



Uncovering the Landscape of Participatory Research in Agricultural Innovation: A Scoping Review

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ABSTRACT

Innovative farming practices to mitigate environmental impacts are critical. Participatory approaches, which actively involve farmers in co-developing solutions, are vital for overcoming resistance and enabling successful, context-specific agricultural innovations. This scoping review maps participatory methodologies in agricultural innovation, identifying their key characteristics and factors contributing to their success. We used PRISMA-ScR guidelines and conducted a systematic search on the databases Scopus and Web of Science, out of 807 studies published between 1994 and 2022, 34 met our criteria. Data extraction involved coding theoretical frameworks, project phases, duration, participant types, barriers, facilitators, innovations, and modes of participation into categories: contributory, collaborative, and co-created. We used Atlas.ti for coding transparency and analysis. Projects spanned 26 countries, primarily in Europe and Africa, with an average duration of 5 years. Innovative practices were grouped into the following themes: climate change, crop choice, irrigation, pest management, and technical improvements. Most projects involved farmers in defining research questions. Participants included farmers, experts, NGOs, private companies, and public organizations.

Successful projects actively involve stakeholders, especially farmers, from idea generation to implementation, and benefit from strong relationships and informal, flexible interactions. Intermediaries, like extension agents, are effective in bridging gaps and fostering trust. Our review indicates the need for clearer reporting guidelines to enhance comparability and effectiveness across participatory research.

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INTRODUCTION

The global demand for agricultural products is rising steadily, yet the capacity to fulfill this demand is facing growing challenges due to the impacts of climate change (Arora 2019; Malhi et al. 2021). However, agriculture also contributes significantly to the human-induced effects on climate change (Crippa et al. 2021; Foley et al. 2011). Various stakeholders, including governments, companies, scientists, and citizens, are actively seeking to innovate farming practices to address the pressing issue of climate change (Berrang-Ford et al. 2019). Such innovation can address global challenges by reducing greenhouse gas emissions (GHG) (Galanakis 2024), avoiding land-use conflicts while ensuring future food production through practices like agrivoltaics (Bojnec et al. 2024), agroforestry (Fatima et al. 2024), or introducing new crops (Shams et al. 2024). However, the adoption and maintenance of innovative practices can face resistance from farmers due to socio-economic, agricultural, and psychological factors (Rosário et al. 2022). Involving farmers and incorporating their needs and knowledge into the development of these changes through collaborative and participatory methods can mitigate resistance to innovative practices (Van de Gevel et al. 2020). Participatory approaches can also boost the creative process of research (Reed et al. 2023), and ensure local relevance of the innovations. In order to realize such bottom-up approaches, participation must be implemented effectively, with attention to the specific context and consideration of relevant stakeholders (Jennings 2005). By integrating diverse stakeholders in innovations and transitions, participatory methodologies can nurture the research process, aiding in navigating the complexities of contextual transformation and global innovations (Anandajayasekeram 2022).

Collaboration between the scientific community and lay stakeholders in agricultural sectors has existed for many decades, motivated by both ethical considerations and the pursuit of more effective outcomes (Altieri and Nicholls 2017). However, ambiguities persist owing to the diverse aims of participatory approaches, ranging from applied knowledge production to basic research, and methodologies exhibit significant variability in terms of timing, actors involved, modes of participation, and theoretical frameworks (Jennings 2005). These elements are interdependent, and choices made in these processes—for instance concerning which actors to involve—will be influenced by and will influence the modes of participation (Ebitu et al. 2021). This implies that if participatory approaches are aimed at developing and/or supporting innovation in agricultural practices, the type of innovation itself can impact other aspects of the participatory process.

Success in participatory approaches requires not only technical expertise but also knowledge of process and methodologies to navigate the dynamics within specific contexts and among various actors, influenced by the participatory nature and application context (Sense, 2007). Therefore, it is essential to systematically examine and compare definitions of participatory approaches in the context of agricultural innovation. This allows for the identification of key elements that contribute to the ethical and pragmatic success of these methods (Grant and Osanloo 2014).

Existing literature provides theoretical frameworks that guide both the practical and ethical aspects of these projects, helping evaluate theoretical models and project outcomes, including participation modes (Bonney et al. 2009; Irwin 1995; Minkler and Wallerstein 2011). Notably, Bonney and colleagues (2009) have provided a clear definition of the potential stages of scientific research in which citizens can actively participate. These stages are outlined in ten steps, ranging from defining research questions to discussing results. The authors also discuss how projects can be categorized into three macro families. *Contributory projects*, in which citizens primarily participate as data collectors; *collaborative projects*, in which citizens can also be involved in the stages of defining or redefining research methods; and *co-created projects*, in which participants are engaged in all stages. Theoretical frameworks also tend to outline specific modes of participation. For example, so called citizen science projects frequently engage farmers in tasks such as animal sightings or soil surveys, enabling scientists to analyze and interpret the data collected (Irwin 1995; Ryan et al. 2018). Compared with approaches where participation is mostly limited to data collection, participatory action research promotes deeper collaboration through alternating phases of reflection and action, ensuring maximum participant involvement (Cuéllar-Padilla & Calle-Collado, 2011; McIntyre, 2008). While there have been attempts to categorize and systematically classify this kind of research project, such as the systematization of citizen science projects for sustainable agriculture (Ebitu et al. 2021) or agroecological transitions projects (Sachet et al. 2021), the authors of this scoping review are unaware at the time of writing of any systematic reviews specifically focusing on projects aimed at innovative changes in farming practices.

Therefore, recognizing the necessity to enhance the design of innovative practices involving citizens, this scoping review aims to map participatory approaches used in agricultural systems, analyzing their key characteristics and indicators of success in promoting innovation in production practices. We here use the term “agricultural system” to refer to a broad spectrum of

agricultural activities and settings encompassing any context where farming and land cultivation activities are central to the research scope. Central to this review are studies that include the direct involvement of farmers, whether they are agricultural entrepreneurs or laborers, as active participants in the research process. While the literature remains heterogeneous in defining participatory approaches and the methods to conduct such projects, for the purposes of this review, we define “participatory” as requiring the engagement of farmers in at least 1 of the 10 operations of scientific research outlined by Bonney et al. (2009). The ambition of this scoping review is to lay the groundwork for evidence-based guidelines able to orient the participatory research methods and techniques for innovation in agriculture. To achieve this goal, we propose to create a taxonomy of current participatory research practices in agricultural innovation by: 1) analyzing the innovations proposed in these papers, 2) identifying the types of participants involved, 3) exploring the degree and manner of participation associated with participants, 4) examining the theoretical frameworks that can guide these processes, and finally, 5) identifying the facilitators and barriers to the success of these projects.

METHODS

This scoping review follows the guidelines outlined in the Preferred Reporting Items for scoping reviews and Meta-Analyses (PRISMA-ScR) extension for scoping reviews (Tricco et al. 2018), and was conducted in accordance with these guidelines in the following steps.

FORMULATING THE RESEARCH QUESTION

The review aimed to answer the question “How are farmers involved in research activities within agricultural systems to promote innovation in agricultural practices?”

IDENTIFY RELEVANT STUDIES

Two databases were considered to search for relevant papers: Scopus and Web of Science. The search string was formulated based on the concepts “participatory methods,” “agriculture,” and “innovations,” and we searched in title, abstract, and keywords. The search terms, particularly those related to innovation, were intentionally selected as potential synonyms. This approach aimed at casting a wide net to ensure the inclusion of a broad range of papers that might discuss innovation in diverse ways. The rationale was to conduct an exhaustive search and allow for a manual refinement process, whereby non-relevant studies would be excluded during the screening phase. A search was undertaken in February 2023 using the following search string:¹

TITLE-ABS-KEY (agri* OR smallholder* OR farm*) AND TITLE-ABS-KEY (“action research” OR “active citizenship” OR “citizenscience” OR “collaborative research” OR “community based participatory research” OR “community-based research” OR “community-led research” OR “community-participatory research” OR “cooperative research” OR crowdsourcing OR “participat* research” OR “participatory action research” OR “participatory assessment” OR “participatory co-creation” OR “participatory co-design” OR “participatory evaluation” OR “participatory exercise” OR “participatory method” OR “participatory monitoring” OR “participatory process” OR “participatory science” OR “participatory study” OR “stakeholder-led research”) AND TITLE-ABS-KEY (“innovation model” OR “innovation framework” OR “innovation” OR restructuring OR renovation OR modernization OR remodelling OR revolution OR recasting OR reorgan*).

STUDY SELECTION

The resulting unique papers were uploaded to Rayyan (Uzzani et al. 2016), a collaborative software used for conducting blind-mode screening in systematic reviews. This enabled researchers to independently assess each paper, ensuring that at least two researchers reviewed each paper.

All papers needed to meet the following inclusion criteria:

1. Participants: Studies were included if they were conducted in an agricultural system and involved farmers (here defined as individuals who run the farm themselves, or who are employed as farm workers).
2. Outcomes: Studies aimed to enact changes in production or resource management practices.
3. Concept under investigation: Farmers or producers were involved/participating in at least 1 of the 10 operations in which citizens can be involved based on the definition of the possible models for public participation in scientific research as described by Bonney et al. (2009).
4. Study design: Publications were original research papers describing the collection of primary data and/or an intervention and were not any form of review.
5. Characteristics: Studies without temporal restrictions were considered for inclusion.
6. Language: Studies not in English were excluded. English was chosen for its global accessibility, comprehensive literature coverage, and widespread scientific convention.

The titles and abstracts of all retrieved articles were independently reviewed by two researchers who made inclusion decisions based on the predefined criteria through

consensus. Subsequently, two authors reviewed all articles selected for full-text review. In cases where conflicts arose during the full-text review, a third researcher was engaged in discussions until consensus was reached.

COLLATING AND SUMMARIZING THE RESULTS

A standardized data extraction sheet was developed and completed by two researchers containing the following elements:

1. Theoretical framework used in participatory research: whether the authors explicitly mentioned a theoretical framework that guided how they participated in their project.
2. Phases of the project: when named and cited, the various phases of the project were reported.
3. Duration of the project: if timeframe was clearly declared by authors or if it could be reconstructed from the dates of the project phases.
4. Type of participants included: all the participants involved in the project.
5. Barriers: what hindered the development of the project; only problems explicitly stated by the authors were considered.
6. Facilitators: what authors stated enabled or supported project development.

7. Innovation pursued: the change in production practices sought through participatory design.
8. Modes of participation: this classification was derived from the models for public participation in scientific research as described by Bonney et al. (2009), who outline ten steps through which citizens can engage in scientific research projects. These steps are illustrated in [Figure 1](#).

ANALYSIS PROCEDURE

The researchers labeled the above eight elements on the text with the support of Atlas.ti and then extracted and reported them in a data sheet for analysis. The country where the study was conducted, project timeframe, theoretical frameworks of participation, and research project phases were mapped and described narratively. After being labeled and extracted from each paper, the ten steps defining modes of participation were summarized, and then classified into three steps, contributory, collaborative, and co-created, and were subsequently discussed in narrative form. According to the original models by Bonney et al. (2009), a project is considered contributory if citizens are involved only in stage 5, and possibly in stages 7 and 9; collaborative if citizens are involved in stages 5, 6, 7, and possibly 4, 8, and 9; and co-created if citizens participate in all ten stages.

1. choosing or defining questions/issues,
2. gathering information and resources,
3. developing explanations,
4. designing data collection or implementation methodologies,
5. collecting data or implementing experiments,
6. analyzing samples,
7. analyzing data,
8. interpreting data,
9. disseminating conclusions or translating results into action,
10. engaging in discussions about the results and formulating new questions.

Figure 1 Ten steps of public participation in scientific research projects, adapted from Bonney et al. (2009).

However, this classification was adapted to better fit the projects reviewed, as Bonney's models was developed within the context of citizen science, which generally aims to produce new knowledge. In contrast, the studies included in this review are focused on changes in production practices and innovation. This shift in focus alters the role of farmer participation, as farmers in these projects are more engaged in implementing changes and assessing outcomes with researchers than in merely collecting or analyzing data. Consequently, the task of data analysis tends to fall more naturally within the responsibilities of the scientific team, without necessarily excluding farmers from the process.

This disconnect in applying Bonney's models could be attributed to the supportive role of science in these types of projects, where the objective is to encourage practical changes rather than to only gather data. As a result, the two pivotal phases for determining participation are phase one, defining the research question, and phase four, co-designing the methodology. If farmers are not involved in either phase, the project is classified as contributory; if they are involved in one of the two, it is collaborative; if they participate in both, it is co-created.

Although the stages of scientific research in which farmers can participate are not equivalent categories, a participation level from 1 to 10 was assigned to each study based on the extent of farmer involvement across different research phases.

Finally, barriers and facilitators were identified through a two-step coding process. First, instances explicitly labeled by the authors of the reviewed papers as barriers or facilitators to the participatory process were coded in a top-down fashion. Then, within each identified barrier or facilitator, a bottom-up coding process was conducted to extract specific descriptors from the text. These descriptors were later thematically grouped during the analysis phase.

Data extraction was made with the support of Atlas.ti (Smit and Scherman 2021) software for qualitative analysis, to increase the transparency of the coding by making them public. Those files are available on request to the authors while the extraction and analysis sheet is available in the supplemental materials and is described in the section 2 of Supplemental File 1: Appendix A.

SEARCH RESULTS

A total of 807 papers were initially identified from Scopus and Web of Science. After the screening processes, 34 papers, published over a period from 1994 to 2022, were selected as detailed in the prisma flow chart depicted in Figure 2. Most of the papers (58) assessed for eligibility that were excluded were research projects not aimed at innovation and thus changing farmers' production

practices. Another 49 papers were excluded because they did not collect primary data or were not direct reporting of an agricultural innovation project, such as reviews or commentary papers.

FINDINGS

GENERAL CHARACTERISTICS: COUNTRIES AND PROJECTS' TIMEFRAMES

Projects were conducted in 26 different countries; two projects included sites that spanned multiple countries (Andrieu et al. 2019; Dolinska et al. 2020). The majority of the countries were in Europe (12) and Africa (12), with Italy having the most studies overall (4).

The average duration of projects was approximately 5 years, with a range from a minimum of 8 days to a maximum of 22 years, although data for 4 cases could not be retrieved from the paper. In particular, 2 projects lasted less than 1 month (Dorward et al. 2003; Kimeli et al. 2017), 4 were finished in 1 year (Berthet et al. 2020; Burbi et al. 2016; Calliera et al. 2021; Chowdhury et al. 2010), 8 in 2 years (Andrieu et al. 2019; Carton et al. 2022; Krupnik et al. 2012; Osorio-García et al. 2019; Pagliarino et al. 2020; Périnelle et al. 2021; Sturdy et al. 2008; Valdivia et al. 2014), 7 in 3 years (Aare et al. 2021; Ayre and Nettle 2017; Bloch et al. 2016; Dlott et al. 1994; Dolinska et al. 2020; Orlando et al. 2020; Poussin et al. 2006), 3 in 4 years (Ciaccia et al. 2019; Duker et al. 2020; Mitchell et al. 2001), 2 in 5 years (Srinivasan et al. 2022; Temple et al. 2006), 1 in 7 years (Bhadana et al. 2015), 1 in 8 (Swiergiel et al. 2019) and 1 in 22 (Humphries et al. 2015).

It is important to note that the project duration typically does not include the preplanning phase carried out by researchers before involving other partners and participants.

TYPE OF INNOVATIONS PROMOTED

Each research project included was conducted with the aim of achieving an innovation in farming practices or resource management. These innovations were subsequently classified thematically into five main related themes of innovation: climate change, crop choice, irrigation, pesticides and herbicides, and technical improvement.

The most frequent innovations pursued in the included projects were related to crop choice and cultivation systems, for example, including more legume cultivation in farms (Carton et al. 2022; Périnelle et al. 2021) or planting trees in crop fields (Hocking and Islam 1994). Climate change-related projects address challenges such as Greenhouse Gas (GHG) mitigation (Burbi et al. 2016), or they strengthen the adaptive capacity of farmers (Kimeli

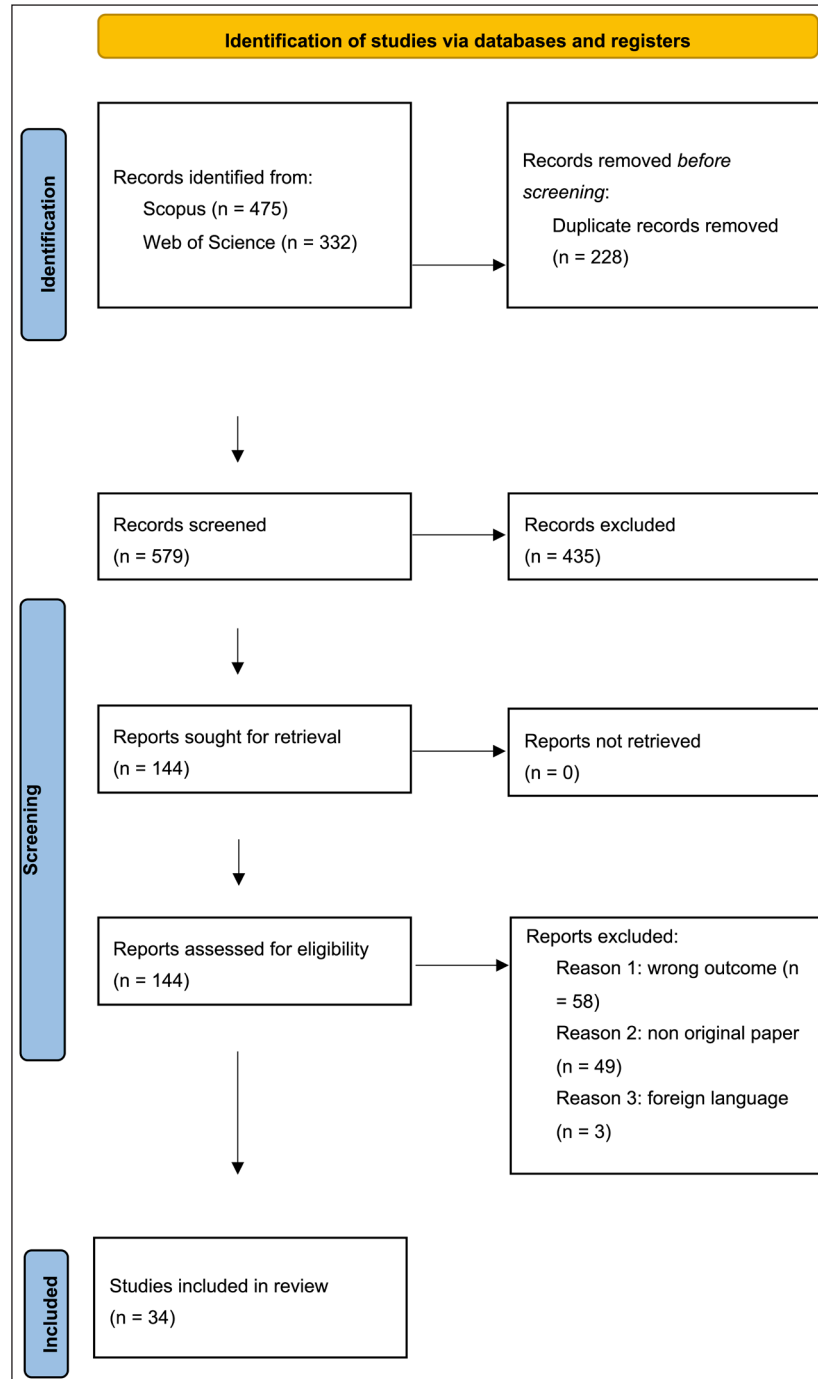


Figure 2 PRISMA flow diagram illustrating the study selection process.

et al. 2017). Practice improvement innovations were mainly related to improvement in rice cultivation (Bhadana et al. 2015; Orlando et al. 2020; Pagliarino et al. 2020; Ussivane and Ellwood 2019). Innovations related to irrigation were, for example, aimed at improving an irrigation district (Ayre and Nettle 2017) or increasing the food production with a change in irrigation scheme (Dolinska et al. 2020). Finally, innovations related to herbicides and pesticides mainly tried to reduce their use (Calliera et al. 2021; Della Rossa et al. 2022; Swiergiel et al. 2019).

Some projects were not primarily focused on introducing specific innovations, but rather on supporting the farming community in identifying challenges and collaboratively developing solutions to address them in an innovative way (Ciaccia et al. 2019). These projects did not necessarily prioritize scalability, but rather focused on the lessons learned in terms of science-citizen collaboration. However, there were cases where innovations were directly aimed at advancing scientific knowledge in a broader sense (Aare et al. 2021; Orlando et al. 2020).

TYPE OF INVOLVED PARTICIPANTS

In the analyzed papers, the reporting of participants varied across the studies. Some studies provided tables that specified the type and number of participants (e.g.: [Dlott et al. 1994](#); [Hocking and Islam 1994](#)). In other studies, participants could be identified only through descriptions of the research process (e.g.: [Chowdhury et al. 2010](#); [Dorward et al. 2003](#); [Humphries et al. 2015](#); [Srinivasan et al. 2022](#)).

A total of 75 different participants were coded and classified into 15 categories, which were further grouped into five main categories: citizens, experts, nongovernmental organizations (NGOs), private companies, and public organizations, as shown in [Table 1](#).

The *citizen* group consists of farmers, their associations, and members of the local community, all of which were present in every project considered. Notably, all the studies included smallholder farmers, a category of agricultural producers who typically operate on a smaller scale and are more vulnerable to socio-economic and environmental challenges. The category of *experts* was further divided into three main types: technicians, scientists, and facilitators. Technicians are professional advisors with specific expertise in agriculture-related areas, such as pest control advisors ([Mitchell et al. 2001](#)). Scientists refers to academics involved in the research in addition to the

authors of the paper. Facilitators, the most prevalent type, operate at the intersection of the other two categories and the citizens, often serving as extension agents. However, it is noteworthy that in certain cases, researchers themselves also engage in farming activities, such as in the case of Mas Masumoto ([Dlott et al. 1994](#)).

The NGOs involved primarily focus on community development and support. *Private companies* encompass a wide range of entities, including processors such as bakeries, suppliers of various products such as seeds, certification bodies (for products like wine), companies within the industrial supply chain, and investment firms. *Public organizations* predominantly consist of government agencies and environmental protection institutions.

THEORETICAL FRAMEWORK FOR PARTICIPATION AND RESEARCH STEPS

Except for one among the included studies ([Della Rossa et al. 2022](#)), which did not specify the theoretical framework adopted to guide the participatory approach design, a total of 27 theoretical frameworks emerged from 34 papers, as shown in [Table 1](#) in Supplemental File 1: Appendix A. However, the authors often state that while a theoretical framework inspired their work, it was adapted to suit the specific context and purpose.

In seven papers, it was not possible to clearly delineate the phases or the steps followed in the participatory research, whereas in the 27 cases in which it was possible, the majority of the participatory projects envision 3 phases (33.3%), 4 phases (18.5%), or 7 phases (18.5%), with a range that fell between 2 and 8 steps.

In two papers ([Ciaccia et al. 2019](#); [Pagliarino et al. 2020](#)), phases were indicated as a cyclic loop, and in one case subprojects were used instead of phases ([Swiergiel et al. 2019](#)). Finally, it should be taken into account that those steps were in some cases not considered a linear process but a series of overlapping phases that alternate continuously, as in the case of the data-information-knowledge-wisdom (DIKW) hierarchy approach that guided Orlando et al. ([2020](#)).

MODES OF PARTICIPATION

Participation in scientific research projects varied among the included papers. The average score obtained from the sum of the presence of the ten steps in which farmers could or could not be included in the research was 4.9, with a most frequent score of 6. Regarding extreme values, a score of 1 was observed in only one case, while no cases scored 10, which would represent full involvement of participants in every phase of the project, from research design to implementation. All projects included in our review, with the exception of two ([Carton et al. 2022](#);

CATEGORY	TYPES OF PARTICIPANTS	% OF PAPERS WITH PARTICIPANT TYPE
Citizens	Farmers	100%
	Farmers' associations	18%
	Local community	9%
Experts	Technicians	15%
	Scientists	24%
	Facilitators	41%
NGOs	NGOs	21%
Private companies	Processors	15%
	Suppliers	9%
	Certifying bodies	3%
	Industries	6%
	Investment companies	3%
Public organizations	Not specified private companies	3%
	Governing agencies	24%
	Environmental protection institutions	6%

Table 1 Distribution of participant categories and types in the reviewed papers. NGOs: nongovernmental organizations.

Périnelle et al. 2021), should be defined as contributory. The two phases in which farmers participated most frequently were the co-design of methodologies for data collection or experimental changes, and the definition of research questions or project-related issues. These phases imply co-creative participatory processes, even though citizens were not involved in all phases in any of the projects considered, and participation occurred in only one case (Pagliarino et al. 2020) across 8 out of 10 steps.

Moreover, compared with the projects described by Bonney and colleagues (2009), the research questions in these projects are often less specific and more driven by the practical problems within the context, with a clear objective of bringing about change. This aligns with the principles of action research and participatory research (Cuéllar-Padilla & Calle-Collado 2011; McIntyre 2008), where addressing real-world issues and involving stakeholders are essential elements.

Applying this classification to the pool of projects included in this study shows 5 contributory, 10 collaborative, and 19 co-created projects, as shown in Table 1 in Supplemental File 1: Appendix A.

BARRIERS AND FACILITATORS

Facilitators to project performance were identified in 20 papers, and 79 descriptors were used to code facilitator elements, which support the success of a participatory project. Those were then classified into 15 subthemes

(see Table 2 in Supplemental File 1: Appendix A). Barriers to project performance were cited in 23 papers, and 63 descriptors were used to code barriers to the success of participatory projects. These were classified into 11 subthemes (see Table 3 in Supplemental File 1: Appendix A). The 15 subthemes of facilitators and the 11 subthemes of barriers were both grouped into three overarching themes: a) *technical*, b) *relational*, and c) *cognitive*, as visually represented in Figure 3.

INFLUENCE OF PARTICIPATION MODES ON PROJECTS

Participatory approaches in agricultural innovation are widespread globally, as reflected by the diversity of nations represented in the studies. Nevertheless, a significant heterogeneity is evident among the projects included in our review, encompassing foundational rationales, methodological references, and desired outcomes. One approach to explore this diversity could be to compare the project’s participation type with the other extracted elements.

Regarding the types of innovations, there were notable co-occurrences between the modes of participation and the innovations promoted. Projects focused on technical improvements generally used contributory and collaborative approaches, reflecting the specific knowledge required for production practices. In contrast, projects addressing complex issues like climate change or

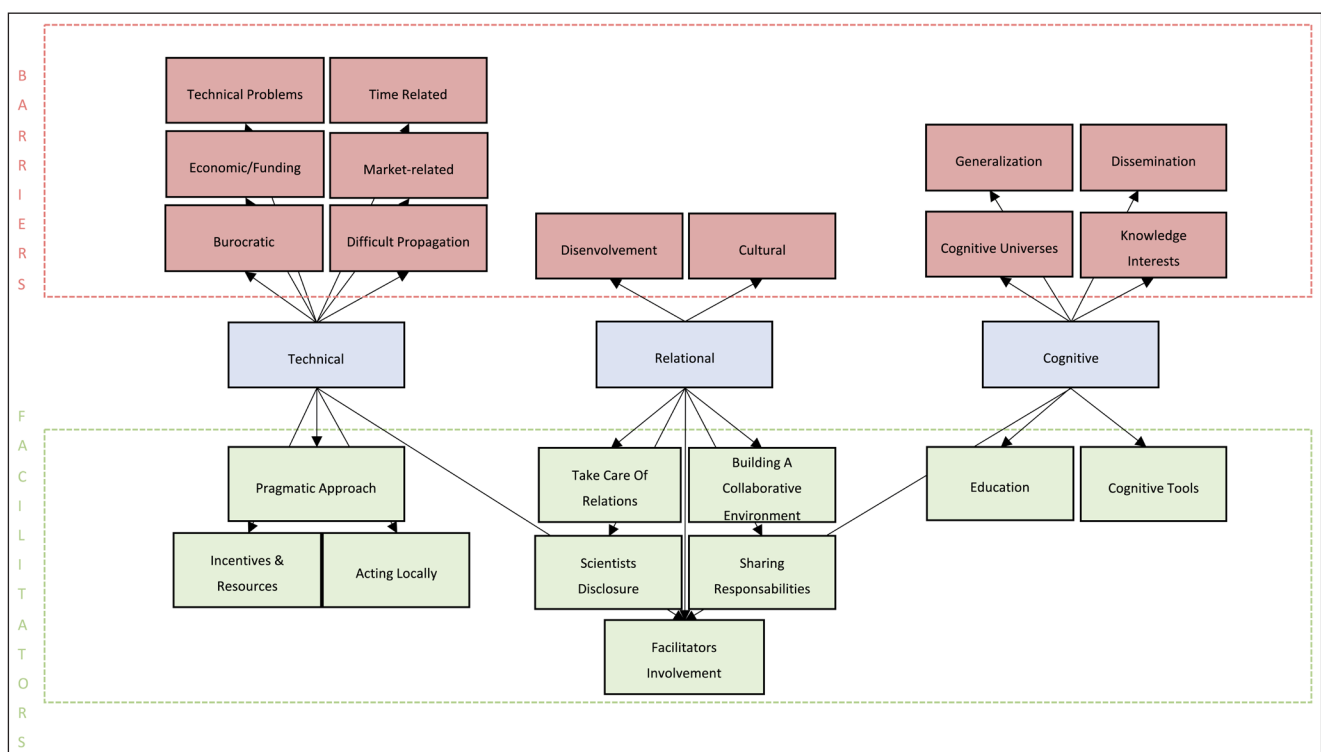


Figure 3 Classification of barriers and facilitators into overarching themes.

pesticide management often employed fully participatory approaches. Specifically, all projects within these themes involved participants in both defining research questions and designing the experimental processes.

When comparing the modes of participation with the theoretical frameworks of the projects analyzed, several clear distinctions emerged. Notably, projects using participatory action research (PAR) methodology did not include contributory approaches, reflecting PAR's focus on active participant involvement (McIntyre 2008). Additionally, some theoretical frameworks did not explicitly use the term "participatory" but still incorporated participatory methods, such as collective decision-making for irrigation management (Krupnik et al. 2012; Valdivia et al. 2014).

Consistent with this rationale, barriers and facilitators were less frequently reported in contributory projects. When they were mentioned, they typically related to issues such as "resistance to technical change" or "lack of training." In contrast, most barriers and facilitators identified in this study were associated with co-created projects. The analysis also highlights a significant difference between practical or behavioral barriers and cognitive or emotional/relational barriers. Practical barriers were more commonly reported, while emotional and relational factors were more frequently mentioned as facilitators.

DISCUSSION

Our scoping review reveals that understanding participation modes is crucial to grasp the dynamics of stakeholder engagement and project success. It is noteworthy that barriers and facilitators were mainly found in studies with a higher degree of participation. The barriers tend to be more tangible, frequently relating to technical or cognitive factors, while relational and emotional aspects, though potentially less emphasized or recognized, became apparent as they contributed to projects' effectiveness and were acknowledged as facilitators.

The analysis of barriers and facilitators highlights that the effectiveness of participatory projects in agricultural innovation largely depends on stakeholder engagement and the development of strong relationships between the different types of participants. Such projects succeed when stakeholders, particularly farmers, are actively involved throughout all stages, from idea generation to project design and implementation. This relationship appears crucial regardless of the project's innovative purpose and is evident in various contexts involving the general population and multiple stakeholders (Jennings 2005; Shalowitz et al. 2009). Additionally, fostering informal and flexible

relationships that focus on targeted actions to strengthen connections with involved actors is essential. This approach promotes a climate of trust and cooperation, which is critical for project success.

In addition, the categorization of barriers and facilitators into *technical*, *emotional/relational*, and *cognitive* components, could be seen as the three primary constituents of engagement, replacing the behavioral factor present in the original construct (Graffigna 2017) with the theme of technical barriers linked to the agricultural system. This suggests that a pivotal determinant in the success of such endeavors lies in the level of project engagement shown by the stakeholders involved. Reaching this level of engagement requires a pragmatic approach that not only provides the necessary resources for the research project but also aligns with farmers' tangible needs. It should consider their time, daily practices, and financial constraints, while sharing the entrepreneurial risk to ensure intrinsic motivation. Also, it is important to maintain informal and flexible relationships with targeted actions to strengthen ties, even beyond direct research objectives. Finally, once relationships are well-established, training and education using interactive, tailored knowledge-sharing strategies can effectively engage participants.

These three key elements of practicality, relationship care, and knowledge process management can be significantly supported by the use of intermediaries who understand both the specific context and the language of researchers and scientists. For example, in one of the studies included (Sturdy et al. 2008), various participatory learning and action (PLA) techniques were used to gather information about farmers' perceptions and to foster metacognitive and critical analysis skills. In this context, farmer learning workshops were facilitated by leaders elected by the community members, who played a crucial role in organizing the workshops, communicating goals, and assisting with the implementation of new practices. These intermediaries effectively bridged the gap between the scientific community and local farmers, ensuring the success of the initiative. Indeed, it should be noted that intermediary figures were not assigned to a specific subtheme because their role encompasses all the three dimensions—*technical*, *relational* and *cognitive*—more comprehensively than other type of facilitators identified in this review. The nature of these intermediaries can vary greatly, ranging from cultural brokers, who facilitate connections between groups from different cultural backgrounds (Ciaccia et al. 2019), to extension agents, who are professionals that provide technical advice and support to farmers, helping them apply research findings to improve their agricultural practices (Andrieu et al. 2019; Bhadana et al. 2015; Chowdhury et al. 2010; Kimeli et al.

2017; Mitchell et al. 2001; Osorio-García et al. 2019; Sturdy et al. 2008; Temple et al. 2006), depending on the purpose and context of action.

Essentially, it seems that the success of these projects does not solely hinge on the theoretical approach, but rather on the establishment of strong project alliances, facilitating effective collaboration that transcends theoretical frameworks, contextual factors, and project objectives.

The review yielded a diverse range of theoretical frameworks used in the projects, and the classification of participatory modes relied on different reporting approaches, rather than uniform project documentation. This suggests that not only the specific context, research objectives, and researchers' intentions may influence this element, but also the project reporting itself. This underscores the need for clearer guidelines in this type of research that, while adaptable to different contexts, still lacks strong common elements in the literature, making comparisons challenging. In this regard, barriers and facilitators identified herein could serve as valuable lessons for other potential projects.

Furthermore, the results of this scoping review demonstrate the multitude of factors that can influence the effectiveness of such projects. They show that although the complexities may increase compared with traditional and top-down research approaches (Ebitu et al. 2021; Sachet et al. 2021), specific adjustments can make a difference.

CONCLUSIONS

The results of this scoping review highlight that it is feasible to stimulate and facilitate alterations in farmers' practices through projects that actively involve them. Importantly, one of the primary factors contributing to the success of such approaches appears to be the stakeholders' engagement with the project. The importance of smallholders within the global agricultural system establishes an opportune environment for the promotion of participatory and innovative initiatives. These endeavors can take the form of widespread networking among smallholders through peer-to-peer exchange projects, or by facilitating connections between farmers and other stakeholders, thereby nurturing dialogue with the scientific, public, and private domains. Consequently, it becomes feasible to amalgamate the benefits of small-scale entities with the wealth of knowledge resources available within the scientific sphere. However, this can occur in various ways, indicating that the fragmentation in defining participatory research is still prevalent in this context (Minkler and Wallerstein 2011). The compilation of

barriers and facilitators synthesized here, along with their analysis, can serve as a guide for those seeking to foster participation among stakeholders to promote projects aimed at modifying production practices in agriculture to enhance social, economic, and ecological sustainability.

LIMITATIONS

Several limitations should be acknowledged. The inclusion of only two databases might have led to overlooking relevant studies. Also, the data extraction process, based on theoretical frameworks and involving qualitative and inter-subjective coding, introduced some subjectivity in the analysis. In addition, a concise representation of the complex, multi-method and multi-actor nature of the projects in a linear manner implies the loss of considerable contextual and specific information of individual studies. Finally, one limitation of this study is that it did not examine all possible interdependencies between the elements extracted from the included projects, mainly owing to the complexity and diversity of the data, which made such analyses challenging.

Despite these limitations, rigorous efforts were made to ensure comprehensive data collection and analysis, providing valuable insights into the subject matter.

DATA ACCESSIBILITY STATEMENT

The data used in this scoping review consist of publicly available published articles. The full list of included papers and the extraction and coding framework are provided in Supplemental File 1: Appendix A.

NOTE

- 1 The search string was used in Scopus and later adapted to Web of Science syntax.

SUPPLEMENTARY FILE

The supplementary file for this article can be found as follows:

- **Supplemental File 1.** Appendix A. This file includes two sections. Section 1 contains the supplementary data tables cited in the text. Section 2 describes the extraction and analysis Excel file used to conduct the scoping review, including details on its structure and how the data were processed across six thematic sheets. DOI: <https://doi.org/10.5334/cstp.767.s1>

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

Michele Paleologo conceived and designed the study, conducted the full-text screening, performed the analysis, and drafted and revised the manuscript. Marta Acampora contributed to the screening and selection of papers and supported the data analysis. Serena Barello contributed to the definition of the search strategy. Guendalina Graffigna supervised the entire process and contributed to refining the conceptual framing of the study.

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