, and political-economic features of the region, especially if the rich agricultural traditions and high biodiversity would be fully used for the transition towards sustainable food systems. To boost agroecology in Mediterranean Europe, better networking and engagement of different actors within a coherent institutional framework supporting the transition is strongly needed.

Author Contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Conceptualization, P.M. and V.G. (Vasileios Gkisakis); Methodology, P.B.; Validation, P.M., V.G. (Vasileios Gkisakis); Resources, P.M., V.G. (Vasileios Gkisakis), V.G. (Victor Gonzalvez) and P.B.; Writing-Original Draft Preparation, P.M., V.G. (Vasileios Gkisakis), V.G. (Victor Gonzalvez) and P.B.; Writing-Review & Editing, P.M., V.G. (Vasileios Gkisakis), V.G. (Victor Gonzalvez), M.D.R. and P.B.;", please turn to the CRediT taxonomy for the term explanation. Authorship must be limited to those who have contributed substantially to the work reported.

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