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Inclusive Innovation Governance for Just Transitions: Insights from the Bean Agri-Food System in the Brunca Region of Costa Rica

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Abstract: This study explores how an inclusive governance of “niche” innovations with family farmers enables or limits the realization of just transitions in family farming at different scales, from the local to the national levels. The research focuses on a case study in the Brunca region of Costa Rica, which has pioneered innovations for bean research with family farmers. The primary source of information for the study was in-depth interviews with relevant stakeholders. Secondary information comes from a desk review of the relevant policies and strategic documents from the relevant authorities. Lastly, a semi-scoping review was conducted to explore gender and intergenerational gaps in plant breeding, as well as potential conflicts between plant breeding and on-farm agro-diversity. The inclusive governance of bean research contributes to the realization of just-transition dimensions of justice, such as recognitional, procedural, and distributional justice, as a result of farmers’ engagement in participatory plant-breeding processes, and due to the coordination between different institutions at the local and national levels. Progress has been made in terms of the recognition and participation of farmers in research and in decision-making locally. The findings show interactions between the local and national scales, in terms of the commercialization of farmers’ seeds. However, the Costa Rican program for bean research struggles to engage family farmers in national decision-making processes and falls short of addressing equality and intergenerational issues. It also faces challenges in reaching a balance between short-term income generation and long-term conservation of agro-biodiversity on the farm. Fostering just transitions in family farming would require a greater inclusion of women and youth by the Costa Rican bean system. This implies allocating resources to increase their capacities and participation in bean research, as well as in decision-making at all levels. This is imperative and could be achieved if the government and relevant stakeholders align their strategic objectives and priorities to shorten gender and intergenerational gaps within the bean production system.

Keywords: inclusive governance; just transitions; niche innovations; recognition; equal participation; family farming



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1. Introduction

The sixth assessment report (AR6) of the Intergovernmental Panel on Climate Change (IPPC) calls for transformations towards sustainable and climate-resilient systems, arguing that such transformations must pay attention to equity and just transitions, ensuring that all relevant stakeholders are broadly and meaningfully involved in decision-making processes at all levels [1]. Agenda 2030 puts an emphasis on the inclusion of all relevant stakeholders in order to achieve the sustainable development goals (SDGs). Family farmers are crucial for the achievement of the SDGs, such as Zero Hunger (SDG2), Life on Earth (SDG15), and Climate Change (SDG13). Family farmers typically manage a diverse range of crops and livestock, which are essential for sustainable agricultural practices [2].

Transitions to sustainability are regarded as essential, complex, and enduring transformation processes, which may enable the shift of established socio-technical systems

towards more sustainable ways of production and consumption [3,4]. For [5], the governance of sustainable transitions must be inclusive and participatory. The issue of justice is crucial to enabling effective and acceptable change. Inclusive governance must include marginalized groups, as well as diverse knowledge and experience [6,7]. For reaching just transitions in the analysis of agri-food systems, it is essential to address aspects of participation, equity, and inclusion [8–10].

The process of moving towards sustainability in family farming usually starts by introducing niche innovations, which can be tested with the attempt to change socio-technical practices at the grassroots level. However, the ultimate goal is to change rules and regulations at the regime level. Social actors play a critical role in scaling-up innovations, not only in terms of the successful adoption of innovations among horizontal groups of peers (scaling up), but also in terms of institutional support by engaging actors at higher levels of governance, such as ministries of agriculture, that facilitate the scaling-up of niche innovations [11,12]. Understanding the transformative capacity [13], as well as how different stakeholders interact between niches and the regime, is crucial for the governance of socio-technical transitions [14].

The Programa de Investigación y Transferencia Tecnológica Agropecuaria en Frijol (PITTA-Frijol) is the name of the Costa Rican program for agricultural research and technology transfer in bean production systems in Costa Rica.

PITTA-Frijol engages family farmers and other relevant stakeholders, including academics, researchers, extension services, and private actors, aiming for inclusive governance for bean research. PITTA-Frijol's inclusive governance promotes participatory bean research, allowing farmers into the breeding process to ensure the ownership of the innovations promoted among family farmers, such as the use of improved seeds. This is considered a good way to improve incomes and seed security among family farmers.

This study explores how the inclusive governance of local innovations promoted with family farmers in the Brunca region of Costa Rica enables or limits the realization of just transitions in family farming. It does so by inquiring into the realization of different justice dimensions, such as recognition, participation, and distribution at different scales, from the local to the national levels. To address our research objective, the following questions were proposed. How does the inclusive governance of niche innovations with family farmers address issues of recognition, equity, and participation?

Does inclusive governance of local innovations with family farmers enable interactions of “niche innovations” between the local and national scales? And what are the shortcomings of the inclusive governance of “niche” innovations in the bean agri-food system that may limit the realization of just transitions in family farming?

Our research fills a knowledge gap in academia on the use of just-transition frameworks in empirical studies to explore how inclusive governance of just transitions can be applied in real-world settings [15]. Furthermore, the study contributes to the analysis of niche–regime interactions, as suggested by [9,10], by observing the realization of just-transition elements of justice, such as recognition, participation, and distributional justice at the niche and regime levels. Our study looks also into the crossroads between two different frameworks of analysis, the multi-dimensional framework of justice and the multi-level perspective (MLP). We attempt to enrich MLP, by analyzing how elements of justice are realized from the local to the national levels.

The paper is structured into five sections. Section 1 presents the rationale for the study, the objectives, and the academic relevance of this research. Section 2 describes the theoretical frameworks that are relevant to understanding inclusive governance for just transitions, as well as for addressing interactions at the local and national levels as part of the multilevel perspective of socio-technical innovations. Section 3 discusses the methods and provides detailed information on the case study for our research. Section 4 presents the findings, which are mainly based on the perspectives of the stakeholders involved in the bean systems of Costa Rica, especially family farmers, followed by the discussion in Section 5. Section 6 presents conclusions and recommendations for future research.

2. Theoretical Framework for Just Transitions

According to [15], just-transition paradigms have acquired multiple connotations in transition research, including their origins as a labor-oriented concept. Its connotation as an inclusive governance framework of justice entails considerations from climate, environmental, and social justice perspectives [16–18]. Just transitions are also conceived as systemic socio-technical transitions from a multiple-level perspective [19,20].

Lately, the term “just transition” has grown to encompass a broader range of individuals, emphasizing the value of safeguarding the rights and welfare of disadvantaged people, who have traditionally endured the negative effects of a fossil-fuel-based economy [10,18]. In the most recent definitions, justice and equality are seen as crucial components of a just transition [15]. Just transition is also seen as a governance strategy that relies on broader stakeholder participation and the involvement of local communities [9].

2.1. Just Transition in Agri-Food Systems and Family Farming

Several scholars have emphasized the need for just transitions to sustainability in the agri-food systems [9,10,21]. The concept of just transitions in food systems arises from the recognition of injustices and inequalities within the globalized food system [5]. Its origins can be traced to a combination of grassroots activism, community initiatives, academic inquiry, and advocacy efforts aimed at addressing social, economic, and environmental injustices within the food systems [5].

For [22], food justice should go beyond distributional considerations and include participation and just representation. Existing inequalities in the food system require rebuilding power relationships as part of the transition to a just agri-food system [23,24]. Several scholars have emphasized the need for inclusive governance for just transitions [25,26]. In terms of governance, issues of participation and democratization have been highlighted [5,9,27].

2.2. Inclusive Governance as a Framework of Justice

The conceptualization of just transition as an inclusive (multi-dimensional) framework for justice recognizes the linkages between distribution, participation, and recognition [28]. According to [9], just-transition frameworks should be multi-dimensional and go beyond distributional matters to include at least three dimensions of justice, including recognitional, procedural, and distributional justice.

2.2.1. Recognitional Justice

Recognition is often associated with the root causes of inequality and unfair distribution and the non-participatory definition of food justice [22]. According to [29], recognition is a core element that contributes to distributional and procedural justice. Recognition includes not just a person’s inherent right to self-awareness; it also implies acceptance of collective identities and their unique needs, concerns, and ways of life in relation to nature [30]. Recognition addresses issues where relevant stakeholders are typically not involved in the decision-making process [30]. According to [31], there are a variety of interests—both shared and unique—that farmers and various stakeholders may have about sustainable agriculture. Therefore, the involvement of farmers is crucial. The role of farmers’ participation in breeding has been highlighted by several scholars in the field of participatory plant breeding (PPB) [32–34].

2.2.2. Procedural Justice

Procedural justice is concerned with the rights and powers of different stakeholders [35]. Fairness, discrimination, and inclusion in decision-making are the main concerns of procedural justice. It is related to the right to take part in discussions that directly impact those concerned. Participation is, therefore, a core element of procedural justice. Understanding the reproduction of inequality and environmental injustice requires examining who is included and who is excluded, who gets the information and knowledge required, and how inclusive the processes should be to support just transitions [36–39]. According

to [39], there are multiple stakeholders interacting and influencing decisions in agri-food systems. The right to speak up during debates may be safeguarded by procedural rules, but recognition is then required to guarantee that the perspectives of different actors are considered seriously [16,17,31].

2.2.3. Distributional Justice

According to [9,10], distributional justice is concerned with the fair distribution of benefits and harms, emerging from both tangible and intangible goods and services. It is also concerned about the obligations that just transitions may entail. The importance of authority, decision-making processes, division of labor, and culture in distributional justice has been highlighted by several scholars [36,37,39]. Distributional justice demands, therefore, strong attention to the needs of the poor [35,37].

For [25], transitions do not occur automatically in food systems if regimes and power imbalances persist. Therefore, interdependent stakeholders in the food-system transition process should work out their differences, cultivate positive relationships, and align their future visions [35,40].

Our study examines the realization of recognition, procedural, and distributional justice in the context of socio-technical transitions by observing their realization at different levels, as proposed in a multi-level perspective framework.

2.3. Multi-Level Perspective in Socio-Technical Transitions

The multi-level perspective (MLP) is an increasingly used framework for studying sustainable transitions in agri-food systems [19]. The MLP is a framework for the analysis of socio-technical transitions to sustainability that puts emphasis on the transition of systems, e.g., agri-food systems [37]. The MLP entails multiple actors and scales and covers niche innovations, sectoral regimes, and larger societal contexts [3]. It explores how niche innovations result in systemic transformations, trying to understand the trajectory of such transitions by identifying their causes [15]. It further explores how different types and forms of agency interact to better achieve the intended transitions, including the inclusion of marginalized groups [38] and the responsibilities that diverse stakeholders can play to boost the transformational potential of grassroots and niche innovations [36]. Changing from one socio-technical system to another is what is meant by a transition in the MLP context—changes that arise from dynamic interaction processes at the intersection of the niche, regime, and landscape [30]. While changes in the landscape put pressure on the current socio-technical regime, niches create conditions for change [41].

Ref. [20] discusses criticisms of the MLP's framework, recognizing the scattered attention paid to the social distribution of benefits, poverty, and inequality issues. Furthermore, he highlights the importance of taking into consideration the long-term pathways in the analysis, since not all transformations are accelerated processes that can be achieved in the short run [20]. Ref. [19] argues that the MLP is used as a framework for research on transitions in the agri-food system because of its weak empirical operationalization of niche, regime, and landscape notions. Furthermore, Ref. [19] adds that transition implications are rarely addressed by the research community, and scattered attention is given to the sustainability of niches and, by extension, of transitions. To account for the complexities of sustainability transition processes, as well as the unique characteristics of the agri-food system, integrative conceptualization and operationalization of the MLP aspects are necessary [19,20,41,42].

The use of MLP in food and seed systems has been addressed by [39,40,43,44]. Some relevant studies from the Latin American region touch upon socio-technical transitions using MLP [45–48]. MLP's application in the Central American context is scattered according to [48], who conducted a systematic review of the literature on socio-technical transitions and sustainable agriculture in Central America and the Caribbean from 2010 to 2021. Their findings indicated a limited use of the MLP in research related to agri-food systems. In a study by [47], which contains an analysis of social innovation in the rural areas of Costa

Rica, they argue that social innovation has a transformative potential, but it must scale up and induce changes in the regime in order to be effective. In the case of seed systems, Ref. [48] used a multi-level perspective in a tracing study of the abandonment of maize landraces over the last 50 years in Morelos, Mexico. The analysis of regime changes revealed that the current regulations of the system favor maize hybrids. This study highlights the value of multi-level analysis to obtain a complete picture of the causes of genetic erosion in situ in the case under analysis. Using a multi-level perspective for bean system analysis, elements of justice contribute to the academic discussion in the Central American region, and eventually into other regions.

3. Methods

The findings from this research are based on a case study and the use of in-depth interviews to gather the perspectives of relevant stakeholders. Using a case study allows us to explore in more detail the enabling and limiting factors for just transitions from the perspectives of family farmers and under specific developmental and environmental conditions.

In-depth interviews with key stakeholders comprised the study's primary source of information. Secondary data for the Costa Rican bean system were gathered through desk research, which included the analysis of relevant strategies, action plans, and policies in the Costa Rican regime. Additionally, a semi-scoping review was carried out to explore gender and intergenerational gaps in plant breeding, as well as potential conflicts between plant breeding and on-farm agro-diversity.

3.1. Case Study: The Costa Rican Program for Agricultural Research and Technology Transfer in Beans (PITTA-Frijol) in the Brunca Region

The study explores innovations promoted with family farmers in the Brunca region by The Costa Rican Program for Agricultural Research and Technology Transfer Program in Beans, or Programa de Investigación y Transferencia Tecnológica Agropecuaria en Frijol (PITTA-Frijol) in Spanish. PITTA-Frijol is a collaborative network aiming to coordinate strategies between private and public actors in formal and informal seed systems. PITTA-Frijol was created in 2006 by executive decree No. 20901 [49]. The National Institute for Agricultural Innovation and Technology Transfer (INTA), at the Ministry of Agriculture and Livestock (MAG), holds the secretariat of PITTA-Frijol.

PITTA-Frijol coordinates and implements technological innovation in bean cultivation, ensuring producers have access to innovations that are appropriate to their economic and environmental conditions [50]. PITTA-Frijol involves representatives from 10 different institutions, namely the Instituto Nacional de Tecnología Agropecuaria (INTA), MAG, the University of Costa Rica (UCR), the National University (UNA), the Technological Institute of Costa Rica (ITCR), the National Seed Office (ONS), the Consejo Nacional de Producción (CNP), the Rural Development Institute (INDER), the University of Distance Education the Universidad Estatal a Distancia (UNED), and representatives of three MAG's sub-national offices in the Brunca, Huetar, and Chorotega regions. PITTA-frijol works closely with farmers' associations (ASOPROS) in the three aforementioned regions.

Figure 1 illustrates the different scales and the stakeholders that interact at the different levels in PITTA-Frijol.

3.1.1. Bean Production System in Costa Rica

Beans are a staple in most Costa Ricans' daily diet and a source of income for many family farmers. Family farmers working in areas smaller than 5 hectares produce 79% of the national bean production [50]. Until the 1980s, Costa Rica was able to match bean production with domestic demand. At the beginning of the 1980s, the area cultivated reached its highest peak. From 1985 onwards, structural agricultural adjustment plans had a detrimental effect on agricultural subsidies, shifting the focus to export products. It resulted in fewer producers and a significant reduction in the total area cultivated [51]. According to [51], the bean-cultivated area declined from more than 69 thousand hectares

at the beginning of the 1990s to just 19 thousand hectares in 2001. Only 46% of the country's domestic bean demand is currently met by domestic bean production.

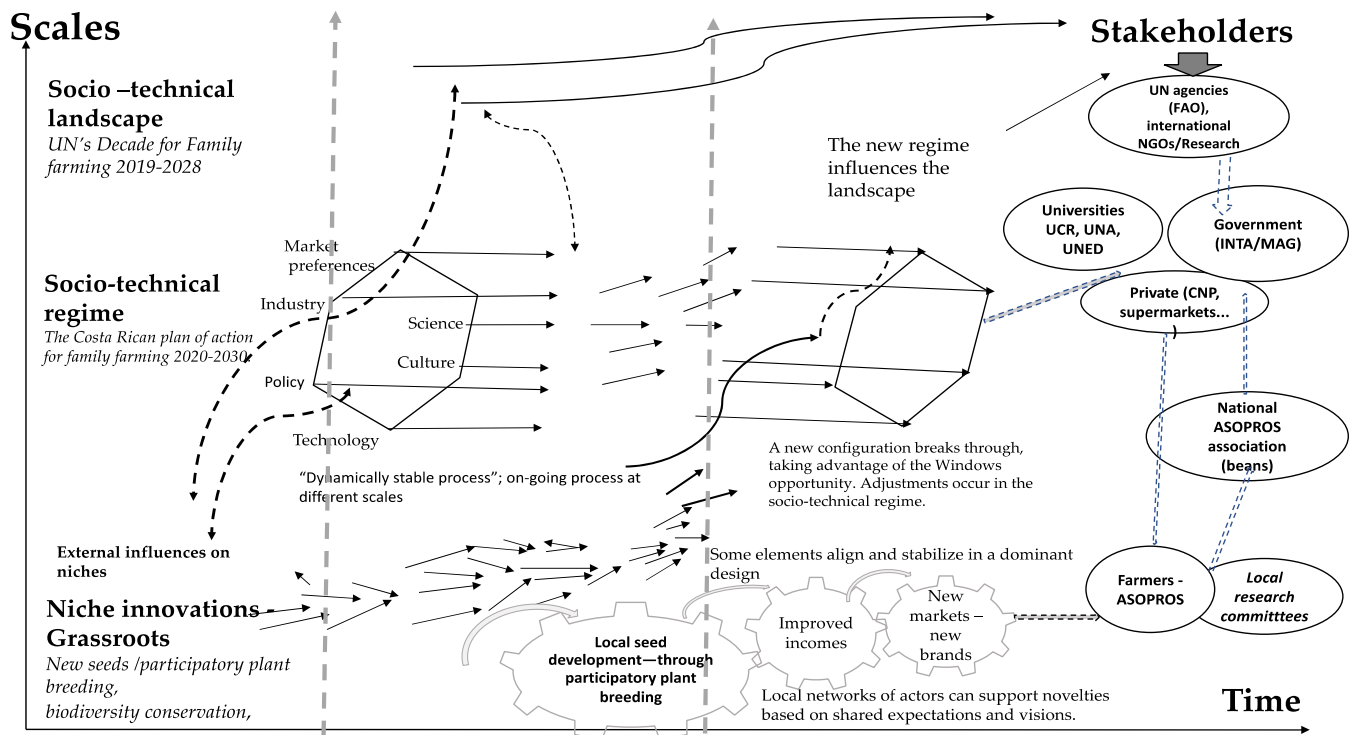


Figure 1. The multi-level perspective as a framework of multiple actors interacting at multiple scales in the case study. Source: [41], with modifications.

The Huetar and Brunca regions are the two major bean producers in Costa Rica. Bean production in the Brunca region is mainly carried out by smallholder farmers on family farms, with an average size ranging between 1 and 5 hectares. Meanwhile, bean production in the Huetar Norte region is carried out by larger producers, and it is more mechanized. The presence of local varieties on farms is limited in Huetar Norte due to its mechanization and homogenization [51].

The Brunca region was chosen as the case-study area because bean cultivation is mainly performed by family farmers, who are more likely to conserve a higher diversity of local varieties on site. Moreover, family farmers in this region are innovating in seed improvement using participatory plant-breeding methods.

3.1.2. Area and Farmers' Associations in the Brunca Region

The Brunca region has an extension of 9.528 km² and represents 18.6% of the Costa Rican territory. It produces 50.8% of the country's bean production [52]. Figure 2. Illustrates the division of the country by productive area of beans.

Farmers' associations, or asociaciones de productores (ASOPROS), are key stakeholders for bean production in the Brunca region. They are organized into five associations, including (1) ASOPRO Veracruz (350 families) in Veracruz of Pejibaye, Pérez Zeledón; (2) ASOPRO Changuena (130 families) in Changuena of Buenos Aires; (3) ASOPRO Guaral in Colinas, Buenos Aires; (4) ASOPRO Concepción (410 families) in Concepción de Pilas de Buenos Aires; and (5) ASOPRO El Aguila (200 families) in El Aguila, Perez Zeledón [52].

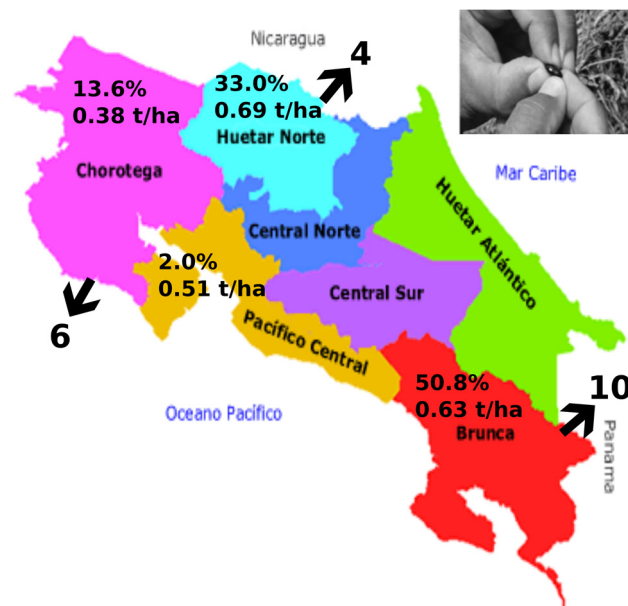


Figure 2. Bean production in Costa Rica 2018–2019. Percentages of total production per region. Source: [52] with modifications. Note: the numbers 4, 6 and 10 refer to the number of the regions.

PITTA-Frijol has pioneered innovations in bean research in the Brunca region by enabling farmers to participate in a range of activities that include setting up, evaluating, and validating participatory plant-breeding trials. In addition, PITTA-Frijol supports local seed production while rescuing and conserving wild populations and native varieties [50]. PITTA-Frijol collaborates closely with the five ASOPROS from the Brunca region.

The inclusive governance framework for justice has been used to analyze the elements of justice embedded in the niche innovations promoted in the case study. A multi-level perspective on transitions was used to explore the interactions between niche innovations at the local level and possible regime changes.

3.2. Desk Research

The desk research encompassed the compilation of relevant documents for family farming at the national (regime) and international (landscape) levels, e.g., the United Nations Decade of Family Farming 2019–2028 [53]. At the national level, Costa Rica has several strategies, action plans, and regulatory instruments that are relevant to family farming, including the National Plan of Action for Family Farming 2020–2030 [54], the law for the development, promotion, and encouragement of organic agriculture N° 8542–2016; the executive decree 01-2018 that formalized and declared of public interest the implementation of the Decade of Family Farming [55]; and the strategic plan for PITTA-Frijol, 2015–2020 [49]. The review included a simple literature search of the relevant literature about the impacts of seed improvements on farmers, including impacts on food security, income, seed security, and biodiversity conservation. The literature is mainly used for the triangulation of research findings and will be particularly useful for the discussion in Section 5.

A Semi-Scoping Review

A semi-scoping review was carried out to explore the findings from academic research regarding gender gaps in plant breeding, as well as to unveil any possible dilemmas between plant breeding and agro-biodiversity conservation on farms. Scoping reviews are useful when responding to broad research questions and for the identification and mapping of the available evidence in a specific research field [56,57]. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping reviews (PRISMA-ScR) [58] was used to systematize the process undertaken for our study. PRISMA-ScR

requires as a first stage the selection of research questions. We defined the following two research questions. What dilemmas can be identified between plant breeding and on-farm agro-biodiversity conservation? What gender gaps can be identified in plant breeding?

The second stage consisted of identifying the relevant literature by using predefined criteria contained in search strings to respond to the research question proposed in this study. The third stage consisted of choosing studies by using our own discrimination criteria. The fourth stage entailed organizing the information. The fifth stage consisted of compiling, analyzing, and documenting the findings [57,58].

The scope of the study was restricted by predefined search strings, containing keywords related to the questions selected. The search strings were the following: plant breeding AND (agro-biodiversity, genetic diversity, local landraces, traditional landraces, on-farm agro-diversity, and in situ agro-diversity) AND gender (gaps, disparities, and differences) AND women (participation, engagement, and inclusion) AND youth (inter-generational gaps, disparities, engagement, and participation). The search was carried out on the Web of Science. Google Scholar was used to retrieve certain materials.

The extent of the search was also defined by the selection criteria, including (i) only review, scoping, and systematic review articles; (ii) only peer-reviewed articles published in academic journals; (iii) only articles with a global perspective or performed in the Latin American region; and (iv) only investigations undertaken in the period 2018–2023/24.

A total of 19 review articles have been analyzed. The selection process is illustrated in Figure 3.

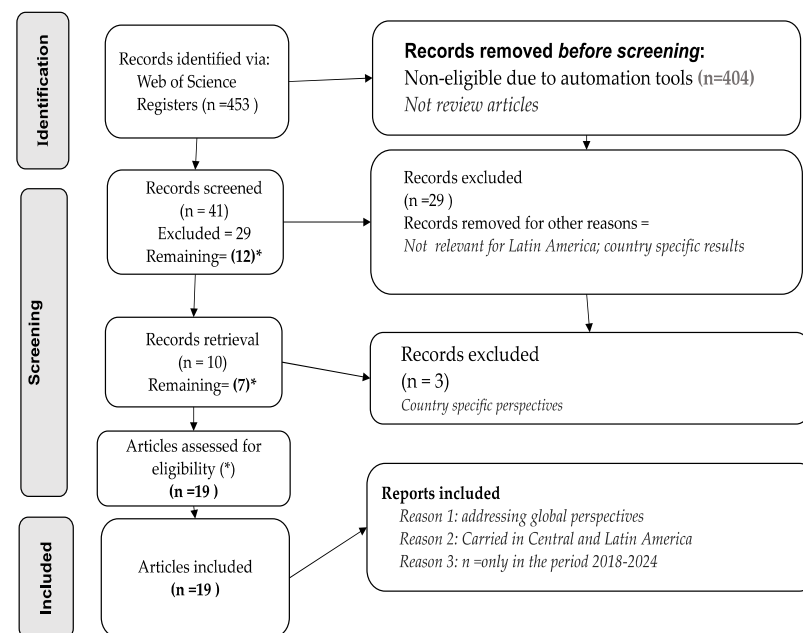


Figure 3. The protocol of the selection process for the semi-scoping review. Source: own elaboration. Note: * Records selected for the final screening.

3.3. In-Depth Interviews

The study includes the perspectives of family farmers engaged in local innovations promoted by the inclusive governance of PITTA-Frijol. This entails the active participation of farmers, research institutions, extension services, and commercial stakeholders. The perspectives of farmers and other relevant stakeholders were gathered through in-depth interviews. In total, 23 interviews were carried out for this study, including three (3) representatives from universities and four (four) from research institutions; five (5) male farmers representing all ASOPROS in the Brunca region; four (4) female farmers; three (3) young farmers; two (2) representatives from private commercialization units; and two (2) representatives from the regional offices of the Ministry of Agriculture in the Brunca

region. The number of in-depth interviews was determined according to the saturation principle. The saturation principle is to determine whether the level of novel information is such that more interviews are needed [59].

In-depth interviews were carried out by using guiding questions, which addressed elements of recognitional, procedural, and distributional justice (Supplementary Materials). Regarding recognitional justice, we investigated the recognition of farmers' traditional knowledge and their role as agro-biodiversity guardians and plant breeders, as well as the recognition of different roles and perspectives, such as those of males, women, and youths. With regard to procedural justice, we explored issues of equal gender participation in field activities and decision-making, as well as their participation in defining agricultural research objectives and strategies. Furthermore, we explored the skills provided to strengthen the participation of farmers in decision-making, such as leadership skills.

To explore issues of distributional justice, we inquired into social and economic benefits, such as market linkages, income generation, gender-responsive budgets, fair compensation schemes, and networking. The interviewed subjects were asked about the performances of the different elements of justice (sub-categories) both at the local and national scales. The idea was to explore interactions between niche (local) and regime changes (national). The categories and sub-categories used during the in-depth interviews are illustrated in Figure 4.

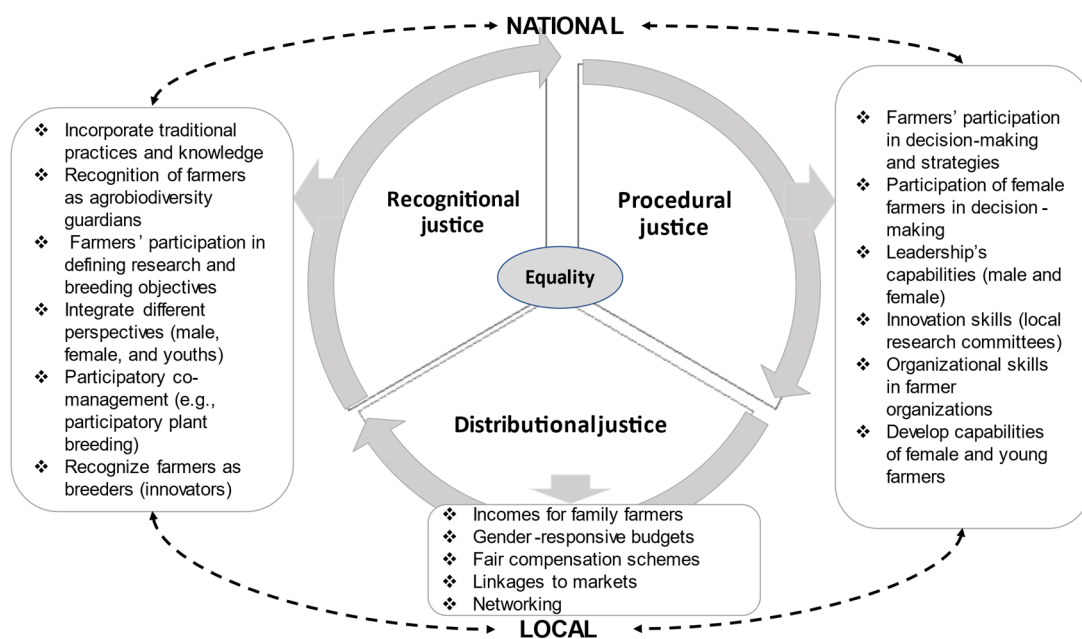


Figure 4. Justice dimensions: categories and sub-categories used for the analysis of the in-depth interviews. Source: own elaboration. Notes: niche innovations are considered to happen at the local scale, while regime changes happen at the national level.

4. Findings

Costa Rica has committed to the UN's Decade of Family Farming by adopting the Costa Rican Plan of Action for Family Farming 2020–2030. From the interviews, we noticed that family farmers did not know about the existence of such a plan. Very few stakeholders, and none of the farmers interviewed, knew about it.

"I did not even know that there was a plan for family farming. What does it mean for us? I feel we family farmers are not of high interest to the politicians". Interview with a farmer

Some of the stakeholders (local agriculture agencies and researchers) expressed that the forthcoming strategic plan by PITTA-Frijol should be aligned with the Costa Rican Action Plan for Family Farming 2020–2030.

“Such action plan for family farming should overcome the paperwork and be accompanied with communication strategies and funds to promote the changes and innovations needed by family farmers”. Interview with an agricultural extension officer

4.1. Inclusive Governance through the Dimensions of Just Transition

The findings from the in-depth interviews are organized according to the dimension of justice considered for the analysis. The sub-categories, organized under recognitional, procedural, and distributional justice, were ranked by the interviewed people as strong, average, weak, very weak, or non-existent.

4.1.1. Findings in Terms of Recognitional Justice

The role of farmers in breeding and the importance of farmers’ traditional knowledge are mentioned in most of the documents analyzed. Several publications acknowledged the crucial role of farmers in plant breeding and the development of new bean varieties in the Brunca region of Costa Rica. Table 1 presents the findings in terms of recognitional justice according to the perspectives of the interviewed stakeholders.

Table 1. Recognitional justice: perspectives from the interviewed stakeholders.

Recognitional Justice Categories/ Sub-Categories	Perspectives of the Interviewed Stakeholders						Impact at Different Scales	
	Farmers			Researchers/ Universities	Extension Agents	Private Market Actors	Local (Niche)	National/ Regime
	Male	Women	Youth					
Incorporation of traditional practices and knowledge systems	++++	++	+	++++	-	++	++++	+++
Recognition of farmers as agro-biodiversity guardians	+++	++	++	+++	-	+	++++	++++
Integration of different perspectives (male, female, and youth)	++	++	-	++	-	++	+++	+
Participatory co-management (e.g., participatory plant breeding)	++	++	-	++	-	-	++++	+++
Recognition of farmers as breeders (innovators)	++++	+++	-	+++	+	+	++	++

Source: own elaboration based on the interviews. Notes: ranking is defined as strong (++++); average (+++); weak (++); very weak (+); and non-existing (-).

The collaborative approach to PPB promoted by PITTA-Frijol recognizes farmers’ traditional knowledge of bean varieties and their role in conserving local agro-biodiversity. Interviewed farmers expressed that their views are respected and are taken into consideration during the definition of breeding objectives in bean research. Farmers in the Brunca region considered that their abilities for plant breeding were recognized by the researchers and institutions alike involved in PITTA-Frijol.

“We feel respected and even recognized as breeders; we get invited to present our results at conferences. I feel humbled and honoured when a famous researcher asks me to present our results and share my experiences about the process of developing a new variety of seed”. Interview with a farmer

The recognition of family farmers as bearers of traditional knowledge and as agro-biodiversity guardians is mentioned in several of the documents analyzed. The interviewed

stakeholders indicated that PITTA-Frijol recognizes them as biodiversity guardians at the local level but not at the national level.

“Our role as agrobiodiversity guardians is recognized by some researchers, but it is not really recognized by the institutions or in national policies. We do not get proper incentives to conserve agrobiodiversity on the farm”. Interview with a farmer

Interviewed stakeholders expressed concerns about the loss of traditional bean diversity. When defining research objectives, family farmers in the Brunca region have focused on increasing productivity and incomes in the short run by cultivating mainly improved varieties. The cultivation of only improved varieties is reducing the diversity of traditional varieties on farmers' fields, which is undermining future breeding solutions.

“The recognition of farmers as guardians of biodiversity is not clearly addressed in the current approach for bean research in the Brunca region. We need to revisit this and get it as part of the institutional strategies and of PITTA-Frijol's plans”. Interview with a university researcher

PPB has been a crucial innovation for farmers in the Brunca region. PITTA-Frijol has strengthened farmers' abilities to develop their own quality seeds, which is a crucial input for farming. The dialogue and close collaboration with researchers, agricultural extension services, and commercial actors is a valuable achievement for the farmers interviewed. The Gene Bank at the Fabio Baudrit Research Station at the University of Costa Rica provides easy access to the germplasm of traditional and improved varieties. This has been possible due to the collaboration established with PITTA-Frijol.

According to the interviewed subjects, PITTA-Frijol in the Brunca region falls short of integrating the perspectives of female and young farmers. The program does not explicitly acknowledge their perspectives when formulating research objectives for plant breeding, which is a limiting factor for PITTA-Frijol.

Female farmers participate in the later stages of seed production, such as testing improved seeds in terms of cooking time and flavor. They also get on board in the commercialization process, working with farmers' organizations cleaning and packaging seeds. Interviewed female farmers argued they do not get involved in research committees because they feel they have less understanding about bean cultivation to be able to contribute significantly. PITTA-Frijol's strategic plan does not include research and other objectives that directly target female farmers and youths.

4.1.2. Findings in Terms of Procedural Justice

In terms of procedural justice, most documents analyzed mentioned the need to address gender issues. References to gender issues, female farmers, women, and youths are found in most strategies and action plans at the national level. However, PITTA-Frijol's strategy does not explicitly mention female farmers and youths. There are no strong initiatives targeting youths and female farmers in the documents analyzed for the Brunca region.

Participation is encouraged by PITTA-Frijol through its PPB approach. The multi-stakeholder governance of PITTA-Frijol entails farmers' participation in local decision-making. Research institutes and universities engage with farmers locally, and the farmers expressed their appreciation for it while also expressing their wish to become part of national decision-making mechanisms. Farmers' opportunities to influence national strategies toward better conditions and funding for basic grain research, commercialization, or in support of family farming's agendas at the national level are limited by their lack of participation in national decision-making (see Table 2).

Table 2. Procedural justice: perspectives from the interviewed stakeholders.

Procedural Justice	Perspectives of the Interviewed Stakeholders						Impact at Different Scales	
	Farmers			Other Stakeholders			Local-Niche	National-Regime
	Male	Women	Youth	Researchers/Universities	Extension Agents	Private Market Actors		
Farmers' participation in decision-making and strategies	++++	++	-	++++	-	+++	++++	-
Participation of female farmers in decision-making	++	-	-	++	-	-	-	-
Leadership capabilities (male and female)	+++	+	+	+++	-	++	++++	-
Innovation skills (local research committees)	+++	++	-	+++	-	++	++++	+++
Organizational skills in farmer organizations	++++	+++	+	+++	+++	+++	+++	++
Development of capabilities in female and young farmers	++	++	+	++	++	++	++	++
Participation of young farmers in decision-making	++	++	+	++	-	+	++	-
Farmers' participation in defining research objectives and breeding objectives	++++	-	-	++++	-	-	++++	+++

Source: own elaboration based on the interviews. Notes: ranking is defined as strong (++++); average (+++); weak (++); very weak (+); and non-existing (-).

Women farmers participate actively in the commercialization activities of the farmers' associations (ASOPROS). They are experts in cleaning, processing, and packaging beans for market purposes. However, the participation of female farmers in decision-making, productive activities, and bean research is scattered.

Limiting factors in terms of procedural justice are gender and intergenerational gaps in PITTA-Frijol. The farmers and stakeholders interviewed expressed their concerns about the scattered involvement of younger generations in bean production and research. Male and female farmers interviewed agreed that bean production is not a preferred activity for female farmers or youths.

"As farmer organizations, we engage local primary school pupils in field days to raise awareness about the importance of bean production and the role of participatory plant breeding for seed development and income generation. Some children get interested, but a long-term initiative to strengthen young generations' engagement in bean and basic grain production is required in the Brunca region and other regions". Interview with a farmer

Younger generations do not want to work in bean production, arguing it does not pay off. This is an issue of high concern for family farmers and institutions engaged in bean production and future plant breeding in the Brunca region.

"New initiatives targeting youth are highly needed to solve intergenerational handover in bean production, research, innovations, and commercialization. We are all getting old". Interview with a farmer

The scattered participation of farmers in decision-making at the national level is a challenge, as expressed by interviewed farmers. Farmers' participation is limited to the local spheres.

"We participate in decisions in the community, but we are not invited to take part in meetings and decisions at the national level. We do not really know about the existence of a plan for family farming and how it is implemented". Interview with a farmer

4.1.3. Findings in Terms of Distributional Justice

In terms of distributional justice, many of the documents examined prioritized income generation and connections to markets over the development of equitable compensation schemes for agroecological and high-quality seed production on family farms. None of the documents under analysis mentioned gender-responsive budgets or any special compensation schemes or innovations to address the concerns of young and female farmers.

During the in-depth interviews, it was observed that PITTA-Frijol has contributed to income generation and market opportunities among family farmers in the Brunca region. The interviewed farmers appreciated the support from PITTA-Frijol in developing seeds and new market opportunities for farmer organizations. Table 3 presents the findings in terms of distributional justice according to the perspectives of interviewed stakeholders.

Table 3. Distributional justice: perspectives from the interviewed stakeholders.

Distributional Justice Categories/Sub-categories	Perspectives of the Interviewed Stakeholders						Impact at Different Scales	
	Farmers			Other Stakeholders			Local Niche	National/Regime
Male	Women	Youth	Research/Universities	Extension Agents	Private Market Actors			
Incomes for family farmers	++++	++	-	+++	++	+++	+++	+++
Inclusive and gender-responsive budgets	+	+	-	+	+	+	++	-
Fair compensation schemes for family farmers	++	+	-	++	-	+++	+++	+++
Linkages to markets	+++	+	-	+++	-	+++	+++	+++
Networking (within and outside the community)	++++	++	+	+++	++	+++	++	+++

Source: own elaboration based on the interviews. Notes: ranking is defined as strong (++++); average (+++); weak (++); very weak (+); and non-existing (-).

The inclusive governance scheme of PITTA-Frijol benefits family farmers. According to the people interviewed, PITTA-Frijol encourages an inclusive governance that connects the formal and informal seed systems. PPB yields high-quality seeds that meet consumer and farmer demands while providing family farmers with stable incomes. The farmers and all interviewed subjects were positive about this innovative way of coordinating research, extension services, and commercialization efforts for bean production. Farmers expressed their gratitude to the researchers for the opportunities given to them to be part of breeding initiatives and the market opportunities that are opening due to their knowledge of seed production.

“PITTA-Frijol has made family farmers able to produce their own quality seed. Quality seed is a crucial input for bean production. By producing their own seeds, farmers have gained some economic autonomy”. Interview with a researcher

After more than a decade of working on seed development, the ASOPROS use improved seeds and have developed their own brands of beans to get higher prices for the quality seeds that they produce. Farmers in the Brunca region also sell to the Institutional Supply Program (PAI), managed by the National Production Council (CNP). The Costa Rican public food supply program involves the procurement of food for schools and prisons. The CNP provides technical support in areas of marketing and agro-industry, such as post-harvest management, food safety, and good agricultural practices. The CNP is also a member of the board of PITTA-Frijol.

“The PAI, or public food supply program, has put an end to bean producers’ strikes, which were very common prior to the policy and regulations that created the PAI. When farmers

sell to the PAI, they are guaranteed a market, at least for a part of their production”.

Interview with a researcher

According to the farmers interviewed, the PAI was an important source of income during the pandemic. It secured food supplies for schools and, at the same time, provided income during a very critical period.

“The PAI is not perfect; it has some issues because it has very bureaucratic procedures and rules, but instead of discrediting it, we would rather recommend improving its functioning to favor national production of basic grains, such as bean production. A basic item in the diet of all Costa Ricans should get the importance it deserves, and Costa Rica cannot rely only on international producers, especially in critical times”. Interview with a farmer

The farmers expressed the need to further strengthen institutional agendas in support of family farming, e.g., public food supply programs such as the PAI. According to the farmers interviewed, the PAI is a stable source of income for family farmers. However, the PAI’s main providers are big producers and importers of beans. Family farmers only get a small portion of this market.

A limiting factor in terms of distributional justice is the low representation of female and young farmers in the breeding and marketing initiatives promoted by farmers’ associations in the Brunca region. The regional offices of MAG are making efforts to engage female farmers in other entrepreneurial initiatives. However, in the case of basic grains, many of the interviewed stakeholders expressed their concerns about the scattered participation of women and youths. The low involvement of younger generations is a challenge for family farming in the Brunca region. The intergenerational handover of bean production concerns both researchers and farmers.

“We are concerned about the intergenerational handover. Making bean production attractive for the new generations of male and female farmers is something that requires urgent attention and concrete actions in the farmer organizations (ASOPROS) and in PITTA-Frijol”. Interview with a farmer

4.2. Interactions between Niche Innovations and Regime Changes

Niche innovations promoted by PITTA-Frijol in the Brunca region are influencing regime changes by anchoring innovations, such as the PPB, into national institutions. These innovations are also leading to changes in national standards for the recognition of farmers’ quality seeds. These are important milestones in strengthening the bean system with family farmers. However, they fall short of addressing intergenerational and equality issues.

Figure 5, presents a summary of the key elements that enable or constrain the realization of just-transition dimensions, identifying the interactions between niche innovations and regime changes. It is based on the information gathered through the in-depth interviews.

The institutional anchoring of PPB for bean improvement is an example of regime change. The farmers’ facilitated access to bean germplasm from national institutions is a result of the inclusive governance in PITTA-Frijol that integrates different stakeholders, including farmers, researchers, and commercializing institutions. The recognition of farmers’ traditional knowledge and their participation in local decision-making have enriched the PPB and led to the adoption of improved seeds by family farmers. Through their involvement in the PPB, farmers maintain their influence in local decision-making across time.

“PPB is important for our Brunca region. We thank the committed people working in bean research. It is good to work hand in hand with researchers and with the support of universities—not just one, but several. We also need committed people to put basic grains high on the agenda, budgets, and plans of the entire country. The country should prioritize basic grain production; it is so called because the Costa Rican (“ticos”) eat

beans at least twice a day, then beans should get the importance they deserve". Interview with a farmer

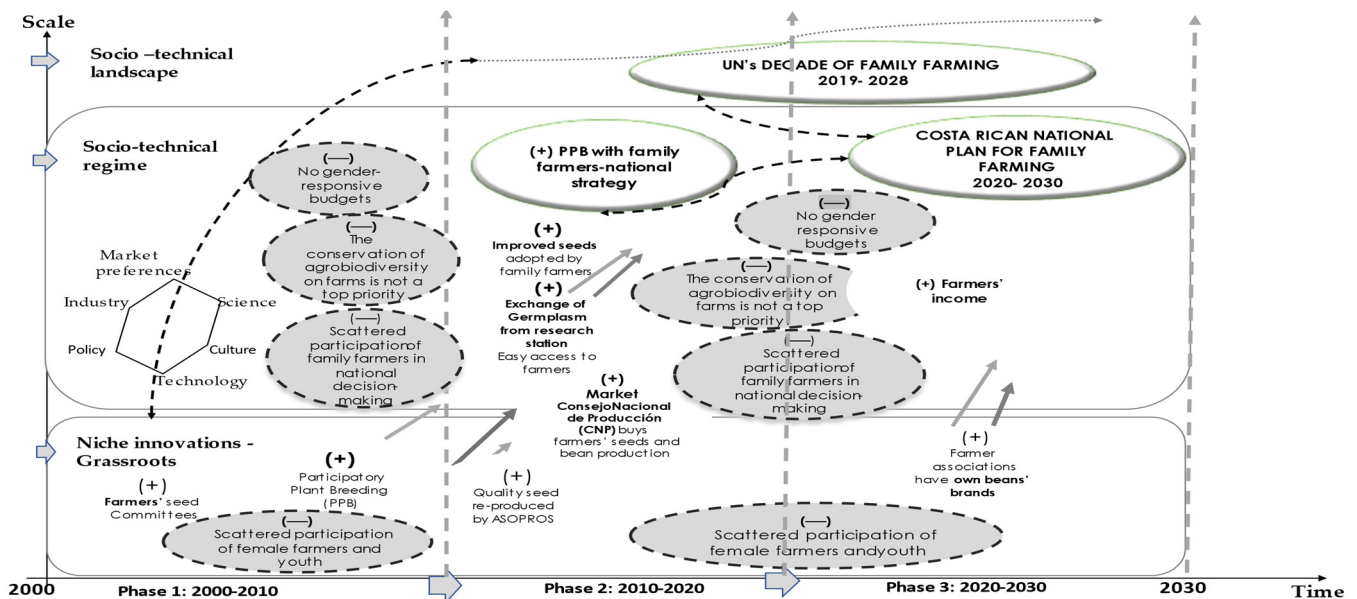


Figure 5. Case study in Costa Rica's Brunca area: niche innovations and the realization of just principles in the interaction between niches and the regime. Source: own elaboration based on [41] and findings of the in-depth interviews. Notes: Enabling factors are represented by the text with a positive sign (+), and limiting factors are illustrated by the circles with a negative sign (−). The way just-transition dimensions perform over time is illustrated in the horizontal axis, with three different periods of time: 2000–2010, 2010–2020, and 2020–2030; 2030 represents the time span of the Costa Rican action plan for family farming.

The farmers' participation is limited to the local sphere. Farmers expressed their desire to participate more actively in national decision-making, e.g., on the board of PITTA-Frijol. The interaction between the local and the national scales is limited by the lack of participation of family farmers in national decision-making spheres, which persists across time. The circles with a negative sign also show farmers' scattered participation in national decision-making (see Figure 4).

Inequality is an underlying barrier to just transitions in the niche innovations supported by PITTA-Frijol. The scattered engagement of women and youth is indicated in the circles on the horizontal axis with a negative sign in Figure 4. Inequality is a barrier that persists over time, both at the local and national scales.

Women and youth argued that, by having more active participation in decision-making in farmer organizations and on the PITTA-Frijol national board, they could contribute to closing gender and intergenerational gaps. Further, they added that such participation should be supported by investments in family farming and innovations targeting especially women and young farmers.

4.3. Findings from the Semi-Scoping Review

Gender inequality [60–63] and biodiversity loss [64–66] are considered crucial challenges for plant breeding. According to [33,64–67], the decline in crop diversity poses significant risks to agricultural resilience and ecosystem services. Modern agricultural practices, in particular the focus on high-yielding varieties, have led to a reduction in traditional, more resilient crop varieties, resulting in crop genetic erosion. One of the main challenges to addressing this problem is the lack of a comprehensive understanding of its extent and its causes, which makes it difficult to find effective solutions.

Gender disparities exist in the areas of knowledge, training, participation in decision-making, and access to resources [33,60–63]. According to several studies, reducing gender gaps can lead to more equal access to information, resources, and decision-making processes in farming systems, which would ultimately help conservation efforts to preserve agrobiodiversity. Greater investments are needed to increase gender approaches in plant breeding, as well as more training to increase the participation of women farmers in plant-breeding research. Investments are also needed to strengthen women farmers' participation in decision-making [60–63].

The need to strengthen farmers' participation in agro-biodiversity conservation and plant breeding is also highlighted in the documents reviewed [67–70]. The use of diverse approaches for crop diversification and conservation on farms is highlighted by several papers [67,70–74].

Some of the solutions proposed in the review documents are listed below.

Systems-based breeding integrates multiple breeding strategies to create resilient crops that meet sustainability objectives [33,60,66,68,69]. Involving farmers in the breeding process produce crops adapted to local conditions and increases farmers' resilience [33,60,64,65,68,70,72,74,75].

Emphasize the conservation and use of local varieties and landraces, ensuring food security through a diverse farming system [60–62,66,73–77]. Gender-sensitive approaches that empower women in agriculture by incorporating their knowledge into biodiversity conservation are also suggested [60,63,67].

Most documents highlight the need for stronger policy frameworks and institutional support to facilitate agro-biodiversity conservation, as well as to promote sustainable agricultural practices involving local communities. More investments to reduce gender gaps are highlighted.

An overview of the papers analyzed is presented in Table 4.

Table 4. Semi-scoping review: selected articles.

Author	Scope	Journal	Title	Year
1. van Bueren, E.T.L.; Struik, P.C.; van Eekeren, N.; Nuijten, E. [33]	Review/global	AGRONOMY FOR SUSTAINABLE DEVELOPMENT	Towards resilience through systems-based plant breeding. A review	2018
2. Occelli, M.; Mukerjee, R.; Miller, C.; Porciello, J.; Puerto, S.; Garner, E.; Guerra, M.; Gomez, M.I.; Tufan, H.A. [60]	Scoping review/global	Nature Plants	A scoping review on tools and methods for trait prioritization in crop breeding programmes	2024
3. Quisumbing, A.; Cole, S.; Elias, M.; Faas, S.; Galiè, A.; Malapit, H.; Meinzen-Dick, R.; Myers, E.; Seymour, G.; Twyman, J. [61]	Review/global	Global Food Security	Measuring Women’s Empowerment in Agriculture: Innovations and evidence	2023
4. Njuki, J.; Eissler, S.; Malapit, H.; Meinzen-Dick, R.; Bryan, E.; Quisumbing, A. [62]	Review/global	Global Food Security	A review of evidence on gender equality, women’s empowerment, and food systems	2022
5. Molina, C.A.; Dudenhoefer, D.; Polar, V.; Scurrah, M.; Ccanto, R.C.; Heider, B. [63]	Review/Latin America	SUSTAINABILITY	Gender Roles and Native Potato Diversity Management in Highland Communities of Peru	2022
6. Ceccarelli, S.; Grando, S. [64]	Review/global	AGRONOMY-BASEL	Diversity as a Plant Breeding Objective	2024
7. Louwaars, Niels [65]	Review/global	Euphytica	Plant breeding and diversity: A trouble relationship	2018
8. Khoury, C.K.; Brush, S.; Costich, D.E.; Curry, H.A.; De Haan, S.; Engels, J.M.; Guarino, L.; Hoban, S.; Mercer, K.L.; Miller, A.J.; et al. [66]	Review/global	NEW PHYTOLOGIST	Crop genetic erosion: understanding and responding to loss of crop diversity	2021

Table 4. Cont.

Author	Scope	Journal	Title	Year
9. Ficiyan, A.; Loos, J.; Sievers-Glotzbach, S.; Tschardt, T. [67]	Review/global	SUSTAINABILITY	More than Yield: Ecosystem Services of Traditional versus Modern Crop Varieties Revisited	2018
10. Vignola, R.; Esquivel, M.J.; Harvey, C.; Rapidel, B.; Bautista-Solis, P.; Alpizar, F.; Donatti, C.; Avelino, J. [68]	Review/Latin America	Agronomy	Ecosystem-Based Practices for Smallholders' Adaptation to Climate Extremes: Evidence of Benefits and Knowledge Gaps in Latin America	2022
11. Engels, J.M.M.; Ebert, A.W. [69]	Review/global	PLANTS-BASEL	How Can We Strengthen the Global Genetic Resources' Conservation and Use System?	2021
12. Engels, J.M.M.; Ebert, Andreas, W. [70]	Review/global	PLANTS-BASEL	A Critical Review of the Current Global Ex Situ Conservation System for Plant Agrobiodiversity. II. Strengths and Weaknesses of the Current System and Recommendations for Its Improvement	2021
13. Chable, V.; Nuijten, E.; Costanzo, A.; Goldringer, I.; Bocci, R.; Oehen, B.; Rey, F.; Fasoula, D.; Feher, J.; Keskitalo, M.; et al. [71]	Review/global	SUSTAINABILITY	Embedding Cultivated Diversity in Society for Agro-Ecological Transition	2020
14. Bravo-Peña, F.; Yoder, L. [72]	Scoping review/global	Journal of Environmental Management	Agrobiodiversity and smallholder resilience: A scoping review	2024
15. Hufnagel, J.; Reckling, M.; Ewert, F. [73]	Review/Global	Agriculture for Sustainable Development	Diverse approaches to crop diversification in agricultural research. A review	2020
16. Acevedo, M.; Pixley, K.; Zinyengere, N.; Meng, S.; Tufan, H.; Cichy, K.; Bizikova, L.; Isaacs, K.; Ghezzi-Kopel, K.; Porciello, J. [74]	Review/Global	Nature Plants	A scoping review of adoption of climate-resilient crops by small-scale producers in low- and middle-income countries	2020

Table 4. Cont.

Author	Scope	Journal	Title	Year
17. Labeyrie, V.; Antona, M.; Baudry, J.; Bazile, D.; Bodin, Ö.; Caillon, S.; Leclerc, C.; Le Page, C.; Louafi, S.; Mariel, J.; et al. [75]	Review/Global	AGRONOMY FOR SUSTAINABLE DEVELOPMENT	Networking agrobiodiversity management to foster biodiversity-based agriculture. A review	2021
18. Guzzon, F.; Rios, L.W.A.; Cepeda, G.M.C.; Polo, M.C.; Cabrera, A.C.; Figueroa, J.M.; Hoyos, A.E.M.; Calvo, T.W.J.; Molnar, T.L.; León, L.A.N.; et al. [76]	Review/Global	AGRONOMY-BASEL	Conservation and Use of Latin American Maize Diversity: Pillar of Nutrition Security and Cultural Heritage of Humanity	2021
19. Nabuuma, D.; Reimers, C.; Hoang, K.T.; Stomph, T.; Swaans, K.; Raneri, J.E. [77]	Scoping review/Global	Global Food Security	Impact of seed system interventions on food and nutrition security in low- and middle-income countries: A scoping review	2022

Source: own elaboration based on semi-scoping review search.

5. Discussion

As suggested by [9–11,23,39], just transitions in food systems require delivering on justice dimensions, such as recognition, participation, equality, and distributional justice. So, how does the inclusive governance of niche innovations with family farmers address issues of recognition, equality, and participation?

The findings of our study show that the inclusive governance of innovations promoted with family farmers in the Brunca region has partially contributed to the realization of just transition's principles, such as recognition, participation, and distributional justice.

5.1. Regarding Recognition Justice

The inclusive governance of bean research in the Brunca region recognizes farmers' traditional knowledge and the role of farmers as guardians of local bean diversity. It combines scientific and traditional knowledge. The incorporation of farmers' knowledge in participatory plant breeding is seen by several scholars as a precondition to ensuring that innovations, such as improved seeds, meet farmers' needs [78–82]. Farmers' active participation in breeding research guarantees higher adoption rates of improved seeds [81,82].

5.2. Regarding Procedural Justice

According to [82], farmers and scientists are able to share decision-making roles and be aware of each other's ideas, hypotheses, and priorities. According to [64,76,78], farmers' traditional knowledge is valuable and necessary when coping with risk and uncertainty. However, one should be cautious against the belief that traditional knowledge is a panacea for all local agricultural problems. In the case analyzed, there are dilemmas about the adoption of improved seeds because they are causing farmers to abandon local varieties to the detriment of local bean diversity [65,67]. A similar situation was observed in a study carried out in Mexico about the use of improved maize varieties [48].

Although male farmers participate in the whole breeding process through the farmers' organizations, women and young farmers are underrepresented in the ASOPROS, both in innovating and in local and national decision-making. For [5,9,10,39,83,84], ensuring enough participation of relevant stakeholders in decision-making is the most fundamental aspect of procedural justice. According to [85], being more resource efficient is simply one aspect of socio-technological innovation. Another involves shifting the power dynamics inside production and consumption systems. PITTA-Frijol has not managed to include an appropriate gender perspective, neither in breeding nor in the organizational management of the ASOPROS. Consequently, gender perspectives are not prioritized when defining breeding objectives, neither at the local nor the national levels. For [29,85,86], inequalities are the root cause of both ecological and social problems. Therefore, a just transition should overcome such unequal relations. Thus, addressing inequalities is crucial for just transitions in food systems, which requires taking concrete measures that go beyond simply committing to gender equality [23,40]. For [12,23,35,47], realizing equality and participation [87] at all scales—from the local to the regime level—are key elements for just transitions to sustainability in agri-food systems.

5.3. Regarding Distributional Justice

In terms of distributional justice, initiatives promoted by PITTA-Frijol have been successful in improving farmers' livelihoods, but they fall short in addressing the needs of women and young farmers. According to [60,63,67], it will be easier to address the needs of households if the preferences of men and women are included in breeding research. There is a need for specialized studies on gender trait preferences, as well as the need to use data on gender trait preferences for priority setting and decision-making [60,81,83,84]. This may improve distributional justice, as well as strengthen the conservation of traditional varieties. The contributions of farmer organizations to income generation among smallholder farmers have been analyzed by [72,75,88]. Although with positive outcomes, they argue that farmers require government and private sector support to improve their role.

“Does inclusive governance of local innovations with family farmers enable interactions of “niche innovations” between the local and national scales?”

An important process in transitions is the interaction between the niche and the regime to incorporate new norms and practices into the regime [26,84,87]. PITTA-Frijol strengthens farmers’ skills for bean research and commercialization, which are considered essential to enabling niche innovations to be adopted by family farmers [9,10].

PITTA-Frijol’s niche innovations have interacted with regime transitions primarily through institutional and technological anchoring. Technological, network, and institutional anchoring have been identified by [12,26,85,89] as possible niche–regime interactions. One example of such a niche interaction is the participatory plant-breeding approach, which has been adopted in bean research by the relevant institutions in Costa Rica. In addition, the gap between formal and informal stakeholders in the seed sector, from the public and commercial sectors, has been narrowed thanks to the PITTA-Frijol program.

Family farmers in the Brunca region have gained autonomy by growing high-quality seeds, which are a crucial input for bean production. For several scholars, the traditional division between the formal and informal seed systems favors intellectual property rights, undermining the autonomy and livelihoods of family farmers [79–82,90–92]. PITTA-Frijol has built a close dialogue between formal and informal actors from the private and public sectors, enabling coordination between production, supply chains, and resource management with the participation of family farmers.

The interaction with research and commercialization units has the potential to build mutual trust and respect and contribute to the explicit recognition of farmers’ traditional knowledge. This seems to be a clear enabler for farmers’ organizations to engage in participatory research and to play a crucial role in promoting innovations, capabilities, and income generation among family farmers.

What are the shortcomings of the inclusive governance of “niche” innovations in the bean system that may limit the realization of just transitions in family farming?

Inequality and fragmented attention to intergenerational issues are limitations for a just transition in family farming in the Brunca region of Costa Rica. According to [78,79,92] and [30], addressing the root causes of injustice in food systems requires plant breeders from public institutions to use their influence to promote equality both during the process and as a goal for plant-breeding outcomes. Unequal approaches normalize unequal power relations, and higher attention to immediate incomes has often led to preserving social inequalities [67,81–84]. Individuals, including youth, may have limited opportunities to exercise agency as food consumers, farmers, or workers in food systems due to the limited opportunities given by the power structures of contemporary food systems [91,93,94].

PITTA-Frijol is struggling to strike a balance between short-term income generation and long-term on-farm biodiversity conservation [95–97]. According to [80,95–97] if there are tensions for the achievement of different elements of justice, it is crucial to strike a balance between different dimensions of justice for the governance of transitions in agri-food systems.

According to [71,72,81], farmers’ diverse agroecosystems have proven to have a high degree of stability and adaptability to deal with harsh weather conditions and satisfy farmers’ needs in critical times. The reciprocal dependence between agriculture and diversity may be undermined if farmers place a low priority on protecting agro-biodiversity on farms [82–84]. The limited attention paid to on-farm agro-biodiversity conservation by family farmers, as observed in the case study, is a current limitation of bean research that may compromise the potential to meet the future needs of family farming.

6. Conclusions and Recommendations

Our findings show that inclusive governance for niche innovations with family farmers contributes to the realization of just-transition principles such as recognition, participation,

and distributional justice. However, it falls short of addressing equality and intergenerational perspectives.

Niche and regime interactions from innovations in our case study are mainly based on institutional anchoring for innovations such as participatory plant breeding and the production of quality seeds by farmer organizations. However, niche and regime interactions are restricted by the lack of participation of family farmers in national decision-making, as well as by the poor participation of women and young farmers at all levels. The limited participation of female and young farmers in niche innovations, as well as in decision-making, limits the opportunities for gender equality in family farming.

Just transitions in family farming are also hampered by farmers' preference for short-term income over preserving agro-biodiversity on the farms in the long term. The inclusive governance of niche innovations with family farmers should strike a balance between short-term income goals and a long-term vision for agro-biodiversity conservation on farms. Furthermore, mechanisms to facilitate inclusive and equal decision-making should be encouraged to foster just transitions in family farming, both at the local and national scales. The participation of women farmers and youth in decision-making in family farming can be improved if the government orients its strategic visions toward reducing gender and intergenerational gaps. This should be followed by adequate funding at the local and national levels.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su16177433/s1>. Annex 1. Interview guide.

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Informed Consent Statement: Prior informed consent was obtained from all interviewed subjects participating in the study.

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References

1. Lee, H.; Calvin, K.; Dasgupta, D.; Krinner, G.; Mukherji, A.; Thorne, P.; Trisos, C.; Romero, J.; Aldunce, P.; Barrett, K.; et al. Synthesis Report of the IPCC Sixth Assessment Report (AR6). 2023. Available online: <https://www.ipcc.ch/report/sixth-assessment-report-cycle/> (accessed on 1 July 2024).
2. Pandey, S.C.; Modi, P.; Pereira, V.; Wamba, S.F. Empowering small farmers for sustainable agriculture: A human resource approach to SDG-driven training and innovation. *Int. J. Manpow.* 2024; *ahead-of-print*. [CrossRef]
3. Geels, F.W. Socio-technical transitions to sustainability: A review of criticisms and elaborations of the Multi-Level Perspective. *Curr. Opin. Environ. Sustain.* 2019, 39, 187–201. [CrossRef]
4. White, D. Just Transitions/Design for Transitions: Preliminary Notes on a Design Politics for a Green New Deal. *Capital. Nat. Social.* 2020, 31, 20–39. [CrossRef]
5. Huttunen, S.; Turunen, A.; Kaljonen, M. Participation for Just Governance of Food-System transition. *Sustain. Sci. Pract. Policy* 2022, 18, 500–514. [CrossRef]
6. Bui, S.; Costa, I.; De Schutter, O.; Dedeurwaerdere, T.; Hudon, M.; Feyereisen, M. Systemic ethics and inclusive governance: Two key prerequisites for sustainability transitions of agri-food systems. *Agric. Hum. Values* 2019, 36, 277–288. [CrossRef]
7. Ensor, J.; de Bruin, A. The role of learning in farmer-led innovation. *Agric. Syst.* 2022, 197, 103356. [CrossRef]
8. Ortiz, W.; Vilsmaier, U.; Osorio, Á.A. The diffusion of sustainable family farming practices in Colombia: An emerging sociotechnical niche? *Sustain. Sci.* 2018, 13, 829–847. [CrossRef]

9. Tschersich, J.; Kok, K.P.W. Deepening democracy for the governance toward just transitions in agri-food systems. *Environ. Innov. Soc. Transit.* **2022**, *43*, 358–374. [CrossRef]
10. Tribaldos, T.; Kortetmäki, T. Just transition principles and criteria for food systems and beyond. *Environ. Innov. Soc. Transit.* **2022**, *43*, 244–256. [CrossRef]
11. Kivimaa, P.; Boon, W.; Hyysalo, S.; Klerkx, L. Towards a typology of intermediaries in sustainability transitions: A systematic review and a research agenda. *Res. Policy* **2019**, *48*, 1062–1075. [CrossRef]
12. Gaitán-Cremaschi, D.; Klerkx, L.; Aguilar-Gallegos, N.; Duncan, J.; Pizzolón, A.; Dogliotti, S.; Rossing, W.A. Public food procurement from family farming: A food system and social network perspective. *Food Policy* **2022**, *111*, 102325. [CrossRef]
13. Ortiz, R.; Peris, J. The Role of Farmers & Umbrella Organizations in Building Transformative Capacity around Grassroots Innovations in Rural Agri-Food Systems in Guatemala. *Sustainability* **2022**, *14*, 2695. [CrossRef]
14. Genus, A.; Coles, A.-M. Rethinking the multi-level perspective of technological transitions. *Res. Policy* **2008**, *37*, 1436–1445. [CrossRef]
15. Wang, X.; Lo, K. Just transition: A conceptual review. *Energy Res. Soc. Sci.* **2021**, *82*, 102291. [CrossRef]
16. Schlosberg, D. *Defining Environmental Justice: Theories, Movements, and Nature*; Oxford University Press: Oxford, UK, 2007.
17. Kaljonen, M.; Kortetmäki, T.; Tribaldos, T.; Huttunen, S.; Karttunen, K.; Maluf, R.S.; Niemi, J.; Saarinen, M.; Salminen, J.; Vaalavuo, M.; et al. Justice in transitions: Widening considerations of justice in dietary transition. *Environ. Innov. Soc. Transit.* **2021**, *40*, 474–485. [CrossRef]
18. McCauley, D.; Heffron, R. Just transition: Integrating climate, energy and environmental justice. *Energy Policy* **2018**, *119*, 1–7. [CrossRef]
19. El Bilali, H. The Multi-Level Perspective in Research on Sustainability Transitions in Agriculture and Food Systems: A Systematic Review. *Agriculture* **2019**, *9*, 74. [CrossRef]
20. Geels, F.W. From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Res. Policy* **2004**, *33*, 897–920. [CrossRef]
21. Fitzgerald, L.; Davies, A.R. Creating Fairer Futures for Sustainability Transitions. Available online: <https://compass.onlinelibrary.wiley.com/doi/full/10.1111/gec3.12662> (accessed on 23 April 2023).
22. Loo, C. Towards a More Participative Definition of Food Justice. *J. Agric. Environ. Ethics* **2014**, *27*, 787–809. [CrossRef]
23. Lamine, C.; Darnhofer, I.; Marsden, T.K. What enables just sustainability transitions in agrifood systems? An exploration of conceptual approaches using international comparative case studies. *J. Rural Stud.* **2019**, *68*, 144–146. [CrossRef]
24. Ortiz-Valverde, R.O.; Mesías, P.A.; Peris-Blanes, J. Just transitions through agroecological innovations in family farming in Guatemala: Enablers and barriers towards gender equality. *Environ. Innov. Soc. Transit.* **2022**, *45*, 228–245. [CrossRef]
25. Leeuwis, C.; Boogaard, B.; Atta-Krah, K. How food systems change (or not): Governance implications for system transformation processes. *Food Secur.* **2021**, *13*, 761–780. [CrossRef] [PubMed]
26. Bui, S.; Cardona, A.; Lamine, C.; Cerf, M. Sustainability transitions: Insights on processes of niche-regime interaction and regime reconfiguration in agri-food systems. *J. Rural Stud.* **2016**, *48*, 92–103. [CrossRef]
27. Murphy, S.P.; Cannon, S.M.; Walsh, L. Just transition frames: Recognition, representation, and distribution in Irish beef farming. *J. Rural Stud.* **2022**, *94*, 150–160. [CrossRef]
28. Schlosberg, D. Theorising environmental justice: The expanding sphere of a discourse. *Environ. Politics* **2013**, *22*, 37–55. [CrossRef]
29. Menton, M.; Larrea, C.; Latorre, S.; Martínez-Alier, J.; Peck, M.; Temper, L.; Walter, M. Environmental justice and the SDGs: From synergies to gaps and contradictions. *Sustain. Sci.* **2020**, *15*, 1621–1636. [CrossRef]
30. Timmermann, C. The Multiple Dimensions of Social Justice Affected by Agricultural Innovation. In *Social Justice and Agricultural Innovation*; Timmermann, R.C., Ed.; The International Library of Environmental, Agricultural and Food Ethics; Springer International Publishing: Cham, Switzerland, 2020; pp. 1–26. [CrossRef]
31. Manono, B.O. New Zealand Dairy Farm Effluent, Irrigation and Soil Biota Management for Sustainability: Farmer Priorities and Monitoring. Available online: <https://www.tandfonline.com/doi/full/10.1080/23311932.2016.1221636#abstract> (accessed on 16 August 2024).
32. Danial, D.; Parlevliet, J.; Almekinders, C.; Thiele, G. Farmers' Participation and Breeding for Durable Disease Resistance in the Andean Region. *Euphytica* **2007**, *153*, 385–396. [CrossRef]
33. van Bueren, E.T.L.; Struik, P.C.; van Eekeren, N.; Nuijten, E. Towards resilience through systems-based plant breeding. A review. *Agron. Sustain. Dev.* **2018**, *38*, 42. [CrossRef]
34. Nandi, R.; Nedumaran, S. Understanding the Aspirations of Farming Communities in Developing Countries: A Systematic Review of the Literature. *Eur. J. Dev. Res.* **2021**, *33*, 809–832. [CrossRef]
35. Velicu, I.; Barca, S. The Just Transition and its work of inequality. *Sustain. Sci. Pract. Policy* **2020**, *16*, 263–273. [CrossRef]
36. Holland, B. Procedural justice in local climate adaptation: Political capabilities and transformational change. *Environ. Politics* **2017**, *26*, 391–412. [CrossRef]
37. York, A.; Yazar, M. Leveraging shadow networks for procedural justice. *Curr. Opin. Environ. Sustain.* **2022**, *57*, 101190. [CrossRef]
38. Young, I.M.; Allen, D.S. *Justice and the Politics of Difference*; Paperback Reissue; Princeton University Press: Princeton, NJ, USA, 2011.

39. Timmermann, C. Agricultural Innovation and Justice in Exchange: Beyond Fair Rewards and Adequate Access. In *Social Justice and Agricultural Innovation*; Timmermann, R.C., Ed.; The International Library of Environmental, Agricultural and Food Ethics; Springer International Publishing: Cham, Switzerland, 2020; pp. 73–97. [CrossRef]
40. Anderson, C.R.; Bruil, J.; Chappell, M.J.; Kiss, C.; Pimbert, M.P. From Transition to Domains of Transformation: Getting to Sustainable and Just Food Systems through Agroecology. *Sustainability* **2019**, *11*, 5272. [CrossRef]
41. Geels, F.W.; Schot, J. Typology of sociotechnical transition pathways. *Res. Policy* **2007**, *36*, 399–417. [CrossRef]
42. Köhler, J.; Geels, F.W.; Kern, F.; Markard, J.; Onsongo, E.; Wiczorek, A.; Alkemade, F.; Avelino, F.; Bergek, A.; Boons, F.; et al. An agenda for sustainability transitions research: State of the art and future directions. *Environ. Innov. Soc. Transit.* **2019**, *31*, 1–32. [CrossRef]
43. Rattunde, F.; Weltzien, E.; Sidibé, M.; Diallo, A.; Diallo, B.; Brocke, K.V.; Nebié, B.; Touré, A.; Traoré, Y.; Sidibé, A.; et al. Transforming a traditional commons-based seed system through collaborative networks of farmer seed-cooperatives and public breeding programs: The case of sorghum in Mali. *Agric. Hum. Values* **2021**, *38*, 561–578. [CrossRef]
44. Flora, C.B. Seeds of Transition: Essays on Novelty Production, Niches and Regimes in Agriculture. *J. Environ. Qual.* **2005**, *34*, 400–401. [CrossRef]
45. Schiller, K.; Godek, W.; Klerkx, L.; Poortvliet, P.M. Nicaragua’s agroecological transition: Transformation or reconfiguration of the agri-food regime? *Agroecol. Sustain. Food Syst.* **2020**, *44*, 611–628. [CrossRef]
46. Durán, Y.; Gómez-Valenzuela, V.; Ramírez, K. Socio-technical transitions and sustainable agriculture in Latin America and the Caribbean: A systematic review of the literature 2010–2021. *Front. Sustain. Food Syst.* **2023**, *7*, 1145263. [CrossRef]
47. Castro-Arce, K.; Vanclay, F. Transformative social innovation for sustainable rural development: An analytical framework to assist community-based initiatives. *J. Rural Stud.* **2020**, *74*, 45–54. [CrossRef]
48. McLean-Rodríguez, F.D.; Camacho-Villa, T.C.; Almekinders, C.J.M.; Pè, M.E.; Dell’acqua, M.; Costich, D.E. The abandonment of maize landraces over the last 50 years in Morelos, Mexico: A tracing study using a multi-level perspective. *Agric. Hum. Values* **2019**, *36*, 651–668. [CrossRef]
49. FAO; MAG. PITTA Frijol. Available online: https://ofinase.go.cr/wp-content/uploads/frijol_memoriapitta_2019.pdf (accessed on 1 July 2024).
50. Araya, F.C.M.; Hernández, F.J.C. Distribución Agroecológica de Enfermedades del Frijol en Costa Rica. *Agroecological Distribution of Bean Diseases in Costa Rica*. 2003. Available online: <https://repositorio.catie.ac.cr/handle/11554/6067> (accessed on 8 August 2024).
51. Gamboa, V.G.; Blanco, N.A.; Jiménez, R.M.; Bolaños, C.V. Puntos Calientes Agroproductivos y Zonas Multi-Productoras en Costa Rica: Distribución Cantonal 1905–2014. 2023. Available online: https://www.researchgate.net/publication/376310078_Puntos_calientes_agroproductivos_y_zonas_multi_productoras_en_Costa_Rica_distribucion_cantonal_1905-2014 (accessed on 14 July 2024).
52. Valerin, J. Informe Situacional Granos Básicos 2021–2019: Frijol y Maiz. Available online: <http://www.mag.go.cr/bibliotecavirtual/E16-11088.pdf> (accessed on 2 January 2023).
53. FAO Agriculture Organization (FAO); IFAD. United Nations Decade of Family Farming 2019–2028—Global Action Plan. 2019, p. 78. Available online: <https://openknowledge.fao.org/server/api/core/bitstreams/5479e317-17b9-428b-9963-ba88e681ff16/content> (accessed on 1 July 2024).
54. FAO; MAG. Plan Nacional Agricultura Familiar 2020–2030. Available online: <https://www.fao.org/faolex/results/details/es/c/LEX-FAOC208015/> (accessed on 1 July 2024).
55. C. R. Organic Agriculture Law. Ley-Agricultura-Familiar-Eng.pdf. Available online: https://parlatino.org/pdf/leyes_marcos/leyes/ley-agricultura-familiar-eng.pdf (accessed on 26 July 2023).
56. Verdejo, C.; Tapia-Benavente, L.; Schuller-Martínez, B.; Vergara-Merino, L.; Vargas-Peirano, M.; Silva-Dreyer, A.M. What you need to know about scoping reviews. *Medwave* **2021**, *21*, e8144. [CrossRef]
57. Tricco, A.C.; Lillie, E.; Zarin, W.; O’Brien, K.K.; Colquhoun, H.; Levac, D.; Moher, D.; Peters, M.D.J.; Horsley, T.; Weeks, L.; et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann. Intern. Med.* **2018**, *169*, 467–473. [CrossRef] [PubMed]
58. Page, M.J.; McKenzie, J.E.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ* **2021**, *372*, n71. [CrossRef] [PubMed]
59. Sebele-Mpofu, F.Y. Saturation Controversy in Qualitative Research: Complexities and Underlying Assumptions. A Literature Review. Available online: <https://www.tandfonline.com/doi/full/10.1080/23311886.2020.1838706> (accessed on 10 August 2024).
60. Occelli, M.; Mukerjee, R.; Miller, C.; Porciello, J.; Puerto, S.; Garner, E.; Guerra, M.; Gomez, M.I.; Tufan, H.A. A scoping review on tools and methods for trait prioritization in crop breeding programmes. *Nat. Plants* **2024**, *10*, 402–411. [CrossRef] [PubMed]
61. Quisumbing, A.; Cole, S.; Elias, M.; Faas, S.; Galiè, A.; Malapit, H.; Meinzen-Dick, R.; Myers, E.; Seymour, G.; Twyman, J. Measuring Women’s Empowerment in Agriculture: Innovations and evidence. *Glob. Food Secur.* **2023**, *38*, 100707. [CrossRef] [PubMed]
62. Njuki, J.; Eissler, S.; Malapit, H.; Meinzen-Dick, R.; Bryan, E.; Quisumbing, A. A review of evidence on gender equality, women’s empowerment, and food systems. *Sci. Innov. Food Syst. Transform.* **2023**, *165*.
63. Molina, C.A.; Dudenhoefer, D.; Polar, V.; Scurrah, M.; Ccanto, R.C.; Heider, B. Gender Roles and Native Potato Diversity Management in Highland Communities of Peru. *Sustainability* **2022**, *14*, 3455. [CrossRef]

64. Ceccarelli, S.; Grando, S. Diversity as a Plant Breeding Objective. *Agronomy* **2024**, *14*, 550. [[CrossRef](#)]
65. Louwaars, N.P. Plant breeding and diversity: A troubled relationship? *Euphytica* **2018**, *214*, 114. [[CrossRef](#)]
66. Khoury, C.K.; Brush, S.; Costich, D.E.; Curry, H.A.; De Haan, S.; Engels, J.M.; Guarino, L.; Hoban, S.; Mercer, K.L.; Miller, A.J.; et al. Crop genetic erosion: Understanding and responding to loss of crop diversity. *New Phytol.* **2022**, *233*, 84–118. [[CrossRef](#)]
67. Ficičyan, A.; Loos, J.; Sievers-Glotzbach, S.; Tschardtke, T. More than Yield: Ecosystem Services of Traditional versus Modern Crop Varieties Revisited. *Sustainability* **2018**, *10*, 2834. [[CrossRef](#)]
68. Vignola, R.; Esquivel, M.J.; Harvey, C.; Rapidel, B.; Bautista-Solis, P.; Alpizar, F.; Donatti, C.; Avelino, J. Ecosystem-Based Practices for Smallholders & Adaptation to Climate Extremes: Evidence of Benefits and Knowledge Gaps in Latin America. *Agronomy* **2022**, *12*, 2535. [[CrossRef](#)]
69. Engels, J.M.M.; Ebert, A.W. How Can We Strengthen the Global Genetic Resources' Conservation and Use System? *Plants* **2024**, *13*, 702. [[CrossRef](#)] [[PubMed](#)]
70. Engels, J.M.; Ebert, A.W. A Critical Review of the Current Global Ex Situ Conservation System for Plant Agrobiodiversity. II. Strengths and Weaknesses of the Current System and Recommendations for Its Improvement. *Plants* **2021**, *10*, 1557. [[CrossRef](#)]
71. Chable, V.; Nuijten, E.; Costanzo, A.; Goldringer, I.; Bocci, R.; Oehen, B.; Rey, F.; Fasoula, D.; Feher, J.; Keskitalo, M.; et al. Embedding Cultivated Diversity in Society for Agro-Ecological Transition. *Sustainability* **2020**, *12*, 784. [[CrossRef](#)]
72. Bravo-Peña, F.; Yoder, L. Agrobiodiversity and smallholder resilience: A scoping review. *J. Environ. Manag.* **2024**, *351*, 119882. [[CrossRef](#)]
73. Hufnagel, J.; Reckling, M.; Ewert, F. Diverse approaches to crop diversification in agricultural research. A review. *Agron. Sustain. Dev.* **2020**, *40*, 14. [[CrossRef](#)]
74. Acevedo, M.; Pixley, K.; Zinyengere, N.; Meng, S.; Tufan, H.; Cichy, K.; Bizikova, L.; Isaacs, K.; Ghezzi-Kopel, K.; Porciello, J. A scoping review of adoption of climate-resilient crops by small-scale producers in low- and middle-income countries. *Nat. Plants* **2020**, *6*, 1231–1241. [[CrossRef](#)]
75. Labeyrie, V.; Antona, M.; Baudry, J.; Bazile, D.; Bodin, Ö.; Caillon, S.; Leclerc, C.; Le Page, C.; Louafi, S.; Mariel, J.; et al. Networking agrobiodiversity management to foster biodiversity-based agriculture. A review. *Agron. Sustain. Dev.* **2021**, *41*, 4. [[CrossRef](#)]
76. Guzzon, F.; Rios, L.W.A.; Cepeda, G.M.C.; Polo, M.C.; Cabrera, A.C.; Figueroa, J.M.; Hoyos, A.E.M.; Calvo, T.W.J.; Molnar, T.L.; León, L.A.N.; et al. Conservation and Use of Latin American Maize Diversity: Pillar of Nutrition Security and Cultural Heritage of Humanity. *Agronomy* **2021**, *11*, 172. [[CrossRef](#)]
77. Nabuuma, D.; Reimers, C.; Hoang, K.T.; Stomph, T.; Swaans, K.; Raneri, J.E. Impact of seed system interventions on food and nutrition security in low- and middle-income countries: A scoping review. *Glob. Food Secur.* **2022**, *33*, 100638. [[CrossRef](#)]
78. Napolitano, C.; Clavijo, C.; Rojas-Bonzi, V.; Miño, C.I.; González-Maya, J.F.; Bou, N.; Giraldo, A.; Martino, A.; Miyaki, C.Y.; Aguirre, L.F.; et al. Understanding the conservation-genetics gap in Latin America: Challenges and opportunities to integrate genetics into conservation practices. *Front. Genet.* **2024**, *15*, 1425531. [[CrossRef](#)] [[PubMed](#)]
79. Hruska, A. Sustainable Seed Systems for Family Farming: Promoting More Inclusive Public Institutions—Lessons Learned from Mesoamerica. In *Community Seed Production*; FAO: Rome, Italy, 2015; pp. 105–112. [[CrossRef](#)]
80. Lusty, C.; Hamilton, R.S.; Guarino, L.; Richards, C.; Jamora, N.; Hawtin, G. Envisaging an Effective Global Long-Term Agrobiodiversity Conservation System That Promotes and Facilitates Use. *Plants* **2021**, *10*, 2764. [[CrossRef](#)]
81. Ceccarelli, S.; Guimarães, E.P.; Weltzien, E. *Plant Breeding and Farmer Participation*; FAO: Rome, Italy, 2009.
82. Almekinders, C.J.M.; Louwaars, N.P.; de Bruijn, G.H. Local seed systems and their importance for an improved seed supply in developing countries. *Euphytica* **1994**, *78*, 207–216. [[CrossRef](#)]
83. Ashby, J.; Polar, V. *The Implications of Gender Relations for Modern Approaches to Crop Improvement and Plant Breeding*; Routledge: London, UK, 2019; pp. 11–34. [[CrossRef](#)]
84. Weltzien, E.; Rattunde, F.; Christinck, A.; Isaacs, K.; Ashby, J. Gender and Farmer Preferences for Varietal Traits. In *Plant Breeding Reviews*; John Wiley & Sons, Ltd.: Hoboken, NJ, USA, 2019; pp. 243–278. [[CrossRef](#)]
85. Berkhout, F.; Wiczorek, A.J.; Raven, R. Avoiding Environmental Convergence: A Possible Role for Sustainability Experiments in Latecomer Countries? *Inst. Econ.* **2011**, *3*, 367–385.
86. Park, C.M.Y.; Picchioni, F.; Franchi, V. Feminist approaches to transforming food systems: A roadmap towards a socially just transition. *Trop. Agric. Assoc. J. Ag4Dev* **2021**, *42*, 17–19.
87. Ramos-Mejía, M.; Franco-García, M.-L.; Jauregui-Becker, J.M. Sustainability transitions in the developing world: Challenges of socio-technical transformations unfolding in contexts of poverty. *Environ. Sci. Policy* **2018**, *84*, 217–223. [[CrossRef](#)]
88. Bizikova, L.; Nkonya, E.; Minah, M.; Hanisch, M.; Turaga RM, R.; Speranza, C.I.; Timmers, B. A Scoping Review of the Contributions of Farmers' Organizations to Smallholder Agriculture. *Nat. Food* **2020**, *1*, 620–630. [[CrossRef](#)]
89. Polita, F.S.; Madureira, L. Evolution of Short Food Supply Chain Innovation Niches and Its Anchoring to the Socio-Technical Regime: The Case of Direct Selling through Collective Action in North-West Portugal. *Sustainability* **2021**, *13*, 3598. [[CrossRef](#)]
90. Almekinders, C.J.M.; Hardon, J. Bringing Farmers Back into Breeding: Experiences with Participatory Plant Breeding and Challenges for Institutionalisation. Agromisa, Report. 2006. Available online: <https://cgspace.cgiar.org/handle/10568/51557> (accessed on 6 January 2023).
91. Tschersich, J. Norm conflicts as governance challenges for Seed Commons: Comparing cases from Germany and the Philippines. *Earth Syst. Gov.* **2021**, *7*, 100097. [[CrossRef](#)]

92. Westengen, O.T.; Winge, T. *Farmers and Plant Breeding: Current Approaches and Perspectives*; Routledge: London, UK, 2019.
93. Glover, D.; Sumberg, J. Youth and Food Systems Transformation. *Front. Sustain. Food Syst.* **2020**, *4*, 547057. [[CrossRef](#)]
94. Glover, D.; Sumberg, J.; Ton, G.; Andersson, J.; Badstue, L. Rethinking Technological Change in Smallholder Agriculture. *Outlook Agric.* **2019**, *48*, 169–180. [[CrossRef](#)]
95. Chappell, M.J.; LaValle, L.A. Food security and biodiversity: Can we have both? An agroecological analysis. *Agric. Hum. Values* **2011**, *28*, 3–26. [[CrossRef](#)]
96. Harkness, C.; Areal, F.J.; Semenov, M.A.; Senapati, N.; Shield, I.F.; Bishop, J. Stability of farm income: The role of agricultural diversity and agri-environment scheme payments. *Agric. Syst.* **2021**, *187*, 103009. [[CrossRef](#)]
97. Riechers, M.; Balázsi, Á.; Betz, L.; Jiren, T.S.; Fischer, J. The erosion of relational values resulting from landscape simplification. *Landsc. Ecol.* **2020**, *35*, 2601–2612. [[CrossRef](#)]

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