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Systematic Review

Farmers' Transition to Climate-Smart Agriculture: A Systematic Review of the Decision-Making Factors Affecting Adoption

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Abstract: Agriculture is currently facing major challenges related to ensuring the food security of a rising population and climate change with extreme weather patterns. At the same time, agriculture is a cause of environmental degradation, pollution and biodiversity loss. Climate-smart agriculture (CSA) is proposed as an approach that provides a roadmap to sustainable agricultural development. Despite this, farmer adoption rates of CSA practices and technologies in Europe remain low. This paper seeks to systematically review and synthesize the factors that facilitate or hinder farmers' uptake of CSA in Europe. Out of the 2827 articles identified in the Web of Science and Scopus databases, a total of 137 research articles were included for analysis following the PRISMA methodology. The factors are categorized into seven categories, namely socio-demographics, psychological, farm characteristics, practice/technology-related attributes, biotic/abiotic, systemic and policy factors, with the majority of the studies focusing on the first four categories, while systemic and policy factors are relatively understudied. The results highlight for the first time that the adoption of CSA does not depend solely on farmer characteristics but also on the food systems and structures in which farmers operate, as well as the interactions with other value chain actors. To promote the adoption of CSA practices, extension and advisory services along with access to timely and reliable information, play a vital role in increasing awareness and in the provision of training and the encouragement of farmers' behavioral shifts towards sustainable practices. From a technological point of view, adapting technologies to be easy to use, compatible with current farming objectives and cost-efficient will render them less risky investments for farmers and will foster adoption rates. Finally, support from the government in terms of financial support, subsidies and reduced bureaucratic procedures is crucial for motivating CSA adoption.

Keywords: climate-smart agriculture; adoption process; decision-making factors; food systems

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1. Introduction

Until recently, European agricultural intensification focused on productivity and incomes to meet the global food supply with little consideration for long-term environmental impacts [1,2]. The agricultural sector remains an important economic activity for European countries, accounting for 1.3% of Europe's GDP in 2021 [3] and employing 4% of the labor force [4]. The global food system is currently facing profound challenges related to ensuring the food security of a rising population and climate change, with extreme and unpredictable weather patterns, which jeopardize agricultural growth and the resilience of food production systems [5,6]. At the same time, agriculture is a major cause of environmental degradation, including greenhouse gas (GHG) emissions [5], soil erosion, water and air pollution, land degradation and biodiversity loss [7]. These environmental challenges negatively affect social and economic outcomes such as human welfare, social inclusion and economic prosperity, and they lead to the depopulation of rural areas [5,6,8].

Agriculture and climate change are policy priorities on the European agenda, which recognizes the need for immediate action. The European Union (EU) has set a number of policies, notably the European Green Deal and the Common Agricultural Policy (CAP), to provide the roadmap towards more sustainable, resilient and profitable agricultural systems. Climate-smart agriculture (CSA) has been suggested as an approach to promote sustainable agricultural development for food security under climate change pressures [5]. CSA is based on three main pillars: sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change, and reducing and/or removing GHG emissions [8,9]. This approach recognizes that synergies and trade-offs between the three pillars should be considered in the planning and implementation of agricultural strategies [8] and provides the groundwork to orient technical, policy and investment conditions for agriculture to respond to climate change and future food demands [5]. CSA encompasses a set of practices that support the agricultural "triple win": productivity, mitigation and adaptation. The practices comprise integrated crop management, agroforestry, pest and nutrient management, reduced tillage, land management, reduced fertilizer use and soil management, as well as smart agricultural technologies, including robotic systems, drones, remote sensing, satellites and the Internet of Things [8]. Despite EU policies and CSA practices being around for some time, adoption and diffusion in Europe remains slow and low [5,6].

EU policies have neglected the behavioral aspects of the shifts to CSA for a long time, mainly focusing on financial incentives. Only recently, with CAP voluntary eco-schemes, has there been a budgetary shift to more voluntary approaches that acknowledge behavioral perspective in the adoption of sustainable agriculture practices [10]. As such, in order to foster the adoption of CSA in Europe, increasing our understanding of barriers and drivers to adoption is of utmost importance. Farmers' adoption processes of CSA practices may be complex and difficult, especially due to the disparity between the long-term benefits for society as opposed to the unperceived or negligible short-term benefits for the farmers, especially because of the investment costs and resources required [6]. Even more, transitions to new sustainable practices and behaviors are long-term, complex and multidimensional processes that require changes at different technological, socio-cultural, organizational, institutional, economic and political levels [2]. Hence, understanding the complex farmer decision-making processes will enable the design and implementation of policy interventions that can overcome barriers to the adoption of CSA practices.

Existing research has revealed a number of factors affecting farmer adoption of CSA practices, including technology, socioeconomic, psychological, farming structures, biophysical, institutional and policy factors [7,11,12]. To date, the existing literature has primarily employed the theories of reasoned action and planned behavior [13], the Theory of Diffusion of Innovations [14] and the Technology Acceptance Model [15] to investigate farmer decision-making processes. These models and theories have revealed a vast number of factors that are relevant to the adoption of sustainable practices in the agricultural sector. Financial situation, market and regulatory circumstances, age and educational levels, farming characteristics, information provision, personal attitudes, social pressure and perceived benefits related to the new practice have been shown to impact farmers' decisions [7,10,12,16,17]. However, existing studies have examined farmer behavior in isolation without accounting for the complex decision making taking place in food systems, where interacting actors in the agri-food value chain, including advisors, industry, policy-makers and consumers, affect farmer transition to CSA. Transitions to CSA do not always depend solely on farmer characteristics but on the systemic factors of the food systems that create trade-offs, feedback loops and synergies that affect farmer decision making. Despite this, the importance of systemic and policy factors in the transitions to CSA remains relatively under-studied to date. Hence, this paper acknowledges that accounting for the role of food systems is imperative to uncover decision-making processes that lock farmers in or motivate them to move to sustainable, productive and CSA practices, examining these not as single, isolated processes but embedded in a set of interactions with multiple actors that have varying and sometimes conflicting interests and goals [18]. Moreover, the findings from existing studies remain rather inconclusive as to the importance of certain factors (e.g., demographics, attitudes and motives) in farmer behavioral shifts to CSA. This may be due to the complex interaction effects of factors that influence farmers' decision making and the wide variety of determinants, contexts and methodological approaches applied by the researchers [19]. Hence, systematically synthesizing the wide variety of decision-making factors is required to advance our understanding of the farmer transition to CSA.

Previous systematic reviews investigating the decision-making factors that affect farmers' adoption have mainly focused on general sustainable agricultural practices [7,12,19] or single practices, such as precision agriculture [1], organic farming [20] and conservation agriculture [21], among others, but not on CSA. Moreover, the literature in Europe is still limited, with most CSA studies focusing on Africa, Asia and Latin America [6]. Consequently, this literature neglects the contextual specificities of Europe, where agriculture is characterized by small farms [22], traditional agricultural practices, high reliance on subsidies and strict environmental regulations. Hence, there is a need to understand the European specificities with regard to production systems and conditions as well as the impact of European policies, such as the CAP, on the agricultural sector, which pose different challenges than in areas outside of Europe.

The main objective of this paper is to provide a systematic review of the literature on the decision-making factors that affect European farmers' adoption of CSA practices and technologies. Due to the wide diversity of measures reported in farmer adoption literature, this review will focus on studies that examine the final choice of farmers related to practices they have adopted, their willingness to pay or their intention to adopt CSA practices. These variables are important proxies of the adoption of practices, while other variables, like preferences or attitudes, are excluded from this analysis since they may not always translate into adoption due to various obstacles, such as a lack of financial resources or skills. Our systematic review differs from previous studies in the following ways: 1. It stresses the importance of food systems in the transitions to CSA by accounting for the key role of systemic and policy factors influencing farmers' decisions, which have been neglected in previous studies; 2. It provides a systematic review of farmer decision-making factors relating to the adoption of CSA practices; 3. It focuses on Europe to account for its contextual specificities; and 4. It examines studies reporting on the final decision to adopt or not adopt. This paper consists of four sections. The first outlines the methodology for the systematic review process and data analysis. The second presents the results and discusses the findings. The third draws knowledge from the findings to provide recommendations for institutions and policies. The fourth concludes the paper.

2. Materials and Methods

The objective of this study is to provide a systematic review of the variety of factors that drive or hinder farmers' adoption of CSA practices in Europe. We specified the research question as follows: "What factors influence farmer decision making for climate-smart agriculture practices and technologies?". To synthesize research, we used the PRISMA methodology (see Supplementary Materials) [23], following a stepwise and iterative process of research question formulation, protocol development, literature search, data extraction, quality assessment, data analysis and interpretation. Our systematic review focused on peer-reviewed empirical studies, including journal articles and conference papers, which were published in English. Expert consultation informed the systematic review process with the engagement of various stakeholders, including farmers, advisors, industry stakeholders, consumers and policy advisors, as part of a European research project, with the aim of increasing the validity of the findings and the relevance of the results for agri-food value chain stakeholders.

2.1. Study Selection

This original search was conducted in March 2024, and the information was sourced from two databases, Scopus and Web of Science. We employed a combination of keywords and their synonyms to locate studies published during the past twelve years, from 2012 to 2024, in the English language. In order to limit the results and focus on empirical studies, the results were filtered in the two databases to include only peer-reviewed articles and conference papers. To identify keywords and synonyms, a broad list of keywords based on previous reviews was used [1,7,12,19]. The search strategy was iteratively developed with the involvement of the researchers of this paper and was trialed several times. The search keywords were related to producers (farmer* OR producer*), influencing factors (factor* OR driver* OR barrier* OR determinant* OR percept* OR motivat* OR attitud*), behavior (decision* OR behaviour* OR behavior* OR switch* OR adopt* OR uptake OR behavio*change OR transition* OR conversion OR implement* OR "willingness to pay") and climate-smart agriculture practices or technologies ("sustainable agriculture" OR "sustainable farming" OR "organic farming" OR "organic agriculture" OR "climate-smart agriculture" OR "climate-smart farming" OR "precision farming" OR "precision agriculture" OR "smart farming technolog*" OR "smart farming" OR "smart agriculture"). The search resulted in a total of 2827 papers eligible for screening.

2.2. Screening Process

To be eligible for further consideration in the systematic review, the study had to meet the following inclusion criteria: (1) it had to be conducted at a farm level, meaning that the surveyed population had to be farmers; (2) analyzed primary data to assess the impact of factors on the adoption of CSA practices; (3) examined the adoption of CSA practices as the dependent variable; (4) the research was carried out in Europe; and (5) the research had to be relevant to the subject matter. We used a two-step screening process by first screening the titles and abstracts, followed by reading the full text of the paper in the second stage. The aforementioned eligibility criteria were applied in both screening stages to decide whether or not to include the articles for further analysis. Only articles that met the criteria were used for further analysis. The selection process was completed independently and cross-checked by the authors to ensure validity in the selection process and to resolve any doubts about eligibility for inclusion.

Figure 1 depicts the search and screening procedure for the articles using the PRISMA methodology. Initially, 2827 articles were obtained through database searches, 1685 from Scopus and 1142 from the Web of Science. In total, 764 duplicates were removed. During the first screening process, based on titles and abstracts, 2583 articles were excluded due to not meeting the inclusion criteria or being duplicates, as specified in Figure 1. The remaining 244 articles were subjected to full-text screening and assessed for inclusion. At this stage, 107 articles were excluded because they did not involve farmers as their study population, did not use primary data, the adoption of CSA practices was not their dependent variable, were not carried out in Europe or were irrelevant to the scope of our review, as can be seen in Figure 1. Finally, 137 articles fulfilled the criteria and were included for analysis.

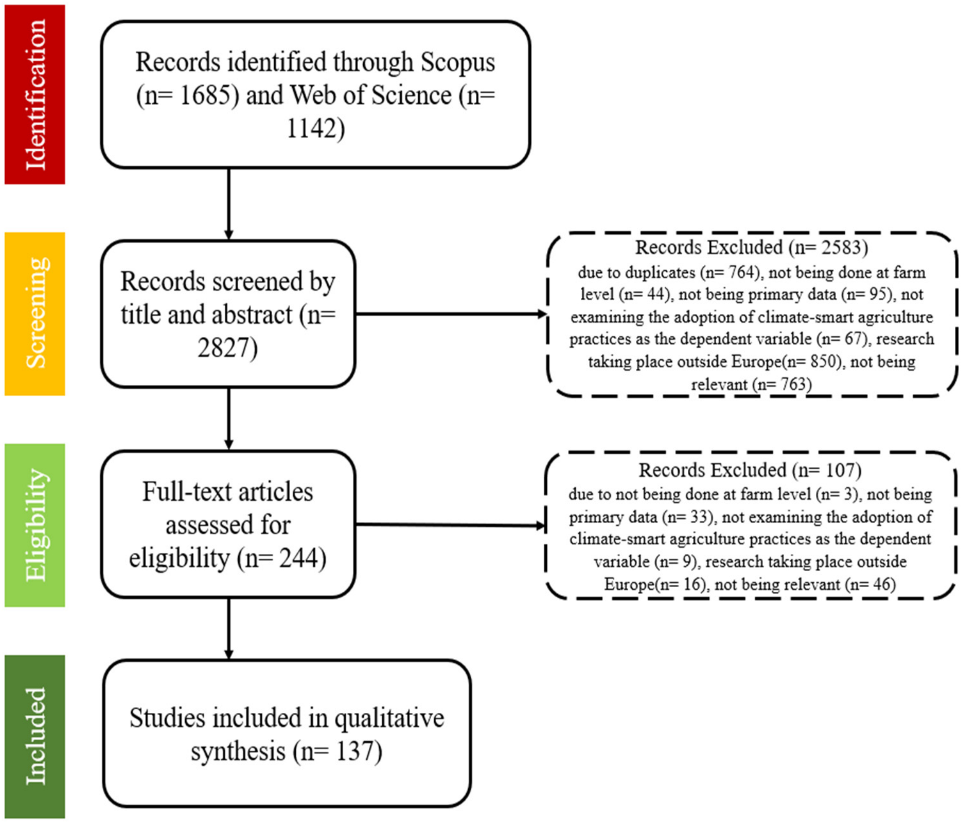

Figure 1. PRISMA flow diagram to illustrate the steps involved in the systematic review.

2.3. Data Extraction and Analysis

Key data were extracted from the articles that were in line with the objectives of our systematic review. The data were extracted manually following the review of the full text of the articles and were recorded in a designated spreadsheet for systematic review. The background of the 13 selected studies was recorded, capturing the year of publication, authors, country in which the research was conducted, type of research employed to investigate farmers' adoption (quantitative, qualitative or mixed) and the CSA practices and technologies examined in the research. The different types of data extracted appear in Table 1 below. For the in-depth analysis of the articles, we examined the full text of the articles, especially focusing on the methodology and results section of each article and any tables reporting the statistical analysis of the significance of the variables and the direction of influence. The accuracy of the data extraction process was verified independently by the authors and cross-checked, and discrepancies were resolved through discussion. The factors affecting farmers' decision to adopt CSA practices were classified into seven large categories consisting of smaller subcategories. These categories involve socio-demographic, psychological, farm characteristics, biotic/abiotic, characteristics of the practice/technology, systemic and policy factors, which are in line with previous research [1,7,12,19]. Additionally, CSA practices were classified into six categories for descriptive purposes; these are as follows: a. Smart farming technologies, digital tools and AI; b. organic farming; c. renewable energy sources; d. natural resource preservation; e. biodiversity preservation; and f. other CSA practices. In order to categorize the CSA practices, two of the authors conducted the content analysis independently while categorization was cross-checked, and discrepancies were resolved through discussion.

The synthesis of the findings from multiple studies was carried out by counting the number of times that a variable was shown to have a positive, negative or non-significant effect on farmers' adoption of CSA practices across the studies. This paper does not provide a ranking of the importance of decision-making factors or a meta-analysis, given their context-specific attributes and the lack of homogeneity across studies that do not allow for cross-study comparisons.

Table 1. Types of data extracted throughout the systematic review process.

Type of Data	Data Recorded
Authors' names	
Year of publication	2012–2024
Geographical location of the study	European countries
Type of research	Quantitative, qualitative or mixed
CSA practices	a. smart farming technologies, digital tools and AI, b. organic farming, c. renewable energy sources, d. natural resources preservation, e. biodiversity preservation, and f. other CSA practices.
Decision-making factors	a. socio-demographic, b. psychological, c. farm characteristics, d. biotic/abiotic, e. characteristics of the practice/technology, f. systemic and g. policy factors

3. Results

This section presents the analysis of the results of the systematic review. An overview of the study characteristics is provided to demonstrate the distribution of the number of studies in time for the period 2012–2024, the geographical location of the studies, the type of CSA practices examined and the research methods used. Decision-making factors that affect farmers' transition to CSA are categorized into socio-demographic, psychological, farm characteristics, biotic/abiotic, practice/technology-related characteristics, systemic and policy factors. The effect of these various factors in the adoption of CSA practices is presented and discussed in detail in this section based on the analysis of the research studies included in the systematic review. Appendix A presents the studies that have been included in this review along with their key characteristics.

3.1. Study Characteristics

A total of 137 studies that were conducted in the past 12 years, from 2012 to 2024, were analyzed for this systematic review. As evident from Figure 2, the number of publications relevant to the review was quite low for the years 2012–2016, ranging from two to six publications per year. The number of publications increased to nine for 2017 and 2018 and thirteen for 2019. Almost half of the studies in this review were published between 2020 and 2022, accounting for 49% of the total number of reviewed studies. This indicates the increasing attention that CSA practices and decision-making factors affecting adoption have been receiving in recent years. In 2023, there was a slight drop in the numbers to fifteen studies, while in 2024, four studies have been published up to March 2024.

Regarding geographical location, this systematic review included studies that were reportedly conducted in 31 European countries, as displayed in Figure 3, with the highest concentration of studies being in Germany (33), Italy (24), France (16), Greece and the Netherlands (14), Spain, UK and Switzerland (13), and Denmark (10). It is evident that Central, northern and southern European countries are well represented, while the context of Eastern countries is less frequently examined.

In terms of the type of climate-smart agriculture practices investigated in the studies, Figure 4 shows that most of the studies (46 of 137, i.e., 34%) focus on the first group, namely "smart farming technologies, digital tools and artificial intelligence (AI)" and the second group of "organic farming" practices with 26% (36). In the first group, technologies such as sensors, drones, variable rate irrigation, robots and decision support systems have been studied. Considerably fewer studies fell into the other four groupings of natural resources preservation (e.g., crop rotation, mixed cropping, no-tillage, reduced tillage, integrated pest management and water management), with 17% (23); biodiversity preservation (e.g., microbial applications, beekeeping and species mixture), with 8% (11); and renewable energy sources and animal welfare (e.g., animal feed), with 2% (3). Finally, 13% of the studies (18) did not look at a specific sustainable practice.

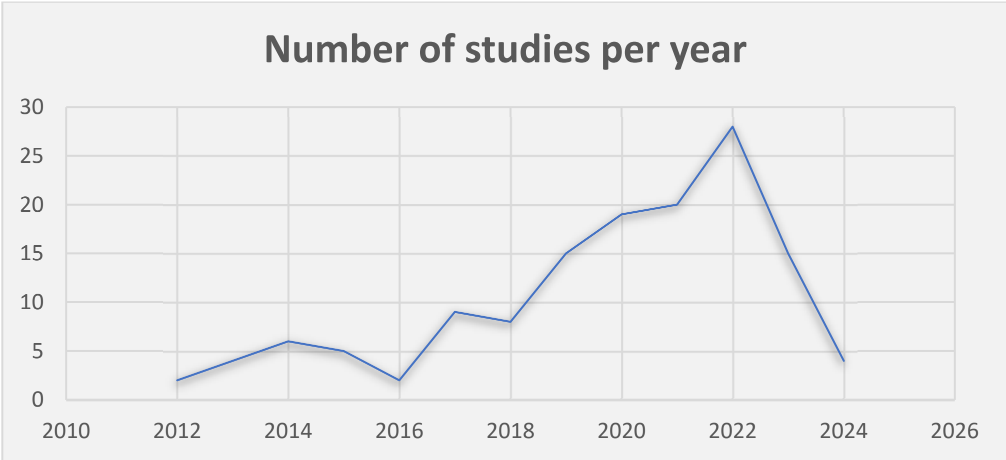

Figure 2. Number of studies published per year.

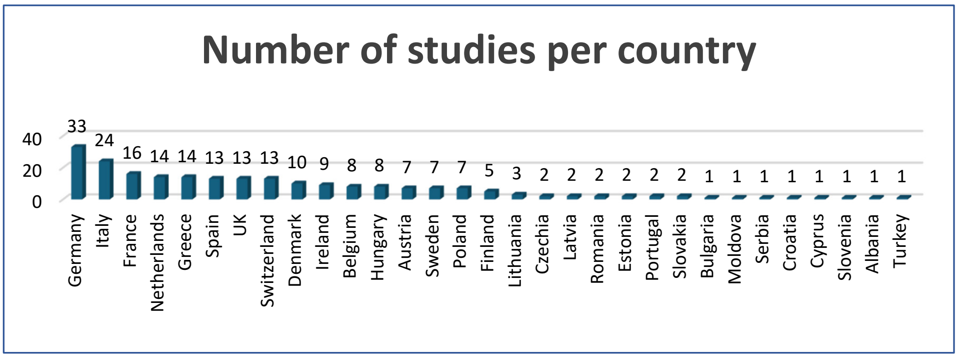

Figure 3. Number of studies published per country.

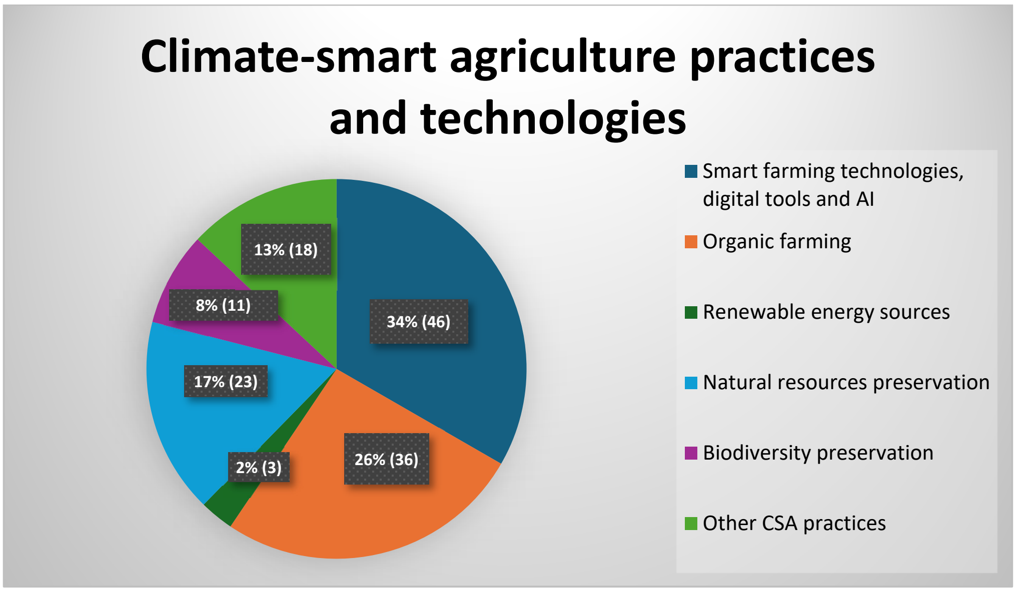

Figure 4. Climate-smart agriculture practices studied in the articles.

With regard to the type of research, as can be seen in Figure 5, the majority of the studies employed quantitative methods via surveys, accounting for 56% (77) of the articles reviewed. This was followed by 31% (42) of the articles employing qualitative methods, using interviews and focus groups, while 13% (18) used mixed methods approaches.

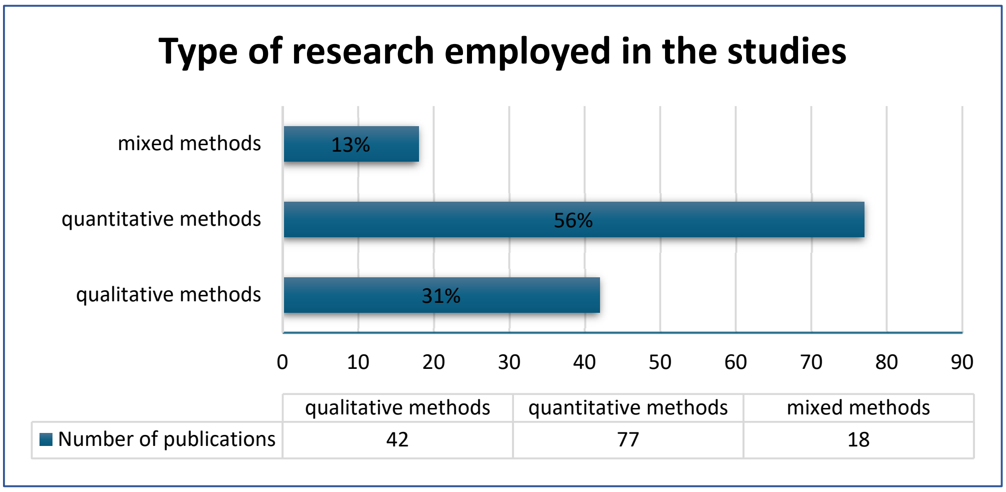

Figure 5. Types of research employed in the studies.

3.2. Determinants of Farmer Adoption of CSA Practices

In summary, our review of 137 articles reveals a variety of factors that influence decision making by farmers when it comes to CSA practices. For each subsection below, tables are provided to summarize the significant determinants. The decision-making factors have been broadly categorized into socio-demographics, psychological factors, farm characteristics, biotic/abiotic, characteristics of the practice/technology, systemic and policy factors based on categorizations used in previous studies [1,7,12]. Table 2 summarizes the factors identified in the review under each of the seven categories, as well as the number of papers that have examined each category of factors.

Table 2. Review of the factors affecting the adoption of CSA.

Categories	Factors Identified	No. of Studies Examining Factors
Socio-demographic	Age, educational level, gender, farming experience, on-farm income, off-farm income, full-time farmers, household size	55
Psychological	Awareness, knowledge, farmer skills, perceived behavioral control, motives, attitudes, trust, subjective norms, risk aversion, resistance to change, innovativeness, environmental consciousness, responsibility for future generations	91
Farm characteristics	Farm size, size of arable land, farm yield, farm profitability, farm ownership, farm successor, labor availability, shared machinery	48
Biotic/abiotic	Weeds, pests, crop diseases, soil quality, temperature, precipitation, drought weather conditions	15
Practice/technology related	Perceived usefulness, perceived ease of use, perceived compactivity, costs, benefits, trustworthiness, lack of verified impact, availability of certification	87
Systemic	Social norms, social learning, social networks, information sources, extension and advisory services, marketing and communication, research education and knowledge, access to market, access to credit, direct marketing, short supply chains, market demand, availability of infrastructure, collective decisions and participatory approach, membership in a cooperative	80
Policy	Legal framework, financial support, degree of bureaucracy	54

3.2.1. Socio-Demographic Factors

Socio-demographic factors encompass the demographic characteristics (e.g., age, gender and level of education) and household characteristics (e.g., household size and income) of the farmers. Out of the socio-demographic factors, age has been more frequently studied in 44 papers of the review, followed by educational level in 38 papers. The effect of farmers' age on the adoption of CSA was assessed, demonstrating an inverse relationship in 28 out of 44 studies. Compared to older farmers, young farmers are more likely to adopt CSA practices because they are usually more interested in new practices and technologies, and it is easier for them to learn to use and also to search for suitable solutions to fit their production systems [24,25]. Education level, including agricultural education, has a positive association with the adoption of CSA in 55.3% of the studies. This is mainly due to the fact that farmers with higher educational attainment possess the appropriate skills and knowledge needed to appreciate the potential benefits of CSA, as well as the capacity to experiment with different solutions [26,27]. On the other side, gender has a non-significant influence on adoption, indicating that socio-cultural inequalities in access to information, knowledge, markets and services, which perpetuate gender disparities, have gradually been eliminated [28,29]. Farming experience can increase adoption because more experienced farmers have greater awareness of the potential benefits of CSA practices for their farm; they possess the necessary knowledge and skills to efficiently implement them and may be in a better financial position to invest in sustainable practices [30].

Regarding household characteristics, the results indicate that higher on-farm and off-farm income are positively associated with the adoption of CSA, as is evident in four out of nine and five out of eight studies, respectively. These farmers have the financial resources to invest in new practices and technologies that are sometimes costly and risky to invest in and require time and effort commitments [7,31,32]. Consistent with previous research, full-time farmers tend to adopt CSA practices more as opposed to part-time farmers [33]. Finally, household size was not considered an important determinant of adoption, which is in line with other related studies [7,19]. Table 3 summarizes the findings for socio-demographic factors, indicating the number of studies where each decision-making factor acted as a driver or barrier or had an insignificant influence on the adoption of CSA. The percentage of articles demonstrating a significant effect is then calculated based on the sum of the number of articles with positive and negative effects divided by the total number of articles examining each decision-making factor.

Table 3. Socio-demographic factors affecting the adoption of CSA.

Socio-Demographics	Driver	Barrier	Insignificant	Total No. of Studies	% Significant
Age	4	28	12	44	72.7
Educational level	21	0	17	38	55.3
Gender (male)	2	5	8	15	46.7
Farming experience	5	2	0	7	100
On-farm income	4	2	3	9	66.7
Off-farm income	5	0	3	8	62.5
Full-time farmers	4	1	1	6	83.3
Household size	1	1	3	5	40

3.2.2. Psychological Factors

Psychological factors include individual cognitive, affective and dispositional factors that may influence farmers' adoption of CSA. As evident in Table 4, perceived behavioral control, motives and attitudes have been most extensively studied in 29, 27 and 26 papers, respectively. A review of the articles provides considerable evidence on cognitive factors such that farmer awareness related to environmental challenges, climate change, the benefits of CSA practices and current regulatory frameworks for sustainable agriculture plays a significant role in promoting adoption. In this review, 88.2% of the articles indicated that farmers who are aware are in a better position to assess the challenges facing agriculture and the benefits of the transition to sustainable practices [34–36]. Similarly, farmer knowledge of climate change and different CSA practices and technologies motivates them to adopt CSA [31,37–39]. Moreover, farmers skilled in farming, technology and computer use, as well as analytical thinking, feel more confident and are better equipped with the capacity to use new practices and, hence, are more likely to adopt them, as evident in seven out of ten studies [37,40]. Adoption increases with perceived behavioral control when the farmers feel they have the control, confidence, skills and resources to adopt a CSA practice [24,41].

Motives are an important factor considered in farmer decision making research studies. Farmers cite a number of farming motives when deciding about whether to adopt CSA practices, such as economic returns, modernization and improvement of farming activities, farm productivity and yield, product quality, environmental and animal welfare, moral obligation, keeping family traditions, cultural heritage preservation and social embeddedness. These motives significantly and differentially impact the adoption process [42–45]. Attitudes play a fundamental role in farmers' decision making. In this review, 22 out of 27 articles show that positive attitudes towards the environment and climate change, pro-environmental attitudes and positive attitudes towards CSA practices positively affect adoption [31,46,47]. Trust also plays a crucial role in adoption since farmers will not accept CSA practices if they cannot trust the sources promoting them, including the media, peers and other value chain stakeholders, as well as governments [33,48,49]. Finally, subjective norms relate to what farmers believe to be socially approved by family, peers and society. These influence adoption rates since farmers will act in accordance with social expectations in order to remain valued members of their respective social groups [48,50].

With regard to dispositional factors, risk aversion refers to a reluctance to take on risks, while resistance to change refers to an unwillingness to abandon traditional agriculture practices. Both these personality traits influence farmer behavior such that farmers who are more risk-averse and resistant to change are more reluctant to adopt CSA practices and technologies, as is evident in 100% of the studies investigating these factors [41,51–53]. Conversely, farmer innovativeness is a driver for adoption. Innovators are usually open to new experiences, seek to try out new practices more quickly than others and are willing to take on more risks [37,43,54,55]. In addition, farmers who have environmental consciousness and perceived responsibility for future generations are more likely to adopt CSA practices. These farmers are conscious of the impact of their agricultural activities on the environment, animal welfare, public health and food security on the one side, and they feel a sense of moral obligation to protect and act on behalf of future generations on the other side [44,54,56]. Table 4 summarizes the findings of the studies with respect to the effect of psychological factors on the adoption of CSA practices.

Table 4. Psychological factors affecting the adoption of CSA.

Psychological Factors	Driver	Barrier	Insignificant	Total No. of Studies	% Significant
Awareness	15	0	2	17	88.2
Knowledge	20	0	1	21	95.2
Farmer skills	7	0	3	10	70
Perceived behavioral control	28	0	1	29	96.6
Motives	19	8	0	27	100
Attitudes	22	1	4	27	85.2
Trust	3	0	0	3	100
Subjective norms	23	3	1	27	96.3
Risk aversion	8	0	0	8	100
Resistance to change	5	0	0	5	100
Innovativeness	9	1	2	12	83.3
Environmental consciousness	12	0	0	12	100
Responsibility for future generations	2	0	0	2	100

3.2.3. Farm Characteristics

Of the various farm characteristics, farm size and the availability of labor are the decision-making factors that have been studied the most, in 34 and 15 papers, respectively. Farm size has been largely identified as an important driver of farmer adoption of CSA practices in 22 out of 34 studies. Farmers with larger farms benefit from economies of scale, reduced costs and higher investment returns [24] and may be more prone to investing in CSA practices to facilitate organizational complexity in their farming activities [57]. Likewise, this is also applicable to larger size of cultivable land, which is associated with increased adoption rates [7,58]. Even more, farms with increased profitability and yield have greater resource capacity and are more likely to invest in CSA practices, especially when farmers believe that the practice or technology offers gains in profitability and yield [59–61].

Farm ownership also plays a role, with land tenants being less likely to engage in CSA practices compared to farm owners due to the insecurity involved in tenancy, risk aversion, reduced financial capacity and their decisions frequently being constrained by the will of landlords [31,52,58,62]. Conversely, four out of six articles show that the availability of succession planning increases the likelihood of a farmer adopting a CSA practice. The longevity of a farm makes the farmer more willing to engage in an investment activity that will increase the profitability and the environmental status of the farm and make the business attractive for the successor [58,59,63].

The findings of this systematic review further indicate that the different types of farming systems (crop, livestock and mixed) create different adoption rates of CSA practices depending on the benefits the practice or technology offers for different farming systems [64–66]. With regard to labor availability, despite the fact that the increased supply of labor is diminishing the risk of investing in new methods or technologies that require significant labor input, this is not found to be a key consideration for the final decision to adopt CSA practices [35,66–68]. The availability of shared machinery has been studied in a few articles of this review, but findings are inconclusive about the effect on farmers' adoption of CSA practices [58,60]. Table 5 summarizes the effects of farm characteristics on the adoption of CSA practices.

Table 5. Farm characteristics affecting the adoption of CSA.

Farm Characteristics	Driver	Barrier	Insignificant	Total No. of Studies	% Significant
Farm size	22	6	6	34	82.4
Size of arable land	8	1	1	10	90
Farm outputs (yield and profitability)	5	2	1	8	87.5
Farm ownership	6	3	3	12	75
Farm successor	4	0	2	6	66.7
Labor availability	5	2	8	15	46.7
Shared machinery	2	0	2	4	50

3.2.4. Biotic/Abiotic Factors

The geographical locations of farms play a significant role in the decision-making process. Different farm locations (e.g., countries, regions and urban/rural) lead to different adoption rates due to regional differences, such as for farms located in urban or rural areas, favorable or protected areas or mountainous regions, different access to infrastructure and differences associated with natural, historical, social, economic and political contexts [43,57,63].

The uptake of CSA depends on biotic factors, including the presence of weeds, pests and diseases. CSA practices, such as crop diversification and the use of crop resistant varieties, are considered to be effective in increasing the resilience of farms against biotic stresses, while other practices, like organic farming, increase their exposure to these risks. Finally, abiotic factors, such as temperature, precipitation, drought and extreme weather events, did not significantly affect the adoption of CSA, in contrast with soil quality, where farmers were more receptive to change to CSA to reverse the effects of poor soil quality [6,29,31,69]. Table 6 below shows the results of studies with respect to the effect of biotic/abiotic factors on the adoption of CSA.

Table 6. Biotic/abiotic factors affecting the adoption of CSA.

Biotic/Abiotic Factors	Driver	Barrier	Insignificant	Total No. of Studies	% Significant
Weeds pressure	0	2	0	2	100
Pests	1	0	1	2	50
Crop diseases	1	0	0	1	100
Soil quality	0	5	1	6	83.3
Temperature	0	0	1	1	0
Precipitation	1	0	2	3	100
Drought	0	0	1	1	0
Extreme weather conditions	1	1	3	5	40

3.2.5. Characteristics of the Practice/Technology

The characteristics of CSA practices are a key determinant of the decision to adopt. Among the eight factors of this category, perceived costs and benefits associated with the adoption of the practices/technologies have been examined in most of the papers of the review, with 37 and 49 papers, respectively. With respect to the practice/technology, characteristics associated with perceived usefulness, ease of use and compatibility drive adoption. Perceived usefulness refers to the extent to which farmers anticipate that utilizing a CSA practice will be advantageous in enhancing farm productivity, reducing workload and simplifying farm operations [34,70,71]. Perceived ease of use, which is associated with farmers' beliefs about user-friendliness and ease of learning to use a new practice or technology, has been found to have a positive relationship, with adoption seen in 13 out of 16 studies. The compatibility between the new technology or practice and the current farm practices, goals and values of the farmer is also taken into consideration [72–74].

Our analysis points out the importance of perceived costs and benefits associated with the new practice or technology in farmer decision making. These costs are associated with investment costs, reduced farm yield, training requirements, increased workload and long payback periods, which are negatively associated with adoption rates, as evident in 37 studies [5,44,51,67,72,75–77]. On the other hand, perceived benefits, such as economic gains, environmental benefits, improved societal outcomes, including food safety and quality, higher yields and reduced production costs, have been identified as significant drivers of adoption in 46 studies [38,39,55,67,78,79].

Farmers identify a lack of trust in technologies as an important lock-in since unresolved issues surrounding data ownership, privacy protection and information technology security reduce their trust in technologies and hinder adoption [78,80]. Furthermore, the perceived absence of solid evidence on the positive impact of a practice or technology is negatively associated with the adoption of CSA in eight studies. Potential adopters require assurances of their beneficial impact, and when benefits are uncertain, there is a lower probability of adoption among farmers [5,81].

Finally, the role of certification schemes has been studied in a few articles. The findings indicate that farmers view certification in a positive light as providing a guarantee for product quality, subsidies, higher selling prices and indirect publicity incentivizing them to adopt CSA practices. However, some farmers also pointed out the high bureaucratic burden, control, and time needed for certification schemes [2,44,82]. Table 7 summarizes the findings with regard to the association of practice/technology-related factors with the adoption of CSA.

Table 7. Characteristics of the practice/technology affecting the adoption of CSA.

Practice/Technology-Related Factors	Driver	Barrier	Insignificant	Total No. of Studies	% Significant
Perceived usefulness	17	0	1	18	94.4
Perceived ease of use	13	0	3	16	81.3
Perceived compatibility	13	0	0	13	100
Perceived costs	0	37	0	37	100
Perceived benefits	46	0	3	49	94
Perceived trustworthiness	7	0	0	7	100
Perceived lack of verified impact	0	8	1	9	88.9
Availability of certification	5	0	0	5	100

3.2.6. Systemic Factors

Systemic factors refer to all those factors that operate at the food system level and create feedback loops and trade-offs that, in turn, affect farmers' decisions. The main contribution of this paper is to show that transitions to climate-smart agriculture are not always under farmers' control but also depend on the behavior and interests of other value chain stakeholders in the food systems. As is evident, systemic factors are relatively under-studied, with the exception of extension and advisory services (studied in 46 papers. Hence, understanding the influence of these factors is imperative. Firstly, social norms significantly influence adoption in 81.8% of the studies, such that CSA practices that are socially acceptable and supported within the community are more likely to be adopted by farmers than those that are disapproved of. The norms and values of the society about what a "good farmer" is and the societal expectations about environmental protection, animal welfare, and public health dictate what is socially acceptable and, hence, provide signals relating to community support and peer pressure [47,54]. Social learning, through observing and experiencing first-hand how other farmers use CSA practices in their farms, increases trust in new practices and encourages adoption [55]. In a similar vein, the social networks that a farmer has access to affect decisions such that social networks of like-minded individuals who value CSA are more likely to be mimicked by peer farmers [8,15,37,39].

Regarding access to information, the results indicate a positive correlation with the adoption of CSA in 14 out of 17 studies. Information sources such as farmer open days, discussion groups, TV, radio, and social media raise farmer awareness of CSA practices, encouraging adoption [36,52,76,77,83]. In addition, extension and advisory services play a critical role in promoting the adoption of CSA practices and technologies among farmers, as is evident in 44 out of 46 studies. Ongoing training services, through courses, field visits and demonstrations, as well as technical support, can provide farmers with the necessary knowledge, skills and confidence to use new practices and help them overcome barriers to adoption. Furthermore, most studies highlight the importance of tailored advisory services that take into account individual farm characteristics and farmer needs [5,55,75,84,85]. Marketing and communication campaigns have been found to have a positive association with adoption since they play a critical role in raising awareness and educating not only farmers but also other agri-food value chain actors about the benefits of a transition to CSA [86,87]. On the other hand, a lack of research, education, and knowledge provided by universities and governments has been negatively associated with adoption, highlighting the need for accessible and relevant information as well as education to support adoption [44,88].

The results further indicate that easy access to markets and the availability of alternative channels to sell their products directly to customers (direct marketing) enables closeness between farmers and buyers and leads to higher profitability, encouraging them to adopt CSA [44,89]. Short supply chains are mostly viewed as enablers of the adoption of CSA practices as they reduce dependence on intermediaries and increase control over price setting [44,89]. Access to credit through loans can help farmers invest in CSA practices as it improves their financial resources and investment opportunities [54]. On the other hand, 11 studies demonstrate that low market demand, such as in cases when consumers do not see the added value of the products and are not willing to pay price premiums, can inhibit the adoption of CSA practices and technologies since market demand creates feedback loops from buyers to farmers about the practices they should use [2,90]. A lack of infrastructure, such as a lack of high-speed internet, irrigation systems, inadequate roads, transportation, and communication systems, can make the adoption of CSA practices more challenging [6,29,71,88].

Our systematic review further suggests that collective decisions and participatory approaches where farmers are allowed to share their experiences and knowledge with other value chain stakeholders and actively engage in the decision-making process can increase their engagement in the implementation of CSA practices, as evident in 14 studies. The development of partnerships and collective goals between farmers, processors, retailers and consumers can align the interests of different actors. In these instances, farmers feel a sense of control over and trust in decisions when their voice is heard [44,49,76,91]. Finally, membership in a cooperative is found to be positively associated with the adoption of CSA practices. An agricultural cooperative provides a platform for farmers to share knowledge and resources, receive advice and technical support and facilitates collective action and peer learning [44,52]. Table 8 summarizes findings for systemic factors and their impact on the adoption of CSA.

Table 8. Systemic factors affecting the adoption of CSA.

Systemic Factors	Driver	Barrier	Insignificant	Total No. of Studies	% Significant
Social norms	5	4	2	11	81.8
Social learning	11	0	2	13	84.6
Social networks	7	0	4	11	63.6
Information sources	14	1	3	18	77.8
Extension and advisory services	44	0	2	46	95.7
Marketing and communication campaigns	9	0	1	10	90
Lack of research, education and knowledge	0	7	0	7	100
Access to market	7	0	0	7	100
Direct marketing	5	0	0	5	100
Short supply chains	3	0	0	3	100
Access to credit	4	0	0	4	100
Market demand	11	0	0	11	100
Lack of infrastructure	0	14	0	14	100
Collective decisions and participatory approach	14	0	0	14	100
Membership in a cooperative	9	0	4	13	69.2

3.2.7. Policy Factors

Existing legal frameworks and financial incentives affect farmer transitions to CSA. Existing policy frameworks can either incentivize or disincentivize the adoption of CSA practices. In this review, 17 out of 30 studies showed that policies that are considered by farmers to increase the economic viability of their farms and facilitate transition and cooperation along the value chain incentivize farmers. However, in some cases (12 out of 30 studies), policies act as a barrier when they fail to compensate farmers' loss of income, come with administrative burdens, there is a lack of payment differentiation according to different contexts, and a lack of long-term governmental vision [37,48,72,92,93].

In general, government financial assistance was viewed by farmers as an incentive to the uptake of CSA practices, as is shown in 34 studies. Financial support exists in the form of subsidies, tax reductions and schemes to compensate for lost income and investment risks. However, farmers identified a number of constraints in the provision of financial support, such as compensation that does not cover costs, complex and bureaucratic procedures and heavy penalties for mistakes [82,83,94,95].

Finally, bureaucratic procedures, such as those involved in the provision of subsidies and certifications, create a burden for farmers. Resources, in terms of time and effort, as well as skills and knowledge of the procedures required to complete the paperwork, highlight the negative role that bureaucracy has in the adoption of CSA practices [44,89,96]. Table 9 summarizes findings for policy factors affecting the adoption of CSA.

Table 9. Policy factors affecting the adoption of CSA.

Policy Factors	Driver	Barrier	Insignificant	Total No. of Studies	% Significant
Legal framework	17	12	1	30	96.7
Financial support	34	0	3	37	91.9
Bureaucracy	0	10	0	10	100

4. Discussion

Summarizing the findings, it is evident that, in line with previous research, age and education, attitudes, farm size and perceived costs/benefits associated with the practices are significant determinants of behavior, while other factors, such as gender and household size do not play a role [25,26,41,67]. This review significantly contributes to previous research by stressing the importance of systemic and policy factors in the transition to CSA, which have been relatively under-studied to date. The findings of this systematic review demonstrate the important role of policy frameworks and financial support in the wider uptake of CSA in Europe. Financial support, although viewed in a positive light, may be inflexible and comes with high bureaucratic procedures, controls and costs [38,84,92]. European governments should design well-thought-out and targeted subsidies that reduce costs and minimize the risks of investment, especially in cases where the adoption of CSA practices does not involve high economic benefits to farmers, to encourage adoption. Improving access to formal credit will be a reliable approach to reducing perceived risks and is expected to increase willingness to adopt CSA practices [54]. Policies could combine programs that incentivize CSA practices with risk management tools to reverse farmer risk aversion. In policy design, there is no one size fits all policy due to the heterogeneity of contexts and farmer characteristics. Hence, policies that target more disadvantaged farmers, such as providing support to farmers with low income or living in areas with low soil quality, will facilitate wider adoption. Moreover, a mix of voluntary and mandatory schemes in policy design can be more effective, with voluntary schemes targeting farmers who have high environmental concern and risk tolerance and mandatory schemes addressing farmers who are more resistant to change.

Access to extension services, education and training increases awareness, builds farmers' skills and encourages adoption. This result is in line with previous research, highlighting the importance of extension and advisory services in the adoption of CSA practices [2,5,90]. The role of advisors should be further strengthened to become the main point of contact for providing reliable, practical and scientifically founded advice to farmers' daily problems. Opportunities for field visits and farm demonstrations also provide a tool for effective peer-to-peer learning and learning-by-doing. Moreover, the availability of capacity-building activities through farmer networks, farmer associations, NGOs and formal education programs should be increased, and farmers should be encouraged to participate in education and training activities related to CSA.

Our findings further indicate that access to information should be considered for the upscaling of CSA practices. As has been previously suggested, farmers need access to timely, reliable and unbiased information about CSA practices and the regulatory framework surrounding adoption in order to increase their awareness and trust [34,57]. Information sharing through social networks could also be effective. Participatory approaches, where farmers can exchange information with peers will increase their understanding of the benefits and costs associated with implementing CSA practices. Mass media could also play a role in raising public awareness about climate challenges and the ways to overcome them in order to establish a value chain-wide understanding of the mutual short- and long-term benefits of a transition to CSA. This, in turn, will decrease resistance to change from other value chain stakeholders (e.g., retailers) with conflicting interests and will increase market demand and willingness to pay higher prices for goods produced in a climate-friendly way.

From a practice/technological point of view, the results indicate that the characteristics of the practice/technology, such as perceived ease of use, usefulness and compatibility, motivate adoption, a finding which is in line with previous evidence [34,70,71]. On the other side, cost considerations and risky investments are major barriers to the adoption of new practices and technologies [38,66]. Trust in the technologies plays a role in farmers' acceptance of innovations. These decision-making factors are expected to play a key role in the coming years, especially with the advent of new technologies, such as the Internet of Things (IoT), Artificial Intelligence (AI) and cloud-based technologies. Previous studies indicate that these technologies are perceived as complex and difficult to use while they still require significant initial investment with respect to financial costs, time, effort and training requirements for farmers. Furthermore, data-driven technologies raise data ownership, sharing and privacy concerns, threatening farmers' trust in these technologies [97]. To address these barriers, adapting current CSA practices and technologies to be easier to use, less complex and more compatible with current farming operations, different geographical locations and farming systems would scale up their adoption rates in Europe. Designing CSA solutions that are cost- and risk-effective and have clear environmental and social benefits would minimize losses to the environment and also increase economic benefits for farmers. Increasing transparency in the procedures used for farmer data collection and sharing in data-driven technologies will be the next big challenge in order to gain farmers' trust relating to the use of new technologies.

The findings further demonstrate that certification schemes that suit farmers' needs and that are more flexible and less bureaucratic need to be in place to increase the uptake. The availability of infrastructure, access to market and direct selling are facilitating the adoption of CSA [29,66,71]. The wider availability of internet connectivity, irrigation systems and transportation make farmer adoption of CSA practices and technologies easier. Similarly, bringing markets for the farmers' products closer to where the production is or creating alternative channels to sell products (e.g., online marketplaces) will reduce the risk of low market demand for CSA produce.

5. Conclusions

To date, an integrative framework of the "lock ins" and "levers" that hinder or motivate farmers to adopt CSA has been lacking. This review is important from a research and policy perspective. To our knowledge, this is the first review to provide a comprehensive overview of the factors that influence farmers' decision to adopt CSA practices in the European context. Even more, it is the first review to highlight the importance of systemic and policy factors in the transition to CSA. Farmers' decisions not only depend on their individual characteristics but also on the food systems in which they operate, which create power dynamics, feedback loops and trade-offs that influence farmer behavior. This review is important for policy making as well since it helps policy makers to make informed decisions, focusing on identifying and removing barriers to the adoption of CSA practices by designing short- and long-term interventions.

From the review, it is evident that systemic and policy factors have not been adequately examined in the studies; hence, more research is needed to understand the mechanisms within the food systems in which farmers operate influence farmer transition to CSA. Even more, the majority of the studies focused on single aspects of the adoption process, failing to capture the complex and multidimensional nature of the adoption process. For instance, studies that investigate socio-cultural factors exclude the examination of institutional and policy factors. Adopting a food system approach, where the farmer is not viewed in isolation but as an embedded actor in the food system where power dynamics, structures and trade-offs affect behavioral change towards CSA, would yield a better understanding of farmer adoption.

Contextual differences in previous studies (e.g., country, practice and farming system), as well as the breadth of designs and methodological approaches employed, result in inconclusive findings for certain factors and have made cross-study comparisons difficult. Hence, a meta-analysis to identify the important determinants of farmer transition to CSA is warranted. Moreover, the effect of factors on the adoption of CSA may change over time, while systemic and policy factors require time to change the behavior of farmers. Longitudinal studies are needed in order to examine the long-term changes and effects of various decision-making factors on farmer adoption of CSA practices. Most of the papers in this review examined adopters and non-adopters, thus neglecting farmers who have previously used CSA practices and quit. Examining this category of farmers could uncover barriers to adoption that are different from those of non-adopters. Moreover, most of the studies reviewed were correlational or qualitative, rendering it difficult to establish causal relationships between decision-making factors and the adoption of CSA. Hence, future studies could expand our knowledge by employing methodologies to show causality or rely on path analysis rather than regression.

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Appendix A

Author and Year	Factors Studied	Geographical Location	Climate-Smart Agricultural Practice Category
De Master, 2012 [83]	Collective decisions and participatory approach, information sources, legal framework, financial support and degree of bureaucracy	Poland	Organic Farming
Theocharopoulos et al., 2012 [39]	Knowledge, attitudes and financial support	Greece	Organic Farming
Koutsoukos and Iakovidou, 2013 [98]	Environmental consciousness, knowledge, attitudes, marketing and communication campaigns, lack of research, education, and knowledge, lack of infrastructure, extension and advisory services, legal framework and perceived benefits	Greece	Organic Farming
Läpple, 2013 [99]	Age, gender, educational level, risk aversion, motives, attitudes and information sources	Ireland	Organic Farming
Läpple and Kelley, 2013 [100]	Attitudes, perceived behavioral control, subjective norms and financial support	Ireland	Organic Farming
Nave et al., 2013 [52]	Age, off-farm income, farm ownership, educational level, farm size, farm location, awareness, risk aversion, innovativeness, social networks, information sources, extension and advisory services, membership in a cooperative and labor availability	France	Natural resources preservation
Bartulović and Kozorog, 2014 [101]	Farm location, environmental consciousness, motives, perceived behavioral control, social norms, collective decisions and participatory approach, extension and advisory services, financial support and perceived benefits	Slovenia	Organic Farming
Busse et al., 2014 [51]	Resistance to change, marketing and communication campaigns, farmer skills, information sources, extension and advisory services, short supply chain, legal framework, financial support, availability of certification, perceived costs, and perceived benefits	Germany	Smart farming technologies, digital tools and AI
Chatzimichael et al., 2014 [94]	Age, educational level, farm size, knowledge, social learning, information sources, access to market and financial support	Greece and Germany	Organic Farming
Karali et al., 2014 [31]	Age, off-farm income, farm ownership, farm successor, farm size, weed pressure, extreme weather conditions, environmental consciousness, risk aversion, attitudes, subjective norms, information sources, extension and advisory services, direct marketing, legal framework, financial support, degree of bureaucracy, perceived costs and perceived benefits	England, Scotland, Northern Ireland, and Ireland	Organic Farming
Kemp et al., 2014 [38]	Age, educational level, farm successor, farm size, farm location, knowledge, innovativeness, subjective norms, social norms, information sources and perceived benefits	The Netherlands	Other CSA practices
Tzouramani et al., 2014 [69]	Extreme weather conditions, environmental consciousness, social network, market demand, financial support and perceived benefits	Greece	Organic Farming

Author and Year	Factors Studied	Geographical Location	Climate-Smart Agricultural Practice Category
Dinis et al., 2015 [62]	Gender, farm ownership, farming experience, size of arable land, farm location, awareness, perceived benefits and labor availability	Italy and Portugal	Organic Farming
Gailhard et al., 2015 [102]	Age, on-farm income, educational level, farm size, soil quality, innovativeness, social networks and membership in a cooperative	Germany	Natural resources preservation
Läpple and Kelley, 2015 [85]	Age, off-farm income, household size, educational level, farm size, environmental consciousness, risk aversion, motives, social networks, information sources, extension and advisory services and access to market	Ireland	Organic Farming
Marques et al., 2015 [103]	Age, farm size, knowledge, financial support and perceived trustworthiness	Spain	Natural resources preservation
Papadopoulos et al., 2015 [82]	Extension and advisory services, legal framework, financial support and availability of certification	Greece	Organic Farming
Casagrande et al., 2016 [104]	Awareness, farmer skills, risk aversion, perceived behavioral control, extension and advisory services, perceived costs, perceived benefits and farm outputs	Estonia, Germany, the UK, Ireland, Belgium, France, Switzerland, Austria, Italy and Spain	Natural resources preservation
Long et al., 2016 [5]	Awareness, market demand, extension and advisory services, legal framework, lack of verified impact and perceived costs	The Netherlands, France, Switzerland and Italy	Other CSA practices
Case et al., 2017 [105]	Perceived behavioral control, lack of infrastructure, perceived costs and perceived benefits	Denmark	Natural resources preservation
De Olde et al., 2017 [92]	Collective decisions and participatory approach, legal framework and financial support	The Netherlands	Organic Farming
Kušová et al., 2017 [106]	Age, farm ownership, educational level, size of arable land, farmer skills, motives and perceived benefits	Czechia	Smart farming technologies, digital tools and AI
Latawiec et al., 2017 [79]	Farming experience, farm size, soil quality, environmental consciousness, knowledge, motives, perceived costs and perceived benefits	Poland	Natural resources preservation
Lemken et al., 2017 [68]	Age, off-farm income, farm ownership, educational level, farm size, farm location, awareness, attitudes, perceived ease of use and labor availability	Germany	Natural resources preservation

Author and Year	Factors Studied	Geographical Location	Climate-Smart Agricultural Practice Category
Naspetti et al., 2017 [107]	Attitudes, subjective norms and perceived ease of use	Austria, Belgium, Denmark, Finland, Italy and the UK	Biodiversity preservation
Paustian and Theuvsen, 2017 [66]	Age, gender, farm ownership, full-time farmers, farming experience, educational level, farm size, size of arable land, farm location, soil quality, farmer skills, knowledge, extension and advisory services, lack of verified impact and labor availability	Germany	Smart farming technologies, digital tools and AI
Pinna, 2017 [44]	Environmental consciousness, responsibility for future generations, motives, lack of research, education, and knowledge, collective decisions and participatory approach, membership in a cooperative, access to market, direct marketing, short supply chains, degree of bureaucracy, availability of certification, perceived costs and perceived benefits	Italy and Spain	Organic Farming
Zrakić et al., 2017 [108]	Membership in a cooperative, access to market, direct marketing and perceived benefits	Croatia	Organic Farming
Knuth et al., 2018 [84]	Educational level, farm size, extension and advisory services, membership in a cooperative and legal Framework	Germany	Smart farming technologies, digital tools and AI
Mattila et al., 2018 [109]	Age, off-farm income, farm size, size of arable land, extension and advisory services, farm outputs and labor availability	Finland	Organic Farming
Papadopoulos et al., 2018 [46]	Gender, educational level, environmental consciousness, attitudes, market demand, financial support and perceived benefits	Greece	Organic Farming
Partalidou et al., 2018 [75]	Knowledge, resistance to change, motives, extension and advisory services, perceived costs and perceived benefits	Greece	Smart farming technologies, digital tools and AI
Pilarova et al., 2018 [29]	Age, gender, farm ownership, household size, educational level, farm location, weed pressure, soil quality, drought, lack of infrastructure, extension and advisory services, access to credit, perceived costs and labor availability	Moldova	Natural resources preservation
Schoonhoven and Runhaar, 2018 [54]	Awareness, responsibility for future generations, innovativeness, subjective norms, social norms, market demand, access to credit, legal framework, financial support and perceived benefits	Spain	Other CSA practices
Siepmann and Nicholas, 2018 [47]	Attitudes, social norms and perceived benefits	Germany	Organic Farming
Tamirat et al., 2018 [35]	Age, educational level, farm size, size of arable land, awareness, information sources, extension and advisory services, perceived benefits and labor availability	Germany, Denmark	Smart farming technologies, digital tools and AI

Author and Year	Factors Studied	Geographical Location	Climate-Smart Agricultural Practice Category
Velde et al., 2018 [110]	Awareness, motives and subjective norms	Belgium	Organic Farming
Barnes et al., 2019 [58]	Age, farm ownership, educational level, farm size, membership in a cooperative, perceived usefulness, perceived benefits, labor availability and shared machinery	Belgium, Germany, Greece, the Netherlands and the UK	Smart farming technologies, digital tools and AI
Barnes et al., 2019 [111]	Age, on-farm income, educational level, farm size, farm location, social networks, extension and advisory services, legal framework, financial support, lack of verified impact, perceived compatibility, perceived costs, perceived benefits, labor availability and shared machinery	The UK, Germany, the Netherlands, Belgium and Greece	Smart farming technologies, digital tools and AI
Caffaro et al., 2019 [41]	Attitudes, perceived behavioral control and subjective norms	Italy	Smart farming technologies, digital tools and AI
Caffaro and Cavallo, 2019 [112]	Educational level, farm size and labor availability	Italy	Smart farming technologies, digital tools and AI
Das et al., 2019 [34]	Age, on-farm income, farm size, awareness, knowledge, resistance to change, motives, perceived behavioral control, lack of infrastructure, collective decisions and participatory approach, financial support, perceived usefulness, perceived compatibility, perceived ease of use, perceived costs and perceived benefits	Ireland	Smart farming technologies, digital tools and AI
Home et al., 2019 [77]	Subjective norms, marketing and communication campaigns, lack of infrastructure, market demand, information sources, extension and advisory services, access to market, legal framework, perceived costs and perceived benefits	Switzerland	Organic Farming
Knierim et al., 2019 [88]	Lack of research, education, and knowledge, lack of infrastructure, extension and advisory services, perceived compatibility and perceived costs	Germany	Smart farming technologies, digital tools and AI
Konrad et al., 2019 [65]	Age, full-time farmers, farm size, farm location, soil quality, awareness, innovativeness, social learning and social network	Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Sweden	Smart farming technologies, digital tools and AI
Mingolla et al., 2019 [113]	Attitudes, perceived behavioral control and subjective norm	Belgium	Smart farming technologies, digital tools and AI
Palšová, 2019 [95]	Motives, marketing and communication campaigns, membership in a cooperative, access to market, financial support, degree of bureaucracy and perceived benefits	Slovakia	Organic Farming

Author and Year	Factors Studied	Geographical Location	Climate-Smart Agricultural Practice Category
Penvern et al., 2019 [33]	Full-time farmer, pests, trust and extension and advisory services	Belgium, Denmark, France, Germany, Italy, Latvia, Sweden and Switzerland	Biodiversity preservation
Takeuchi-Storm et al., 2019 [114]	Farm size and perceived benefits	Switzerland, Germany, Denmark, Netherlands, Lithuania and Sweden	Organic Farming
Walder et al., 2019 [60]	Age, off-farm income, full-time farmer, educational level, motives, perceived usefulness, perceived benefits, farm outputs and shared machinery	Austria	Biodiversity preservation
Ayerdi et al., 2020 [115]	Motives, shared machinery, membership in a cooperative, financial support and perceived usefulness	France	Smart farming technologies, digital tools and AI
Balogh et al., 2020 [116]	Knowledge, marketing and communication campaigns, lack of research, education, and knowledge, extension and advisory services, short supply chain, access to credit, legal framework, financial support, perceived compatibility, perceived costs and perceived benefits	Hungary	Smart farming technologies, digital tools and AI
Caffaro et al., 2020 [117]	Perceived usefulness and perceived ease of use	Italy	Smart farming technologies, digital tools and AI
Fantappiè et al., 2020 [118]	Age, educational level, financial support, perceived usefulness and perceived benefits	Italy	Natural resources preservation
Groher et al., 2020 [64]	Age, gender, full-time and farm size	Switzerland	Smart farming technologies, digital tools and AI
Hansmann et al., 2020 [119]	Subjective norms, extension and advisory services, perceived usefulness, perceived costs and perceived benefits	Germany	Organic Farming
Kahramanoglu et al., 2020 [50]	Attitudes, perceived behavioral control and subjective norm	Cyprus	Other CSA practices
Kernecker et al., 2020 [81]	Extension and advisory services, lack of verified impact, perceived usefulness, perceived compatibility, perceived ease of use, perceived trustworthiness and perceived costs	France, Germany, Greece, Serbia, Spain and the Netherlands	Smart farming technologies, digital tools and AI
Kociszewski et al., 2020 [90]	Environmental consciousness, motives, social norms, market demand, marketing and communication campaigns, financial support, degree of bureaucracy, perceived costs and perceived benefits	Poland	Organic Farming

Author and Year	**Factors Studied**	**Geographical Location**	**Climate-Smart Agricultural Practice Category**
Lioutas and Charatsari, 2020 [73]	Age, on-farm income, gender, educational level, attitudes, perceived usefulness, perceived benefits and perceived compatibility	Greece	Smart farming technologies, digital tools and AI
Michels et al., 2020 [57]	Age, gender, educational level, farm size, farm location, farmer skills and innovativeness	Germany	Smart farming technologies, digital tools and AI
Michels et al., 2020 [40]	Age, gender, educational level, farm size, farm location (north, east, west, and south), awareness, innovativeness and perceived costs	Germany	Smart farming technologies, digital tools and AI
Michels et al., 2020 [24]	Age, gender, educational level, farm size, farmer skills, perceived behavioral control and perceived usefulness	Germany	Smart farming technologies, digital tools and AI
Pagliacci et al., 2020 [6]	Size of arable land, farm location, soil quality, precipitation, social learning, lack of infrastructure, legal framework and financial support	Italy	Natural resources preservation
Richard et al., 2020 [91]	Collective decisions and participatory approach, extension and advisory services and perceived costs	France	Natural resources preservation
Schwendner et al., 2020 [120]	Marketing and communication campaigns and access to credit	Switzerland	Biodiversity preservation
Vecchio et al., 2020 [25]	Age, educational level, farm size, knowledge, perceived ease of use and labor availability	Italy	Smart farming technologies, digital tools and AI
Vecchio et al., 2020 [25]	Age, educational level, farm size, knowledge, perceived ease of use and labor availability	Italy	Smart farming technologies, digital tools and AI
Xu et al., 2020 [61]	Farm size, social learning, information sources and farm outputs	France	Organic Farming
Aare et al., 2021 [72]	Age, attitudes, perceived behavioral control, subjective norms, social norms, lack of infrastructure, market demand, extension and advisory services, legal framework, financial support, lack of verified impact, perceived usefulness, perceived compatibility, perceived ease of use, perceived costs and perceived benefits	Denmark	Biodiversity preservation
Bakker et al., 2021 [121]	Attitudes, perceived behavioral control, subjective norms and social learning	Germany and the Netherlands	Natural resources preservation
Balogh et al., 2021 [37]	Educational level, farm size, farmer skills, motives, innovativeness, subjective norms, extension and advisory services and perceived benefits	Hungary	Smart farming technologies, digital tools and AI
Blasch et al., 2021 [122]	Age, farm successor, farm size, social learning, social networks, extension and advisory services, perceived costs and perceived benefits	Austria	Smart farming technologies, digital tools and AI

Author and Year	Factors Studied	Geographical Location	Climate-Smart Agricultural Practice Category
Canavari et al., 2021 [123]	Subjective norms, perceived usefulness and perceived ease of use	Italy	Smart farming technologies, digital tools and AI
Cooreman et al., 2021 [76]	Collective decisions and participatory approach, information sources, extension and advisory services and perceived costs	8 European countries	Other CSA practices
Creissen et al., 2021 [124]	Farm size, farm location and information sources	The UK and Ireland	Natural resources preservation
Cusworth et al., 2021 [125]	Lack of research, education, and knowledge, social norms, collective decisions and participatory approach, market demand, legal framework, financial support	The UK	Biodiversity preservation
González-Rosado et al., 2021 [126]	Extension and advisory services, direct marketing and short supply chain	Spain	Other CSA practices
Gütschow et al., 2021 [86]	Awareness, perceived behavioral control, marketing and communication campaigns, social norms, lack of infrastructure, legal framework, degree of bureaucracy, lack of verified impact and perceived compatibility	Germany	Other CSA practices
Hannus and Sauer, 2021 [70]	Knowledge, perceived usefulness and perceived ease of use	Germany	Other CSA practices
Höglind et al., 2021 [127]	Age, on-farm income, farming experience and farm location	Sweden	Other CSA practices
Kenny and Regan, 2021 [78]	Perceived behavioral control, lack of infrastructure, perceived trustworthiness and perceived benefits	Ireland	Smart farming technologies, digital tools and AI
Khamzina et al., 2021 [128]	Attitudes, perceived behavioral control and subjective norm	France	Organic Farming
Mazurek-Kusiak et al., 2021 [43]	Farm location, environmental consciousness, motives, innovativeness, perceived behavioral control, extension and advisory services, financial support, perceived costs and perceived economic benefits	Poland and Hungary	Organic Farming
Michels et al., 2021 [74]	Perceived behavioral control, perceived usefulness, perceived compatibility and perceived ease of use	Germany	Smart farming technologies, digital tools and AI
Mohr and Kuhl, 2021 [80]	Innovativeness, attitudes, perceived behavioral control, social norms, perceived usefulness, perceived ease of use and perceived trustworthiness	Germany	Smart farming technologies, digital tools and AI
Renault et al., 2021 [56]	Crop diseases, environmental consciousness, knowledge, perceived behavioral control and perceived benefits	Belgium, France, Germany, the Netherlands and Spain	Biodiversity preservation
Rust et al., 2021 [129]	Subjective norms and information sources	The UK	Other CSA practices

Author and Year	Factors Studied	Geographical Location	Climate-Smart Agricultural Practice Category
Schukat and Heise, 2021 [71]	Farmer skills, motives, subjective norms, lack of infrastructure, perceived usefulness, perceived trustworthiness and perceived benefits	Germany	Smart farming technologies, digital tools and AI
Zhllima et al., 2021 [130]	Age, farm ownership, household size, educational level, awareness, motives, attitudes, perceived behavioral control, subjective norms and legal framework	Albania	Organic Farming
Ambrosius et al., 2022 [131]	Motives, social learning and market demand	The Netherlands	Organic Farming
Bagagiolo et al., 2022 [27]	Age, gender, educational level, knowledge, motives and social learning	Italy	Natural resources preservation
Bai et al., 2022 [26]	Age, gender, full-time farmer, educational level, size of arable land, farmer skills, perceived behavioral control and perceived compatibility	Hungary	Smart farming technologies, digital tools and AI
Barnes et al., 2022 [63]	Age, off-farm income, size of arable land, farm ownership, farming experience, educational level, farm successor, farm location, knowledge, risk aversion and labor availability	Scotland	Renewable energy sources
Bernier et al., 2022 [132]	Age, legal framework, perceived costs and perceived benefits	Switzerland	Biodiversity preservation
Blasch et al., 2022 [55]	Age, on-farm income, educational level, farm size, size of arable land, awareness, subjective norms, social learning, perceived costs and perceived benefits	Italy	Smart farming technologies, digital tools and AI
Bodescu et al., 2022 [133]	Perceived behavioral control, extension and advisory services, financial support, lack of verified impact, perceived usefulness, perceived ease of use and perceived costs	Sweden	Smart farming technologies, digital tools and AI
Caffaro et al., 2022 [134]	Motives	Italy	Other CSA practices
Giua et al., 2022 [135]	Social networks, age, educational level, size of arable land, lack of infrastructure, short supply chain, perceived usefulness, perceived ease of use and farm outputs	Italy	Smart farming technologies, digital tools and AI
Happel et al., 2022 [48]	Environmental consciousness, farmer skills, trust, subjective norms, social learning, collective decisions and participatory approach, information sources, extension and advisory services, legal framework, lack of verified impact, perceived trustworthiness, perceived costs and perceived benefits	The Netherlands	Natural resources preservation
Huettel et al., 2022 [136]	Attitudes, perceived behavioral control and subjective norm	Germany	Smart farming technologies, digital tools and AI
Király et al., 2022 [36]	Extreme weather conditions, precipitation, awareness, motives, information sources, extension and advisory services	Hungary	Organic Farming

Author and Year	**Factors Studied**	**Geographical Location**	**Climate-Smart Agricultural Practice Category**
Lähdesmäki, and Vesala, 2022 [137]	Weed pressure, knowledge, resistance to change, motives, attitudes, social norms, financial support, lack of verified impact and perceived costs	Finland	Organic Farming
Leonhardt and Uehleke, 2022 [42]	Age, educational level and motives	Austria	Natural resources preservation
Linares et al., 2022 [89]	Collective decisions and participatory approach, extension and advisory services, access to market, short supply chains, legal framework, financial support and degree of bureaucracy	Austria, Switzerland, Czechia, Germany, Spain, Finland, France, Greece, Italy, Hungary, Lithuania, Latvia, Romania, Sweden and the UK	Other CSA practices
López-Serrano et al., 2022 [87]	Marketing and communication campaigns, legal framework, financial support and perceived benefits	Spain	Natural resources preservation
Maurizio et al., 2022 [96]	Age, educational level, attitudes, degree of bureaucracy, perceived compatibility, perceived ease of use and perceived benefits	Italy	Organic Farming
Möhring and Finger, 2022 [67]	Age, on-farm income, educational level, farm successor, size of arable land, farm location, temperature, risk aversion, social learning, perceived costs, perceived benefits, farm outputs and labor availability	Switzerland	Natural resources preservation
Petrescu-Mag et al., 2022 [138]	On-farm income, extreme weather conditions, precipitation, crop diseases, awareness, lack of infrastructure and perceived benefits,	Romania	Natural resources preservation
Polge and Pagès, 2022 [139]	Subjective norms, social learning, extension and advisory services, membership in a cooperative and short supply chain	France	Other CSA practices
Pombo-Romero et al., 2022 [59]	Farm successor, farm size, farmer skills, risk aversion, social networks, farm outputs, perceived costs and legal framework	Spain	Renewable energy sources
Ryschawy et al., 2022 [49]	Knowledge, trust, social networks, collective decisions and participatory approaches, extension and advisory services and legal framework	France	Natural resources preservation
Tensi et al., 2022 [45]	Age, on-farm income, gender, household size, educational level, farm location, motives, perceived behavioral control, extension and advisory services and membership in a cooperative	The Netherlands and Germany	Biodiversity preservation

Author and Year	Factors Studied	Geographical Location	Climate-Smart Agricultural Practice Category
Todorova, 2022 [93]	Attitudes, legal framework and perceived benefits	Bulgaria	Organic Farming
Vecchio et al., 2022 [140]	Perceived ease of use	Italy	Smart farming technologies, digital tools and AI
Verburg et al., 2022 [2]	Marketing and communication campaigns, lack of research, education, and knowledge, direct marketing, market demand, legal framework, financial support, availability of certification and perceived costs	The Netherlands, Denmark and Austria	Organic Farming
Young et al., 2022 [53]	Resistance to change, motives, perceived behavioral control, subjective norms, social learning, lack of research, education, and knowledge, social norms, collective decisions and participatory approach, market demand, extension and advisory services, short supply chains, direct marketing and financial support	France	Natural resources preservation
Zafeiriou et al., 2022 [141]	Financial support, perceived costs, perceived benefits and farm outputs	Greece	Natural resources preservation
Anastasiou et al., 2023 [11]	Extension and advisory services, perceived usefulness, perceived costs, membership in a cooperative, knowledge, legal framework and financial support	Spain, Greece, Germany and Italy	Smart farming technologies, digital tools and AI
Chylinski et al., 2023 [142]	Extension and advisory services and information sources	Switzerland, France, the Netherlands, Lithuania and the UK	Organic Farming
Czibere et al., 2023 [143]	Educational level, farming experience, farm size, perceived benefits, innovativeness, extension and advisory services, perceived behavioral control and membership in a cooperative	Hungary	Smart farming technologies, digital tools and AI
De Witte et al., 2023 [144]	Collective decisions and participatory approach and extension and advisory services	Spain	Other CSA practices
Ha et al., 2023 [145]	Age, gender, educational level, farm ownership, on-farm income, availability of certification, subjective norms, attitudes, perceived behavioral control and knowledge	Sweden	Other CSA practices
Krzyszczak et al., 2023 [146]	Knowledge, degree of bureaucracy and attitudes	Poland	Other CSA practices
Masi et al., 2023 [147]	Perceived ease of use, perceived costs, financial support, age, farm size, gender, extension and advisory services	Italy	Smart farming technologies, digital tools and AI
Meral and Millan, 2023 [148]	Farming experience, labor availability, perceived compatibility, farm size, attitudes, age, educational level, household size and farm location	Turkey	Organic Farming

Author and Year	**Factors Studied**	**Geographical Location**	**Climate-Smart Agricultural Practice Category**
Monteiro Moretti et al., 2023 [149]	Perceived benefits	Germany and Switzerland	Smart farming technologies, digital tools and AI
Ortega et al., 2023 [150]	Legal framework, knowledge and lack of infrastructure	Spain and Portugal	Biodiversity preservation
Pelissier et al., 2023 [151]	Perceived benefits, extension and advisory services, membership in a cooperative, financial support and perceived behavioral control	Slovakia and Hungary	Smart farming technologies, digital tools and AI
Schneider et al., 2023 [152]	Degree of bureaucracy, legal framework, financial support, extension and advisory services, collective decision and participatory approach and perceived compatibility	Germany	Renewable energy sources
Troiano et al., 2023 [153]	Perceived costs, financial support, extension and advisory services and motives	Italy	Smart farming technologies, digital tools and AI
Wang et al., 2023 [154]	Subjective norms and social networks	Switzerland	Other CSA practices
Zieliński et al., 2023 [155]	Educational level and on-farm income	Poland	Natural resources preservation
Feisthauer et al., 2024 [156]	Attitudes, innovativeness, perceived trustworthiness, financial support and legal framework	Germany	Smart farming technologies, digital tools and AI
Feisthauer et al., 2024 [157]	Attitudes, subjective norms and perceived behavioral control	Germany	Smart farming technologies, digital tools and AI
Follett et al., 2024 [158]	Farm ownership, perceived costs, extreme weather conditions and perceived behavioral control	Wales	Other CSA practices
Mooney et al., 2024 [159]	Legal framework, extension and advisory services and information sources	Britain, Ireland and France	Biodiversity preservation

References

1. Pathak, H.S.; Brown, P.; Best, T. A systematic literature review of the factors affecting the precision agriculture adoption process. *Precis. Agric.* **2019**, *20*, 1292–1316. [CrossRef]
2. Verburg, R.W.; Verberne, E.; Negro, S.O. Accelerating the Transition towards Sustainable Agriculture: The Case of Organic Dairy Farming in the Netherlands. *Agric. Syst.* **2022**, *198*, 103368. [CrossRef]
3. Eurostat. Performance of the Agricultural Sector. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Performance_of_the_agricultural_sector (accessed on 7 February 2023).
4. World Bank. Employment in Agriculture (% of Total Employment) (Modeled ILO Estimate). Available online: https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=EU (accessed on 7 February 2023).
5. Long, T.B.; Blok, V.; Coninx, I. Barriers to the Adoption and Diffusion of Technological Innovations for Climate-Smart Agriculture in Europe: Evidence from the Netherlands, France, Switzerland and Italy. *J. Clean. Prod.* **2016**, *112*, 9–21. [CrossRef]
6. Pagliacci, F.; Defrancesco, E.; Mozzato, D.; Bortolini, L.; Pezzuolo, A.; Pirotti, F.; Pisani, E.; Gatto, P. Drivers of Farmers' Adoption and Continuation of Climate-Smart Agricultural Practices. A Study from Northeastern Italy. *Sci. Total Environ.* **2020**, *710*, 136345. [CrossRef] [PubMed]
7. Begho, T.; Glenk, K.; Anik, A.R.; Eory, V. A Systematic Review of Factors That Influence Farmers' Adoption of Sustainable Crop Farming Practices: Lessons for Sustainable Nitrogen Management in South Asia. *J. Sustain. Agric. Environ.* **2022**, *1*, 149–160. [CrossRef]
8. Lipper, L.; Thornton, P.; Campbell, B.M.; Baedeker, T.; Braimoh, A.; Bwalya, M.; Caron, P.; Cattaneo, A.; Garrity, D.; Henry, K.; et al. Climate-Smart Agriculture for Food Security. *Nat. Clim Change* **2014**, *4*, 1068–1072. [CrossRef]
9. FAO. FAO Success Stories on Climate-Smart Agriculture. In *Food and Agricultural Organisation of the United Nations*; FAO: Rome, France, 2014.
10. Dessart, F.J.; Barreiro-Hurlé, J.; Van Bavel, R. Behavioural Factors Affecting the Adoption of Sustainable Farming Practices: A Policy-Oriented Review. *Eur. Rev. Agric. Econ.* **2019**, *46*, 417–471. [CrossRef]
11. Anastasiou, E.; Fountas, S.; Koutsiaras, M.; Voulgaraki, M.; Vatsanidou, A.; Barreiro-Hurle, J.; Bartolo, F.D.; Gómez-Barbero, M. Precision Farming Technologies on Crop Protection: A Stakeholders Survey. *Smart Agric. Technol.* **2023**, *5*, 100293. [CrossRef]
12. Hoek, A.C.; Malekpour, S.; Raven, R.; Court, E.; Byrne, E. Towards Environmentally Sustainable Food Systems: Decision-Making Factors in Sustainable Food Production and Consumption. *Sustain. Prod. Consum.* **2021**, *26*, 610–626. [CrossRef]
13. Ajzen, I. The Theory of Planned Behavior. *Organ. Behav. Hum. Decis. Process.* **1991**, *50*, 179–211. [CrossRef]
14. Rogers, E.M. *Difusion of Innovations*, 3rd ed.; Free Press: New York, NY, USA, 1983; ISBN 0-02-926671-8.
15. Davis, F.D.; Bagozzi, R.P.; Warshaw, P.R. User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *Manag. Sci.* **1989**, *35*, 982–1003. [CrossRef]
16. Niu, Z.; Chen, C.; Gao, Y.; Wang, Y.; Chen, Y.; Zhao, K. Peer Effects, Attention Allocation and Farmers' Adoption of Cleaner Production Technology: Taking Green Control Techniques as an Example. *J. Clean. Prod.* **2022**, *339*, 130700. [CrossRef]
17. Zhang, L.; Li, X.; Yu, J.; Yao, X. Toward Cleaner Production: What Drives Farmers to Adopt Eco-Friendly Agricultural Production? *J. Clean. Prod.* **2018**, *184*, 550–558. [CrossRef]
18. Dekeyser, K.; Rampa, F.; D'Alessandro, C.; Bizzotto Molina, P. The Food Systems Approach in Practice: Our Guide for Sustainable Transformation. *Eur. Cent. Dev. Policy Manag.* **2020**.
19. Olum, S.; Gellynck, X.; Juvinal, J.; Ongeng, D.; De Steur, H. Farmers' Adoption of Agricultural Innovations: A Systematic Review on Willingness to Pay Studies. *Outlook Agric.* **2020**, *49*, 187–203. [CrossRef]
20. Sapbamrer, R.; Thammachai, A. A Systematic Review of Factors Influencing Farmers' Adoption of Organic Farming. *Sustainability* **2021**, *13*, 3842. [CrossRef]
21. Knowler, D.; Bradshaw, B. Farmers' Adoption of Conservation Agriculture: A Review and Synthesis of Recent Research. *Food Policy* **2007**, *32*, 25–48. [CrossRef]
22. Eurostat Farm Structure Survey. 2016. Available online: https://ec.europa.eu/eurostat/documents/2995521/9028470/5-28062018-AP-EN.pdf/8d97f49b-81c0-4f87-bdde-03fe8c3b8ec2 (accessed on 13 March 2024).
23. Page, M.J.; Moher, D.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E. PRISMA 2020 Explanation and Elaboration: Updated Guidance and Exemplars for Reporting Systematic Reviews. *BMJ* **2021**, *372*, 160. [CrossRef] [PubMed]
24. Michels, M.; von Hobe, C.-F.; Musshoff, O. A Trans-Theoretical Model for the Adoption of Drones by Large-Scale German Farmers. *J. Rural Stud.* **2020**, *75*, 80–88. [CrossRef]
25. Vecchio, Y.; De Rosa, M.; Adinolfi, F.; Bartoli, L.; Masi, M. Adoption of Precision Farming Tools: A Context-Related Analysis. *Land Use Policy* **2020**, *94*, 104481. [CrossRef]
26. Bai, A.; Kovách, I.; Czibere, I.; Megyesi, B.; Balogh, P. Examining the Adoption of Drones and Categorisation of Precision Elements among Hungarian Precision Farmers Using a Trans-Theoretical Model. *Drones* **2022**, *6*, 200. [CrossRef]
27. Bagagiolo, G.; Vigoroso, L.; Pampuro, N.; Cavallo, E. The Role of Social Interaction and Personal Characteristics in Affecting the Adoption of Compost from Organic Fraction of Municipal Solid Waste in Italy. *Agronomy* **2022**, *12*, 445. [CrossRef]
28. Ndiritu, S.W.; Kassie, M.; Shiferaw, B. Are There Systematic Gender Differences in the Adoption of Sustainable Agricultural Intensification Practices? Evidence from Kenya. *Food Policy* **2014**, *49*, 117–127. [CrossRef]

29. Pilarova, T.; Bavorova, M.; Kandakov, A. Do Farmer, Household and Farm Characteristics Influence the Adoption of Sustainable Practices? The Evidence from the Republic of Moldova. *Int. J. Agric. Sustain.* **2018**, *16*, 367–384. [CrossRef]
30. Tey, Y.S.; Brindal, M. Factors Influencing the Adoption of Precision Agricultural Technologies: A Review for Policy Implications. *Precis. Agric.* **2012**, *13*, 713–730. [CrossRef]
31. Karali, E.; Brunner, B.; Doherty, R.; Hersperger, A.; Rounsevell, M. Identifying the Factors That Influence Farmer Participation in Environmental Management Practices in Switzerland. *Hum. Ecol.* **2014**, *42*, 951–963. [CrossRef]
32. Viatte, G. Adopting Technologies for Sustainable Farming Systems: An OECD Perspective. In Proceedings of the Adoption of Technologies for Sustainable Farming Systems Wageningen Workshop Proceedings; OECD: Paris, France, 2001; Volume 14, pp. 14–23.
33. Penvern, S.; Fernique, S.; Cardona, A.; Herz, A.; Ahrenfeldt, E.; Dufils, A.; Jamar, L.; Korsgaard, M.; Kruczyńska, D.; Matray, S. Farmers' Management of Functional Biodiversity Goes beyond Pest Management in Organic European Apple Orchards. *Agric. Ecosyst. Environ.* **2019**, *284*, 106555. [CrossRef]
34. Das V, J.; Sharma, S.; Kaushik, A. Views of Irish Farmers on Smart Farming Technologies: An Observational Study. *AgriEngineering* **2019**, *1*, 164–187. [CrossRef]
35. Tamirat, T.W.; Pedersen, S.M.; Lind, K.M. Farm and Operator Characteristics Affecting Adoption of Precision Agriculture in Denmark and Germany. *Acta Agric. Scand. Sect. B Soil Plant Sci.* **2018**, *68*, 349–357. [CrossRef]
36. Király, G.; Giuseppina, R.; Tóth, J. Transition to Organic Farming: A Case from Hungary. *Agronomy* **2022**, *12*, 2435. [CrossRef]
37. Balogh, P.; Bai, A.; Czibere, I.; Kovách, I.; Fodor, L.; Bujdos, Á.; Sulyok, D.; Gabnai, Z.; Birkner, Z. Economic and Social Barriers of Precision Farming in Hungary. *Agronomy* **2021**, *11*, 1112. [CrossRef]
38. Kemp, R.G.M.; Nijhoff-Savvaki, R.; Ruitenburg, R.; Trienekens, J.H.; Omta, S.W.F. Sustainability-Related Innovation Adoption: The Case of the Dutch Pig Farmer. *J. Chain. Netw. Sci.* **2014**, *14*, 69–78. [CrossRef]
39. Theocharopoulos, A.; Melfou, K.; Papanagiotou, E. Analysis of Decision Making Process for the Adoption of Sustainable Farming Systems: The Case of Peach Farmers in Greece. *Am. Eurasian J. Sustain. Agric.* **2012**, *6*, 24–32.
40. Michels, M.; Fecke, W.; Feil, J.-H.; Musshoff, O.; Lülfs-Baden, F.; Krone, S. "Anytime, Anyplace, Anywhere"—A Sample Selection Model of Mobile Internet Adoption in German Agriculture. *Agribusiness* **2020**, *36*, 192–207. [CrossRef]
41. Caffaro, F.; Roccato, M.; Micheletti Cremasco, M.; Cavallo, E. An Ergonomic Approach to Sustainable Development: The Role of Information Environment and Social-psychological Variables in the Adoption of Agri-environmental Innovations. *Sustain. Dev.* **2019**, *27*, 1049–1062. [CrossRef]
42. Leonhardt, H.; Braito, M.; Uehleke, R. Combining the Best of Two Methodological Worlds? Integrating Q Methodology-Based Farmer Archetypes in a Quantitative Model of Agri-Environmental Scheme Uptake. *Agric. Hum. Values* **2022**, *39*, 217–232. [CrossRef] [PubMed]
43. Mazurek-Kusiak, A.; Sawicki, B.; Kobyłka, A. Contemporary Challenges to the Organic Farming: A Polish and Hungarian Case Study. *Sustainability* **2021**, *13*, 8005. [CrossRef]
44. Pinna, S. Alternative Farming and Collective Goals: Towards a Powerful Relationships for Future Food Policies. *Land Use Policy* **2017**, *61*, 339–352. [CrossRef]
45. Tensi, A.F.; Ang, F.; van der Fels-Klerx, H.J. Behavioural Drivers and Barriers for Adopting Microbial Applications in Arable Farms: Evidence from the Netherlands and Germany. *Technol. Forecast. Soc. Change* **2022**, *182*, 121825. [CrossRef]
46. Papadopoulos, S.; Zafeiriou, E.; Karelakis, C.; Koutroumanidis, T. Organics or Not? Prospects for Uptaking Organic Farming. *New Medit* **2018**, *17*, 13–22. [CrossRef]
47. Siepmann, L.; Nicholas, K.A. German Winegrowers' Motives and Barriers to Convert to Organic Farming. *Sustainability* **2018**, *10*, 4215. [CrossRef]
48. Happel, M.; Orsi, F.; Hartmann, T.; Bakker, M. Fertile Ground, Complex Matter: Plurality of Farmers' Attitudes towards Green Waste Application as Sustainable Soil Management. *Sociol. Rural.* **2022**, *62*, 509–541. [CrossRef]
49. Ryschawy, J.; Grillot, M.; Charmeau, A.; Pelletier, A.; Moraine, M.; Martin, G. A Participatory Approach Based on the Serious Game Dynamix to Co-Design Scenarios of Crop-Livestock Integration among Farms. *Agric. Syst.* **2022**, *201*, 103414. [CrossRef]
50. Kahramanoglu, I.; Usanmaz, S.; Alas, T. Reasons behind the Farmers' Behaviour about the Implementation of Sustainable Farming Practices. *J. Sociol. Soc. Anthropol.* **2020**, *11*, 67–77. [CrossRef]
51. Busse, M.; Doernberg, A.; Siebert, R.; Kuntosch, A.; Schwerdtner, W.; König, B.; Bokelmann, W. Innovation Mechanisms in German Precision Farming. *Precis. Agric.* **2014**, *15*, 403–426. [CrossRef]
52. Nave, S.; Jacquet, F.; Jeuffroy, M.-H. Why Wheat Farmers Could Reduce Chemical Inputs: Evidence from Social, Economic, and Agronomic Analysis. *Agron. Sustain. Dev.* **2013**, *33*, 795–807. [CrossRef]
53. Young, J.C.; Calla, S.; Lecuyer, L.; Skrimizea, E. Understanding the Social Enablers and Disablers of Pesticide Reduction and Agricultural Transformation. *J. Rural Stud.* **2022**, *95*, 67–76. [CrossRef]
54. Schoonhoven, Y.; Runhaar, H. Conditions for the Adoption of Agro-Ecological Farming Practices: A Holistic Framework Illustrated with the Case of Almond Farming in Andalusia. *Int. J. Agric. Sustain.* **2018**, *16*, 442–454. [CrossRef]
55. Blasch, J.; van der Kroon, B.; van Beukering, P.; Munster, R.; Fabiani, S.; Nino, P.; Vanino, S. Farmer Preferences for Adopting Precision Farming Technologies: A Case Study from Italy. *Eur. Rev. Agric. Econ.* **2022**, *49*, 33–81. [CrossRef]
56. Renault, V.; Damiaans, B.; Humblet, M.-F.; Jiménez Ruiz, S.; García Bocanegra, I.; Brennan, M.L.; Casal, J.; Petit, E.; Pieper, L.; Simoneit, C.; et al. Cattle Farmers' Perception of Biosecurity Measures and the Main Predictors of Behaviour Change: The First European-Wide Pilot Study. *Transbound. Emerg. Dis.* **2021**, *68*, 3305–3319. [CrossRef]

57. Michels, M.; Fecke, W.; Feil, J.-H.; Musshoff, O.; Pigisch, J.; Krone, S. Smartphone Adoption and Use in Agriculture: Empirical Evidence from Germany. *Precis. Agric.* **2020**, *21*, 403–425. [CrossRef]
58. Barnes, A.P.; Soto, I.; Eory, V.; Beck, B.; Balafoutis, A.; Sánchez, B.; Vangeyte, J.; Fountas, S.; van der Wal, T.; Gómez-Barbero, M. Exploring the Adoption of Precision Agricultural Technologies: A Cross Regional Study of EU Farmers. *Land Use Policy* **2019**, *80*, 163–174. [CrossRef]
59. Pombo-Romero, J.; Langeveld, H.; Fernández-Redondo, M. Diffusion of Renewable Energy Technology on Spanish Farms: Drivers and Barriers. *Environ. Dev. Sustain.* **2022**, *25*, 11769–11787. [CrossRef]
60. Walder, P.; Sinabell, F.; Unterlass, F.; Niedermayr, A.; Fulgeanu, D.; Kapfer, M.; Melcher, M.; Kantelhardt, J. Exploring the Relationship between Farmers' Innovativeness and Their Values and Aims. *Sustainability* **2019**, *11*, 5571. [CrossRef]
61. Xu, Q.; Huet, S.; Perret, E.; Deffuant, G. Do Farm Characteristics or Social Dynamics Explain the Conversion of Dairy Farmers to Organic Farming? An Agent-Based Model of Dairy Farming in 27 French Cantons. *JASSS* **2020**, *23*, 4. [CrossRef]
62. Dinis, I.; Ortolani, L.; Bocci, R.; Brites, C. Organic Agriculture Values and Practices in Portugal and Italy. *Agric. Syst.* **2015**, *136*, 39–45. [CrossRef]
63. Barnes, A.P.; McMillan, J.; Sutherland, L.-A.; Hopkins, J.; Thomson, S.G. Farmer Intentional Pathways for Net Zero Carbon: Exploring the Lock-in Effects of Forestry and Renewables. *Land Use Policy* **2022**, *112*, 105861. [CrossRef]
64. Groher, T.; Heitkämper, K.; Walter, A.; Liebisch, F.; Umstätter, C. Status Quo of Adoption of Precision Agriculture Enabling Technologies in Swiss Plant Production. *Precis. Agric.* **2020**, *21*, 1327–1350. [CrossRef]
65. Konrad, M.T.; Nielsen, H.Ø.; Pedersen, A.B.; Elofsson, K. Drivers of Farmers' Investments in Nutrient Abatement Technologies in Five Baltic Sea Countries. *Ecol. Econ.* **2019**, *159*, 91–100. [CrossRef]
66. Paustian, M.; Theuvsen, L. Adoption of Precision Agriculture Technologies by German Crop Farmers. *Precis. Agric.* **2017**, *18*, 701–716. [CrossRef]
67. Möhring, N.; Finger, R. Pesticide-Free but Not Organic: Adoption of a Large-Scale Wheat Production Standard in Switzerland. *Food Policy* **2022**, *106*, 102188. [CrossRef]
68. Lemken, D.; Spiller, A.; von Meyer-Höfer, M. The Case of Legume-Cereal Crop Mixtures in Modern Agriculture and the Transtheoretical Model of Gradual Adoption. *Ecol. Econ.* **2017**, *137*, 20–28. [CrossRef]
69. Tzouramani, I.; Alexopoulos, G.; Kostianis, G.; Kazakopoulos, L. Exploring Risk Management Strategies for Organic Farmers: A Greek Case Study. *Renew. Agric. Food Syst.* **2014**, *29*, 167–175. [CrossRef]
70. Hannus, V.; Sauer, J. Understanding Farmers' Intention to Use a Sustainability Standard: The Role of Economic Rewards, Knowledge, and Ease of Use. *Sustainability* **2021**, *13*, 10788. [CrossRef]
71. Schukat, S.; Heise, H. Towards an Understanding of the Behavioral Intentions and Actual Use of Smart Products among German Farmers. *Sustainability* **2021**, *13*, 6666. [CrossRef]
72. Aare, A.K.; Lund, S.; Hauggaard-Nielsen, H. Exploring Transitions towards Sustainable Farming Practices through Participatory Research–The Case of Danish Farmers' Use of Species Mixtures. *Agric. Syst.* **2021**, *189*, 103053. [CrossRef]
73. Lioutas, E.D.; Charatsari, C. Smart Farming and Short Food Supply Chains: Are They Compatible? *Land Use Policy* **2020**, *94*, 104541. [CrossRef]
74. Michels, M.; von Hobe, C.-F.; Weller von Ahlefeld, P.J.; Musshoff, O. The Adoption of Drones in German Agriculture: A Structural Equation Model. *Precis. Agric.* **2021**, *22*, 1728–1748. [CrossRef]
75. Partalidou, M.; Paltaki, A.; Lazaridou, D.; Vieri, M.; Lombardo, S.; Michailidis, A. Business Model Canvas Analysis on Greek Farms Implementing Precision Agriculture. *Agric. Econ. Rev.* **2018**, *19*, 28–45. [CrossRef]
76. Cooreman, H.; Debruyne, L.; Vandenabeele, J.; Marchand, F. Power to the Facilitated Agricultural Dialogue: An Analysis of on-Farm Demonstrations as Transformative Learning Spaces. *J. Agric. Educ. Ext.* **2021**, *27*, 699–719. [CrossRef]
77. Home, R.; Indermuehle, A.; Tschanz, A.; Ries, E.; Stolze, M. Factors in the Decision by Swiss Farmers to Convert to Organic Farming. *Renew. Agric. Food Syst.* **2019**, *34*, 571–581. [CrossRef]
78. Kenny, U.; Regan, A. Co-Designing a Smartphone App for and with Farmers: Empathising with End-Users' Values and Needs. *J. Rural Stud.* **2021**, *82*, 148–160. [CrossRef]
79. Latawiec, A.E.; Królczyk, J.B.; Kuboń, M.; Szwedziak, K.; Drosik, A.; Polańczyk, E.; Grotkiewicz, K.; Strassburg, B.B. Willingness to Adopt Biochar in Agriculture: The Producer's Perspective. *Sustainability* **2017**, *9*, 655. [CrossRef]
80. Mohr, S.; Kühl, R. Acceptance of Artificial Intelligence in German Agriculture: An Application of the Technology Acceptance Model and the Theory of Planned Behavior. *Precis. Agric.* **2021**, *22*, 1816–1844. [CrossRef]
81. Kernecker, M.; Knierim, A.; Wurbs, A.; Kraus, T.; Borges, F. Experience versus Expectation: Farmers' Perceptions of Smart Farming Technologies for Cropping Systems across Europe. *Precis. Agric.* **2020**, *21*, 34–50. [CrossRef]
82. Papadopoulos, S.; Karelakis, C.; Zafeiriou, E.; Koutroumanidis, T. Going Sustainable or Conventional? Evaluating the CAP's Impacts on the Implementation of Sustainable Forms of Agriculture in Greece. *Land Use Policy* **2015**, *47*, 90–97. [CrossRef]
83. De Master, K. Designing Dreams or Constructing Contradictions? European Union Multifunctional Policies and the Polish Organic Farm Sector. *Rural Sociol.* **2012**, *77*, 89–109. [CrossRef]
84. Knuth, U.; Amjath-Babu, T.S.; Knierim, A. Adoption of Farm Management Systems for Cross Compliance–an Empirical Case in Germany. *J. Environ. Manag.* **2018**, *220*, 109–117. [CrossRef] [PubMed]
85. Läpple, D.; Kelley, H. Spatial Dependence in the Adoption of Organic Drystock Farming in Ireland. *Eur. Rev. Agric. Econ.* **2015**, *42*, 315–337. [CrossRef]

86. Gütschow, M.; Bartkowski, B.; Felipe-Lucia, M.R. Farmers' Action Space to Adopt Sustainable Practices: A Study of Arable Farming in Saxony. *Reg. Environ. Change* **2021**, *21*, 103. [CrossRef]
87. López-Serrano, M.J.; Velasco-Muñoz, J.F.; Aznar-Sánchez, J.A.; Román-Sánchez, I.M. Farmers' Attitudes towards Irrigating Crops with Reclaimed Water in the Framework of a Circular Economy. *Agronomy* **2022**, *12*, 435. [CrossRef]
88. Knierim, A.; Kernecker, M.; Erdle, K.; Kraus, T.; Borges, F.; Wurbs, A. Smart Farming Technology Innovations–Insights and Reflections from the German Smart-AKIS Hub. *NJAS-Wagening. J. Life Sci.* **2019**, *90*, 100314. [CrossRef]
89. Linares Quero, A.; Iragui Yoldi, U.; Gava, O.; Schwarz, G.; Povellato, A.; Astrain, C. Assessment of the Common Agricultural Policy 2014–2020 in Supporting Agroecological Transitions: A Comparative Study of 15 Cases across Europe. *Sustainability* **2022**, *14*, 9261. [CrossRef]
90. Kociszewski, K.; Graczyk, A.; Mazurek-Łopacinska, K.; Sobocińska, M. Social Values in Stimulating Organic Production Involvement in Farming—The Case of Poland. *Sustainability* **2020**, *12*, 5945. [CrossRef]
91. Richard, A.; Casagrande, M.; Jeuffroy, M.-H.; David, C. A Farmer-Oriented Method for Co-Designing Groundwater-Friendly Farm Management. *Agron. Sustain. Dev.* **2020**, *40*, 26. [CrossRef]
92. De Olde, E.M.; Carsjens, G.J.; Eilers, C.H. The Role of Collaborations in the Development and Implementation of Sustainable Livestock Concepts in The Netherlands. *Int. J. Agric. Sustain.* **2017**, *15*, 153–168. [CrossRef]
93. Todorova, K. Attitudes of Bulgarian Farmers for Adopting Eco-Innovations. *Sci. Pap. Manag. Econ. Eng. Agric. Rural Dev.* **2022**, *22*, 663–668.
94. Chatzimichael, K.; Genius, M.; Tzouvelekas, V. Informational Cascades and Technology Adoption: Evidence from Greek and German Organic Growers. *Food Policy* **2014**, *49*, 186–195. [CrossRef]
95. Palšová, L. Organic Farming versus Interest of the State for Its Support. *Pol. J. Environ. Stud.* **2019**, *28*, 4:2773–4:2784. [CrossRef]
96. Maurizio, C.; Federico, G.; Righi, S.; Viganò, E. Factors Fostering and Hindering Farmers' Intention to Adopt Organic Agriculture in the Pesaro-Urbino Province (Italy). *AIMS Agric. Food* **2022**, *7*, 108–129. [CrossRef]
97. Saiz-Rubio, V.; Rovira-Más, F. From Smart Farming towards Agriculture 5.0: A Review on Crop Data Management. *Agronomy* **2020**, *10*, 207. [CrossRef]
98. Koutsoukos, M.; Iakovidou, O. Factors Motivating Farmers to Adopt Different Agrifood Systems: A Case Study of Two Rural Communities in Greece. *Rural Soc.* **2013**, *23*, 32–45. [CrossRef]
99. Läpple, D. Comparing Attitudes and Characteristics of Organic, Former Organic and Conventional Farmers: Evidence from Ireland. *Renew. Agric. Food Syst.* **2013**, *28*, 329–337. [CrossRef]
100. Läpple, D.; Kelley, H. Understanding the Uptake of Organic Farming: Accounting for Heterogeneities among Irish Farmers. *Ecol. Econ.* **2013**, *88*, 11–19. [CrossRef]
101. Bartulović, A.; Kozorog, M. Taking up Organic Farming in (Pre-) Alpine Slovenia: Contrasting Motivations of Dairy Farmers from Less-Favoured Agricultural Areas. *Anthropol. Noteb.* **2014**, *20*, 3.
102. Unay Gailhard, İ.; Bavorová, M.; Pirscher, F. Adoption of Agri-Environmental Measures by Organic Farmers: The Role of Interpersonal Communication. *J. Agric. Educ. Ext.* **2015**, *21*, 127–148. [CrossRef]
103. Marques, M.J.; Bienes, R.; Cuadrado, J.; Ruiz-Colmenero, M.; Barbero-Sierra, C.; Velasco, A. Analysing Perceptions Attitudes and Responses of Winegrowers about Sustainable Land Management in Central Spain. *Land Degrad. Dev.* **2015**, *26*, 458–467. [CrossRef]
104. Casagrande, M.; Peigné, J.; Payet, V.; Mäder, P.; Sans, F.X.; Blanco-Moreno, J.M.; Antichi, D.; Bàrberi, P.; Beeckman, A.; Bigongiali, F. Organic Farmers' Motivations and Challenges for Adopting Conservation Agriculture in Europe. *Org. Agric.* **2016**, *6*, 281–295. [CrossRef]
105. Case, S.D.C.; Oelofse, M.; Hou, Y.; Oenema, O.; Jensen, L.S. Farmer Perceptions and Use of Organic Waste Products as Fertilisers–A Survey Study of Potential Benefits and Barriers. *Agric. Syst.* **2017**, *151*, 84–95. [CrossRef]
106. Kušová, D.; Těšitel, J.; Boukalová, Z. Willingness to Adopt Technologies of Precision Agriculture: A Case Study of the Czech Republic. *WIT Trans. Ecol. Environ.* **2017**, *220*, 109–117.
107. Naspetti, S.; Mandolesi, S.; Buysse, J.; Latvala, T.; Nicholas, P.; Padel, S.; Van Loo, E.J.; Zanoli, R. Determinants of the Acceptance of Sustainable Production Strategies among Dairy Farmers: Development and Testing of a Modified Technology Acceptance Model. *Sustainability* **2017**, *9*, 1805. [CrossRef]
108. Zrakić, M.; Jež Rogelj, M.; Grgić, I. Organic Agricultural Production on Family Farms in Croatia. *Agroecol. Sustain. Food Syst.* **2017**, *41*, 635–649. [CrossRef]
109. Mattila, T.E.; Heikkinen, J.M.; Koivisto, A.M.; Rautiainen, R.H. Predictors for Interest to Change from Conventional to Organic Horticultural Production. *Agric. Food Sci.* **2018**, *27*, 217–226. [CrossRef]
110. Velde, F.V.; Charlier, J.; Hudders, L.; Cauberghe, V.; Claerebout, E. Beliefs, Intentions, and beyond: A Qualitative Study on the Adoption of Sustainable Gastrointestinal Nematode Control Practices in Flanders' Dairy Industry. *Prev. Vet. Med.* **2018**, *153*, 15–23. [CrossRef] [PubMed]
111. Barnes, A.P.; Soto, I.; Eory, V.; Beck, B.; Balafoutis, A.T.; Sánchez, B.; Vangeyte, J.; Fountas, S.; van der Wal, T.; Gómez-Barbero, M. Influencing Factors and Incentives on the Intention to Adopt Precision Agricultural Technologies within Arable Farming Systems. *Environ. Sci. Policy* **2018**, *93*, 66–74. [CrossRef]
112. Caffaro, F.; Cavallo, E. The Effects of Individual Variables, Farming System Characteristics and Perceived Barriers on Actual Use of Smart Farming Technologies: Evidence from the Piedmont Region, Northwestern Italy. *Agriculture* **2019**, *9*, 111. [CrossRef]

113. Mingolla, C.; Hudders, L.; Vanwesenbeeck, I.; Claerebout, E. Towards a Biased Mindset: An Extended Theory of Planned Behaviour Framework to Predict Farmers' Intention to Adopt a Sustainable Mange Control Approach. *Prev. Vet. Med.* **2019**, *169*, 104695. [CrossRef] [PubMed]
114. Takeuchi-Storm, N.; Moakes, S.; Thüer, S.; Grovermann, C.; Verwer, C.; Verkaik, J.; Knubben-Schweizer, G.; Höglund, J.; Petkevičius, S.; Thamsborg, S. Parasite Control in Organic Cattle Farming: Management and Farmers' Perspectives from Six European Countries. *Vet. Parasitol. Reg. Stud. Rep.* **2019**, *18*, 100329. [CrossRef] [PubMed]
115. Ayerdi Gotor, A.; Marraccini, E.; Leclercq, C.; Scheurer, O. Precision Farming Uses Typology in Arable Crop-Oriented Farms in Northern France. *Precis. Agric.* **2020**, *21*, 131–146. [CrossRef]
116. Balogh, P.; Bujdos, Á.; Czibere, I.; Fodor, L.; Gabnai, Z.; Kovách, I.; Nagy, J.; Bai, A. Main Motivational Factors of Farmers Adopting Precision Farming in Hungary. *Agronomy* **2020**, *10*, 610. [CrossRef]
117. Caffaro, F.; Cremasco, M.M.; Roccato, M.; Cavallo, E. Drivers of Farmers' Intention to Adopt Technological Innovations in Italy: The Role of Information Sources, Perceived Usefulness, and Perceived Ease of Use. *J. Rural Stud.* **2020**, *76*, 264–271. [CrossRef]
118. Fantappiè, M.; Lorenzetti, R.; De Meo, I.; Costantini, E.A. How to Improve the Adoption of Soil Conservation Practices? Suggestions from Farmers' Perception in Western Sicily. *J. Rural Stud.* **2020**, *73*, 186–202. [CrossRef]
119. Hansmann, R.; Baur, I.; Binder, C.R. Increasing Organic Food Consumption: An Integrating Model of Drivers and Barriers. *J. Clean. Prod.* **2020**, *275*, 123058. [CrossRef]
120. Schwendner, A.-A.; Lam, T.J.; Bodmer, M.; Cousin, M.-E.; Schüpbach-Regula, G.; van den Borne, B.H. Knowledge, Attitude and Practices of Swiss Dairy Farmers towards Intramammary Antimicrobial Use and Antimicrobial Resistance: A Latent Class Analysis. *Prev. Vet. Med.* **2020**, *179*, 105023. [CrossRef] [PubMed]
121. Bakker, L.; Sok, J.; Van Der Werf, W.; Bianchi, F. Kicking the Habit: What Makes and Breaks Farmers' Intentions to Reduce Pesticide Use? *Ecol. Econ.* **2021**, *180*, 106868. [CrossRef]
122. Blasch, J.; Vuolo, F.; Essl, L.; van der Kroon, B. Drivers and Barriers Influencing the Willingness to Adopt Technologies for Variable Rate Application of Fertiliser in Lower Austria. *Agronomy* **2021**, *11*, 1965. [CrossRef]
123. Canavari, M.; Medici, M.; Wongprawmas, R.; Xhakollari, V.; Russo, S. A Path Model of the Intention to Adopt Variable Rate Irrigation in Northeast Italy. *Sustainability* **2021**, *13*, 1879. [CrossRef]
124. Creissen, H.E.; Jones, P.J.; Tranter, R.B.; Girling, R.D.; Jess, S.; Burnett, F.J.; Gaffney, M.; Thorne, F.S.; Kildea, S. Identifying the Drivers and Constraints to Adoption of IPM among Arable Farmers in the UK and Ireland. *Pest Manag. Sci.* **2021**, *77*, 4148–4158. [CrossRef]
125. Cusworth, G.; Garnett, T.; Lorimer, J. Agroecological Break out: Legumes, Crop Diversification and the Regenerative Futures of UK Agriculture. *J. Rural Stud.* **2021**, *88*, 126–137. [CrossRef]
126. González-Rosado, M.; Parras-Alcántara, L.; Aguilera-Huertas, J.; Lozano-García, B. Building an Agroecological Process towards Agricultural Sustainability: A Case Study from Southern Spain. *Agriculture* **2021**, *11*, 1024. [CrossRef]
127. Höglind, L.; Hansson, H.; Manevska-Tasevska, G. Questioning the Dichotomy: A Latent Profile Analysis of Ecological Management Practices in Swedish Agriculture. *J. Environ. Manag.* **2021**, *300*, 113770. [CrossRef] [PubMed]
128. Khamzina, K.; Huet, S.; Deffuant, G.; Streith, M.; Guimond, S. Making the Planet Green Again: The Interplay of Attitudes and Group Norms in the Conversion to Organic Farming. *J. Appl. Soc. Psychol.* **2021**, *51*, 1073–1088. [CrossRef]
129. Rust, N.A.; Jarvis, R.M.; Reed, M.S.; Cooper, J. Framing of Sustainable Agricultural Practices by the Farming Press and Its Effect on Adoption. *Agric. Hum. Values* **2021**, *38*, 753–765. [CrossRef]
130. Zhllima, E.; Shahu, E.; Xhoxhi, O.; Gjika, I. Understanding Farmers' Intentions to Adopt Organic Farming in Albania. *New Medit* **2021**, *20*, 97–111. [CrossRef]
131. Ambrosius, F.H.; Kramer, M.R.; Spiegel, A.; Bokkers, E.A.; Bock, B.B.; Hofstede, G.J. Diffusion of Organic Farming among Dutch Pig Farmers: An Agent-Based Model. *Agric. Syst.* **2022**, *197*, 103336. [CrossRef]
132. Bernier Gosselin, V.; Visschers, V.H.; Bodmer, M.; Meylan, M. Swiss Dairy Farmers' Perceptions Surrounding the Disposal of Waste Milk Containing Antibiotic Residues and Antibiotic Resistance. *Front. Vet. Sci.* **2022**, *8*, 787828. [CrossRef]
133. Bodescu, D.; Coca, O.; Tudoran, A.S.; Măgureanu, A.; Ştefan, G. Implementation of digital decision support systems in agricultural farms-limitations and determining factors. *Sci. Pap. Manag. Econ. Eng. Agric. Rural Dev.* **2022**, *22*, 121–128.
134. Caffaro, F.; De Gregorio, E.; Capello, G.; Vigoroso, L.; Bagagiolo, G.; Cavallo, E.; Biddoccu, M. Drivers of Adoption of Sustainable Practices and Technologies for Soil Protection Among Vine-Growers in North-West Italy. In *Proceedings of the Conference of the Italian Society of Agricultural Engineering*; Springer: Berlin/Heidelberg, Germany, 2022; pp. 411–419.
135. Giua, C.; Materia, V.C.; Camanzi, L. Smart Farming Technologies Adoption: Which Factors Play a Role in the Digital Transition? *Technol. Soc.* **2022**, *68*, 101869. [CrossRef]
136. Huettel, S.; Leuchten, M.-T.; Leyer, M. The Importance of Social Norm on Adopting Sustainable Digital Fertilisation Methods. *Organ. Environ.* **2022**, *35*, 79–102. [CrossRef]
137. Lähdesmäki, M.; Vesala, K.M. How Can Organic Farmers Be Good Farmers? A Study of Categorisation in Organic Farmers' Talk. *Sociol. Rural.* **2022**, *62*, 413–436. [CrossRef]
138. Petrescu-Mag, R.M.; Petrescu, D.C.; Muntean, O.-L.; Petrescu-Mag, I.V.; Radu Tenter, A.; Azadi, H. The Nexus of Traditional Knowledge and Climate Change Adaptation: Romanian Farmers' Behavior towards Landraces. *Local Environ.* **2022**, *27*, 229–250. [CrossRef]

139. Polge, E.; Pagès, H. Relational Drivers of the Agroecological Transition: An Analysis of Farmer Trajectories in the Limagne Plain, France. *Agric. Syst.* **2022**, *200*, 103430. [CrossRef]
140. Vecchio, Y.; De Rosa, M.; Pauselli, G.; Masi, M.; Adinolfi, F. The Leading Role of Perception: The FACOPA Model to Comprehend Innovation Adoption. *Agric. Food Econ.* **2022**, *10*, 5. [CrossRef]
141. Zafeiriou, E.; Chatzissavvidis, C.; Antonopoulou, C.; Arabatzis, G. Sweet Chestnut and Agricultural Development: A Farmers' Perspective for Northern Greece. *Int. J. Agric. Sustain.* **2022**, *20*, 199–215. [CrossRef]
142. Chylinski, C.; Athanasiadou, S.; Thüer, S.; Grovermann, C.; Moakes, S.; Hoste, H.; Petkevicius, S.; Verwer, C.; Verkaik, J.; Werne, S. Reducing Anthelmintic Inputs in Organic Farming: Are Small Ruminant Farmers Integrating Alternative Strategies to Control Gastrointestinal Nematodes? *Vet. Parasitol.* **2023**, *315*, 109864. [CrossRef] [PubMed]
143. Czibere, I.; Kovách, I.; Loncsák, N. Hungarian Farmers and the Adoption of Precision Farming. *Eur. Countrys.* **2023**, *15*, 366–380. [CrossRef]
144. De Witte, R.; Janssen, D.; Sayadi Gmada, S.; García-García, C. Best Practices for Training in Sustainable Greenhouse Horticulture. *Sustainability* **2023**, *15*, 5816. [CrossRef]
145. Ha, T.M.; Manevska-Tasevska, G.; Jäck, O.; Weih, M.; Hansson, H. Farmers' Intention towards Intercropping Adoption: The Role of Socioeconomic and Behavioural Drivers. *Int. J. Agric. Sustain.* **2023**, *21*, 2270222. [CrossRef]
146. Krzyszczak, J.; Baranowski, P.; Lamorski, K.; Sławiński, C.; Siedliska, A.; Bojar, W.; Żarski, W.; Żarski, J.; Kuśmierek-Tomaszewska, R.; Ahmet Ali, K.; et al. Impact Assessment of the Agri-Environment-Climate Measure (M10) of RDP 2014-2020 on Environmental and Climatic Policies Implementation According to the Perception of Polish Farmers. *Int. Agrophysics* **2023**, *37*, 311–323. [CrossRef]
147. Masi, M.; Di Pasquale, J.; Vecchio, Y.; Capitanio, F. Precision Farming: Barriers of Variable Rate Technology Adoption in Italy. *Land* **2023**, *12*, 1084. [CrossRef]
148. Meral, H.; Millan, E. Factors Influencing Conventional Hazelnut Farmers to Transition to Organic Production: The Case of Türkiye. *Erwerbs-Obstbau* **2023**, *65*, 1583–1594. [CrossRef]
149. Moretti, D.M.; Baum, C.M.; Ehlers, M.-H.; Finger, R.; Bröring, S. Exploring Actors' Perceptions of the Precision Agriculture Innovation System–A Group Concept Mapping Approach in Germany and Switzerland. *Technol. Forecast. Soc. Change* **2023**, *189*, 122270. [CrossRef]
150. Ortega, P.; Salcedo, R.; Sánchez, E.; Gil, E. Biopesticides as Alternatives to Reduce the Use of Copper in Spanish and Portuguese Viticulture: Main Trends in Adoption. *Eur. J. Agron.* **2023**, *151*, 126996. [CrossRef]
151. Pelissier, M.; Matečný, I.; Milics, G. State of the art of the use of remote sensing in agriculture in Slovakia and Hungary. *Cartogr. Soc. Slovak Repub.* **2023**, *31*, 33–52.
152. Schneider, A.-K.; Klabunde, F.; Buck, L.; Ohlhoff, M.; Reis, L.; Olvermann, M.; Kauffeld, S.; Engel, B.; Glatzel, G.; Schröder, B. Drawing Transformation Pathways for Making Use of Joint Effects of Food and Energy Production with Biodiversity Agriphotovoltaics and Electrified Agricultural Machinery. *J. Environ. Manag.* **2023**, *335*, 117539. [CrossRef] [PubMed]
153. Troiano, S.; Carzedda, M.; Marangon, F. Better Richer than Environmentally Friendly? Describing Preferences toward and Factors Affecting Precision Agriculture Adoption in Italy. *Agric. Food Econ.* **2023**, *11*, 16. [CrossRef]
154. Wang, Y.; Möhring, N.; Finger, R. When My Neighbors Matter: Spillover Effects in the Adoption of Large-scale Pesticide-free Wheat Production. *Agric. Econ.* **2023**, *54*, 256–273. [CrossRef]
155. Zieliński, M.; Jadczyszyn, J.; Sobierajewska, J. Predispositions and Challenges of Agriculture from Areas Particularly Facing Natural or Other Specific Constraints in Poland in the Context of Providing Environmental Public Goods under EU Policy. *Agric. Econ. Czech Acad. Agric. Sci.* **2023**, *69*, 309–320. [CrossRef]
156. Feisthauer, P.; Hartmann, M.; Börner, J. Adoption Intentions of Smart Weeding Technologies—A Lab-in-the-Field Experiment with German Crop Farmers. *Q Open* **2024**, *4*, qoae002. [CrossRef]
157. Feisthauer, P.; Hartmann, M.; Börner, J. Behavioral Factors Driving Farmers' Intentions to Adopt Spot Spraying for Sustainable Weed Control. *J. Environ. Manag.* **2024**, *353*, 120218. [CrossRef]
158. Follett, E.; Davis, L.; Wilson, C.; Cable, J. Working for the Environment: Farmer Attitudes towards Sustainable Farming Actions in Rural Wales, UK. *Environ. Dev. Sustain.* **2024**, 1–20. [CrossRef]
159. Mooney, S.; Carter, A.; Hynds, P.; Macken-Walsh, Á.; Henchion, M.; Devereux, E.J.; Markiewicz-Kęszycka, M. On-Farm pro-Environmental Diversification: A Qualitative Analysis of Narrative Interviews with Western-European Farmers. *Agroecol. Sustain. Food Syst.* **2024**, *48*, 93–123. [CrossRef]