

REVIEW

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Psychosocial, relational and structural determinants of integrated pest management adoption in OECD countries: a scoping review

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Abstract

To reduce the use of synthetic pesticides, it is necessary to understand the factors underlying their use and the adoption of Integrated Pest Management (IPM) among farmers. To achieve this, this study relied on a scoping review carried out following the PRISMA-ScR guidelines, using five databases and other grey literature sources. A total of 39 scientific references covering OECD countries over 2008 to 2024 period were included after rigorous screening via Covidence and analyzed using the taxonomy of intervention mapping for behaviour change methods and thematic synthesis. The results show a growing scientific interest since 2019 in the adoption of IPM and highlight the influence of psychosociological factors, professional networks and support and sociodemographic factors on adoption. Among the most frequently identified factors are social influences, economic risk perceptions and information access. Specifically, some such as perceptions of economic and production risks, perceived complexity, loss of time or anxiety, lead to an exclusively negative influence on the adoption of these practices. Others (access to information, ease of use, belonging to an organization, perceived benefits and agricultural experience) rather encourage their adoption. However, other factors (social influences, attitudes and beliefs, farm size, level of education, age) are cited as both positive or negative determinants depending on the context. Consequently, authors suggest strengthening extension systems on the economic risk and benefits of adopting alternative practices, as well as the development of agroecological technologies/practices for less complex use and policies that consider social influences among farmers given their important relationship with adoption.

Keywords Pesticides, Integrated pest management (IPM), Scoping review, PRISMA-ScR, Psychosociological factors

1 Introduction

The use of synthetic pesticides is a source of socio-economic, political and ecological concern in view of the consequences caused to human health, that of wildlife and the environment [1–3]. Indeed, synthetic pesticides have harmful effects on the health of



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agricultural workers, consumers as well as on the environment, soils and water quality [4, 5]. They are associated with various diseases such as cancers, genomic damage, oxidative stress, neurological disorders, effects on the respiratory tract, metabolic or thyroid dysfunctions, eczema, Parkinson's, etc. [6, 7]. Recent studies have also revealed the negative consequences of pesticides on infant mortality [8, 9]. The health of wildlife, such as bats [10] and bees [11–13], is also affected by pesticides.

Pesticides have therefore become a great concern for governments [14–16] and for consumers, who are increasingly looking for products with fewer or no pesticides [17]. In response to these effects, regulatory and societal requirements are intensifying, increasingly encouraging a transition to more sustainable agricultural practices, with growing interest in alternative methods [17–21]. Integrated pest management (IPM) aims to reduce dependence on pesticides by combining biological, cultural and mechanical methods to manage pests [22–25]. In this review, the terms used to designate the object of adoption are not strictly equivalent. Integrated Pest Management (IPM) refers to the full decision process described above, whereas the broader expressions alternative practices, pesticide-reduction practices and agroecological practices designate the individual or combined methods that reduce reliance on synthetic pesticides. Because the selected studies overwhelmingly document the prevention, monitoring and control stages, the results reported here mainly concern these stages of the IPM process rather than the evaluation and feedback stage. In North America and more specifically in Quebec, Integrated¹ pest management practices are promoted [27–32]. IPM promotes the adoption of alternative practices to synthetic pesticides. In Quebec's 2011–2021 phytosanitary strategy, it is divided into five stages [32]. Each phase may be associated with a range of methods or practices² tailored to its specific objectives.

- The initial phase emphasizes acquiring in-depth knowledge of pest organisms, including their biology, intervention thresholds, and related factors, through various channels such as phytosanitary alert networks, as well as training programs and advisory services in IPM.
- The second phase aims to prevent the emergence of crop pests through agronomically sound practices. These include, for example, appropriate seeding rates, crop rotation, the use of resistant cultivars, the integration of repellent or deleterious companion plants and trap crops, and the management of on-farm biodiversity to enhance the presence of natural enemies (e.g., flower strips and riparian buffers). Other examples include the use of protective netting, mass trapping techniques, and the implementation of plant biosecurity protocols.
- The third phase focuses on field or greenhouse monitoring and the detection of crop pests using a range of methods, including visual inspection, automated systems, and drone-based surveillance. This involves the application of predictive models, the use of decision-support systems, phytosanitary surveillance as well as the monitoring of pesticide resistance.

¹Decision-making method which consists of using all the techniques necessary to reduce populations of harmful organisms effectively and economically, while respecting health and the environment [26].

²The following examples were compiled by the authors based on the 39 studies reviewed (scoping review) and on feedback from Quebec-based experts in weed science, crop protection, and IPM, notably from Université Laval, the Grain Research Centre (Centre de recherche sur les grains ou CÉROM), and the Ministry of Agriculture, Fisheries and Food of Quebec.

- The fourth phase involves control measures when pest outbreaks could not be prevented. At this stage, priority is given to physical control and mechanical control methods, such as manual or mechanical weeding, the use of autonomous equipment, electric or laser-based weeding, and pest removal through suction or air-blowing systems. Biological and biotechnical control strategies are also favored, including the use of natural enemies (e.g., predators, parasitoids), sterile insect releases, mating disruption techniques, and the application of mineral oils. Chemical control using synthetic pesticides is considered a last-resort option and must be applied with great caution. This includes adhering to intervention thresholds and label recommendations, applying minimum effective doses, avoiding broad-spectrum pesticides, ensuring proper sprayer calibration, and favoring localized or banded applications. Additionally, selecting pesticides with lower environmental and health risks and rotating chemical groups is essential to delay the development of resistance.
- The final phase involves evaluation and feedback, with the objective of improving the planning and effectiveness of future interventions.

However, despite the positive dynamics resulting from these alternative measures, several challenges hinder the achievement of significant effects. On the one hand, resistance from farmers, often linked to the fear of a drop in yield and the high cost of alternatives, limits the adoption of more sustainable practices [33]. On the other hand, the lack of technical support and suitable infrastructure slows down the transition towards an effective reduction of pesticides [24]. Moreover, pressure from agrochemical industries and the complexity of agricultural markets may hamper the implementation of more ambitious policies [34–36]. Furthermore, some literature reviews have documented that beyond the sociodemographic and economic factors of farmers, sociological and psychosociological factors play an important role in the adoption of pesticides and alternative practices [37–44].

Gent et al. [37] studied the factors that influence the adoption of a decision support system to inform pest control decisions in the United States, Holland and Australia and found that farmers' perception of risk and their aversion to these perceived risks may explain the slow adoption of decision support systems and, more broadly, integrated pest management. Shields et al. [41] studied the barriers to the adoption of conservation biological control (flower strips that favor parasitoids by providing nectar and wooded areas serving as habitats for natural enemies) through a review of the international literature. They identified that barriers to adoption include the relative complexity of conservation biological control and challenges related to economic evaluation, as well as perceptions and communication. Based on 34 studies, Pathak et al. [39] explored in their systematic review the adoption processes of precision agriculture technologies in Germany and the United States and used the innovation diffusion framework to analyze the complex interactions between the different factors of the adoption process. They found that relative advantage and motivation are the most frequently mentioned factors influencing the adoption of precision agriculture technologies which optimize the use of pesticides. For their part, Dessart et al. [38] highlighted the importance of behavioural, social and cognitive factors such as factors influencing the adoption of agroecological practices in general and those reducing pesticides in particular in Europe and the United States. Their results show that three groups of factors, namely dispositional factors (personality, resistance to change, risk tolerance, moral and environmental concerns, and farmers' goals),

social factors (descriptive norms, injunctive norms, farmers' need for public recognition), and cognitive factors (knowledge, perceived control, perceived costs and benefits, and perceived risks), influence the adoption of agroecological practices in general and those reducing pesticides in particular. Khanna et al. [42] studied the factors likely to influence the adoption of digital agriculture technologies for weed control in the United States. They found that perceptions of economic risk, farmers' behavioural preferences, peer pressure, and social networks play an important role in adoption decisions.

Based on 225 studies reporting 522 effect sizes, Swart et al. [43] evaluated in their systematic review and meta-analysis the relationship between motivational factors and farmers' adoption of sustainable agricultural practices, including pesticide reduction, in 23 European countries. Their results conclude that attitudes, intentions, and perceived usefulness have greater positive effects than economic outcomes and environmental awareness. Thompson et al. [44] reviewed the literature on voluntary, non-contractual adoption of ecological practices from 2010 to 2022, including those for reducing synthetic pesticides, using a systematic approach, and found stronger evidence of the importance of cognitive, behavioral, and social variables in the adoption of sustainable agricultural practices.

Finally, Rossi et al. [40] found that the factors influencing the adoption of decision support tools for integrated pest management were their robustness, user-friendliness, ease of use, flexibility, frequency of updates, as well as the real and/or perceived benefits envisaged and the user's prior knowledge.

Despite the relevance of these previous studies, they have limitations and those developed in the form of scoping reviews are rare. Some display a general approach while others are limited to a specific national context. Our scoping review aims to fill several gaps. Its added value compared to the few literature reviews we have identified on related topics can be summarized in five points. First, it covers a wider area OECD country (Canada, United States, European Union, Norway, Switzerland, Australia and New Zealand) compared to several recent reviews limited to Europe [38, 40, 43, 44] or in the United States. Second, it focuses on a recent period (2008 to 2024) to consider more current adoption factors. Third, this review makes a methodological contribution insofar as the body of documents retained includes qualitative, quantitative and mixed studies, and not only quantitative studies such as those of [43]. Fourth, it is distinguished by the coverage of a set of IPM practices. It is therefore not limited to the adoption of a single method as some authors have done, in this case [37] and [40] concerning decision-making tools or [41] about biological control or [39] about precision agriculture technologies. Fifth, this review covers many crops instead of just one as in most of the literature reviews previously cited.

Another contribution of our paper is the taxonomy used to classify our adoption factors. To the best of our knowledge, we are the only ones to have used a method inspired by social psychology [45], namely the "Intervention Mapping (IM) taxonomy of behavior change methods," to classify the adoption factors identified in our study. This allows us to formulate more targeted and specific public and economic policy recommendations.

In view of all the above, this study aims to identify and prioritize the factors, especially psychosocial one, that influence the use of synthetic pesticides in agriculture and the adoption of alternative practices, considering the agroeconomic realities of OECD countries, which are comparable to those of Quebec, through a scoping review. This

comparability rests on features that these countries broadly share with Quebec, namely input-intensive production systems, comparable pesticide-regulation and risk-reduction frameworks, structured agricultural extension and advisory services, similar farm-labour structures, and comparable levels of technological adoption. These results will enrich the scientific debate on the agroecological transition by providing perspectives that allow the development of adapted and innovative strategies to facilitate the reduction of pesticides in agriculture.

2 Materials and methods

2.1 Study design

Considering the orientation of the present study, the scoping review as a type of literature review was chosen [46]. This review was conducted according to the methodological framework of JBI Scoping Review Methodology Group guidance. Furthermore, this documentary analysis was carried out in accordance with the principles set out in the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews extension for Scoping Reviews) guidelines developed by Tricco et al. [47], following the steps described in the Prisma diagram of Page et al. [48] (Fig. 1).

3 Research strategies

The literature search relied on a rigorous selection of scientific and technical databases to ensure comprehensive coverage of relevant publications. Five key databases were identified: CAB Abstracts, ABI/INFORM Global, Web of Science, Google Scholar, and EconLit, with the help of a specialized librarian. Theses and dissertations were also included to enrich our corpus. To obtain grey literature, in addition to Google Scholar, searches were conducted on the websites of institutions such as Agriculture and Agri-Food

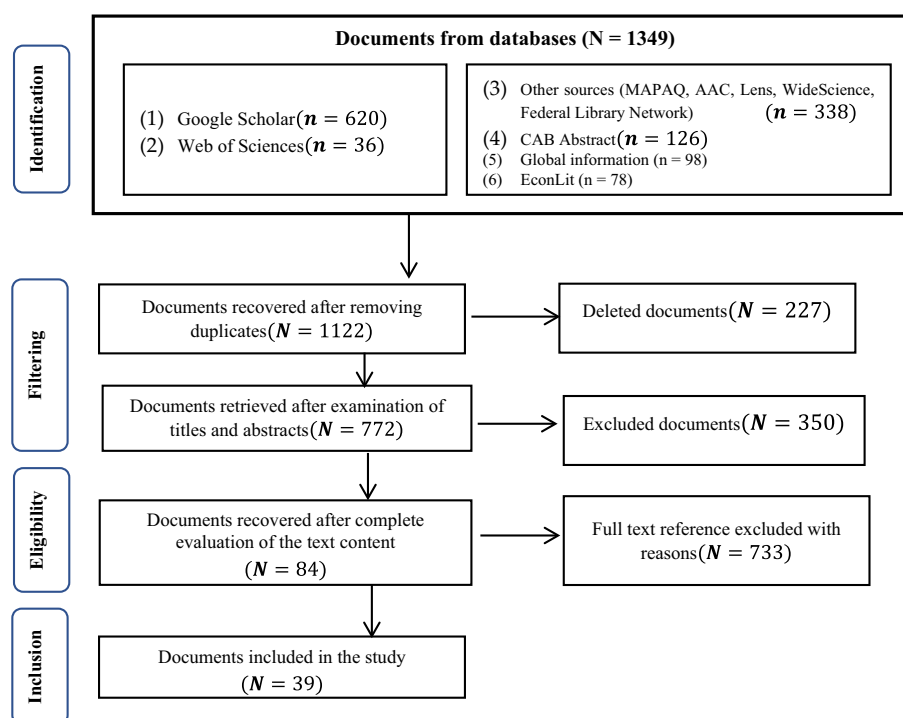


Fig. 1 PRISMA flowchart for record identification and study selection

Canada (AAFC), the Agro-Environmental Research and Development Institute (IRDA), the Canadian Federal Library Network, MAPAQ, Lens, World Wide Science, ResearchGate, and LinkedIn. The choice of these databases was based on their ability to index research in agricultural sciences, environment and agricultural sociology, which are essential for studying the reduction of pesticide use on farms.

Additionally, references were identified using specific keywords and Boolean operators were used to develop search strategies. Search terms included “pesticide reduction,” “sustainable agriculture,” “adoption drivers,” “biopesticides,” “integrated pest management,” “agroecological transition,” “farmers’ perception,” “pesticides,” “herbicides,” “fungicides,” “glyphosate,” “insecticides,” “IPM,” “physical control,” “mechanical control,” “biological control,” “agricultural policies,” “professional networks,” “social norms,” “risk perception,” “economic risk,” etc. Combinations of these keywords were used with boolean (AND, OR, NOT) and adjacency operators to refine the search.

3.1 Eligibility criteria

This study relied on a series of rigorously defined inclusion and exclusion criteria to select the most relevant documents. These criteria that guided the selection process are described in Table 1.

3.2 Selected studies

A total of 1,349 references were listed and imported into Zotero and EndNote bibliographic software. After removing duplicates (227), the references were screened independently by two reviewers using Covidence software in two steps. The choice of this software is linked to the fact that it is considered an online collaborative platform that simplifies the production of systematic reviews and other literature reviews [49]. First, a reading of the titles and abstracts reduced the corpus to 84 relevant studies. Second, after an evaluation of the full texts according to predefined criteria in Table 1, 39 studies were retained. High inter-rater consistency was achieved (Cohen’s Kappa = 0.83). All steps of reference searches and their screening are summarized in Fig. 1 below, including the Prisma Diagram of [48].

3.3 Data extraction and synthesis

The extraction of relevant information from the 39 selected studies was based on the construction of an extraction plan including the relevant variables and information to answer the research question. This plan was introduced into the Covidence software. The data and information from the texts were extracted in a raw form, i.e. without being

Table 1 Inclusion and exclusion criteria considered in this review. Source: Authors (2026)

No	Inclusion criteria	Exclusion criteria
1	Publication in English or French	Text written in a language other than English and French
2	Peer-reviewed articles and non-peer reviewed articles	
3	Quality institutional reports (detailed methodology, clear and precise results, etc.)	Less qualified institutional reports (lack of methodology, lack of clarity in the results)
4	Research specifically focusing on pesticide reduction and alternative practices	Articles that are too general and do not specifically address pesticide reduction
	Studies covering the agricultural contexts of OECD countries	Studies conducted in agricultural contexts too far from the target countries
5	Studies carried out between 2008 and 2024	Studies carried out before 2008

analyzed, to reduce the risk of errors [50, 51]. The information was then exported for analysis.

3.4 Data analysis method

Data analysis and synthesis were carried out using a combination of qualitative and quantitative approaches. The thematic synthesis of Thomas and Harden [52] was conducted to identify recurring trends and discrepancies in the studies. This approach allowed the results to be grouped according to specific categories, such as sociodemographic factors, factors related to professional networks and support, psychosocial factors of pesticide reduction, etc. The final categorization of the results was based on a taxonomy of factors of Kok et al. [45].³

The number of studies concluding that a factor influences the reduction of synthetic pesticides and the adoption of alternative practices is presented (Table 2 in the Appendix—last column). Given that the 39 studies used diverse scientific methodologies (based on qualitative, quantitative, or mixed data and analysis strategies), it was necessary to adopt a procedure that would allow uniform conclusions to be reached. Thus, in qualitative studies, a factor is considered influential when the authors of the study reach this conclusion. For quantitative studies, a factor is considered influential when it is significant at the 5%, 10%, or 1% level. In the latter case, it is important to note that the links between factors and farm practices are generally similar to correlations. It should also be clarified that the corpus of 39 studies includes a small number of systematic reviews and meta-analyses (for example [43] and [44]); this is precisely what the distinction made in the Results between sample sizes counted with and without these review-type studies refers to.

4 Result

This literature review draws on a corpus of 39 studies examining factors influencing the adoption of alternative practices to pesticides. It highlights several key aspects: study characteristics, types of practices studied, methods used, and main adoption factors.

4.1 Characteristics of the included studies

4.1.1 Author(s), document types and funding

The majority of the studies analyzed are scientific articles (32) published or not in peer-reviewed journals (13 with rank, 19 unclassified). In addition, the corpus includes a thesis, a dissertation and five research reports. This diversity limits the risk of publication bias. Approximately 72% of the research received funding, illustrating the growing interest of funders in the issue of pesticides and agroecological practices. The balanced presence of men and women among the researchers demonstrates the involvement of female researchers in this field.

³This is a taxonomy of intervention mapping for behaviour change methods used in psychosocial science. It allows for the grouping of variables and constructs several methods and models that explain behaviour change and proposes policies to influence this behavior (see Kok et al., 2016). According to Kok et al. (2016) "for a behavior change method to be effective: it must target a determinant that predicts behavior; it must be able to change that determinant; it must be translated into a practical application in a way that preserves the parameters for effectiveness and fits with the target population, culture, and context".

4.1.2 Years of publication in studies

The evolution of studies between 2008 and 2024 reveals a relatively progressive research dynamic, marked by phases of low production between 2008 and 2017, with an annual average below two articles (Fig. 2). Furthermore, an acceleration is observed from 2019, during which 8 publications were recorded. This was followed by a second peak in 2022 with 7 studies i.e., an annual average of 4 publications between 2019 and 2022, reflecting a growing scientific interest in the question of adopting alternative practices to pesticides (Fig. 2).

4.1.3 Countries and geographic areas, crops production sectors and practices studied by the authors

The studies analyzed mainly cover the European Union (15), the United States (9), Canada (6), various countries combined (5), Oceania (2), and Switzerland (2). In Canada, most of the research focuses on Quebec and is often funded by governments. In Europe, France is the most represented country, reflecting its commitment to alternative practices.

Field crops are the most studied (18), followed by fruit crops (7) and other crops (3). Some studies combine several types of crops (11). Most research focuses on packages of alternative practices rather than a single one, which highlights the importance of a combined approach to reducing pesticide use. These packages typically bring together several of the methods documented in the corpus, for instance crop rotation and resistant cultivars, on-farm habitat management and biological control, field monitoring and decision-support tools, and mechanical or physical weeding, rather than a single technique used in isolation. This conclusion is consistent with what is often studied in the literature on agricultural technology adoption [53]. The main alternative pest control methods studied include physical (24), mechanical (22), biological (22) and chemical (27) methods. Chemical control remains predominant, although alternative practices are gaining ground. The most studied pesticides are glyphosate-based herbicides, followed by fungicides and insecticides. The development of new effective alternatives remains a priority for research [54], the environment [4, 5, 55, 56] and wildlife health [10, 12].

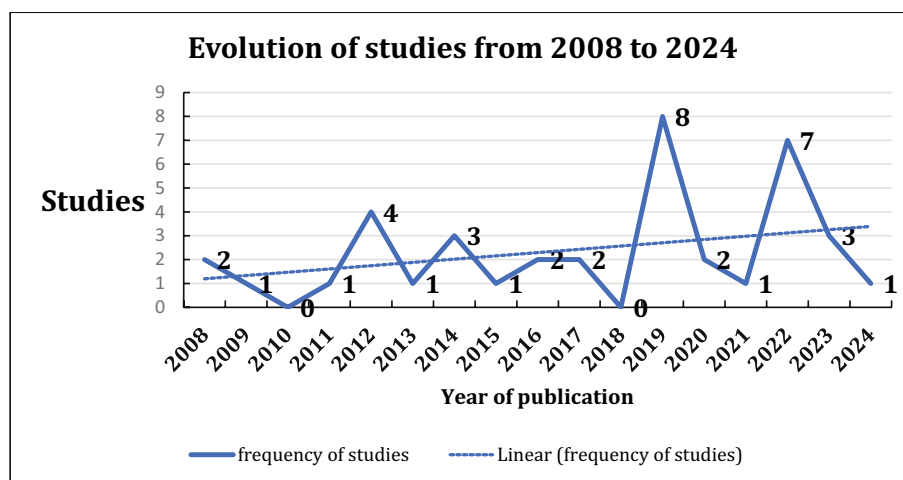


Fig. 2 Evolution of studies included in the review from 2008 to 2024. Source: Construction of authors from the metadata base (2026)

4.1.4 Heterogeneity of study approaches and data sources used

4.1.4.1 Methods, data sources and sample size The approaches used in the different studies vary between quantitative methods (12 studies), qualitative methods (10 studies) and mixed methods (8 studies). Regarding quantitative methods, the studies rely mainly on descriptive statistics (32 studies), statistical tests, probabilistic models (logit, probit), logistic regressions including structural equation models. In qualitative research, content analysis and thematic analysis are predominant.

Regarding data sources, 19 studies used primary data, 10 secondary data, and 10 combined both. Collection methods included surveys, inquiries, interviews, and baseline analyses. The samples of the selected studies ranged from 34 study case and 9031 farmers [17] when literature reviews are not considered. However, when reviews are considered, the samples of affected farmers can be large: for example, 327 778 for the mapping review of [44].

4.1.4.2 Listed theoretical frameworks Nearly half of the studies (19) do not use any theoretical framework, which indicates a need to integrate more structured explanatory models [43, 44, 57]. Among the frameworks used, we find mainly psychosocial theories (theory of planned behavior, technology acceptance model, etc.) (Fig. 3). And these results suggest potential correlations between psychosocial factors and the adoption of alternative practices to pesticides in the countries selected in our study [5, 38, 43, 44]. The classic Rogers Diffusion of Innovation model was applied in 3 studies, which suggests a relationship between the characteristics of an agricultural innovation/practice and pesticide reduction as highlighted by [37, 39]. Other frameworks involving the application of social norms [58], to agricultural structures combined with the promotion of health and the perception of risks of farmers [59] and conflicts for sustainable agricultural transformations [60] were mobilized in a few studies. Metadata analysis also indicates that 10

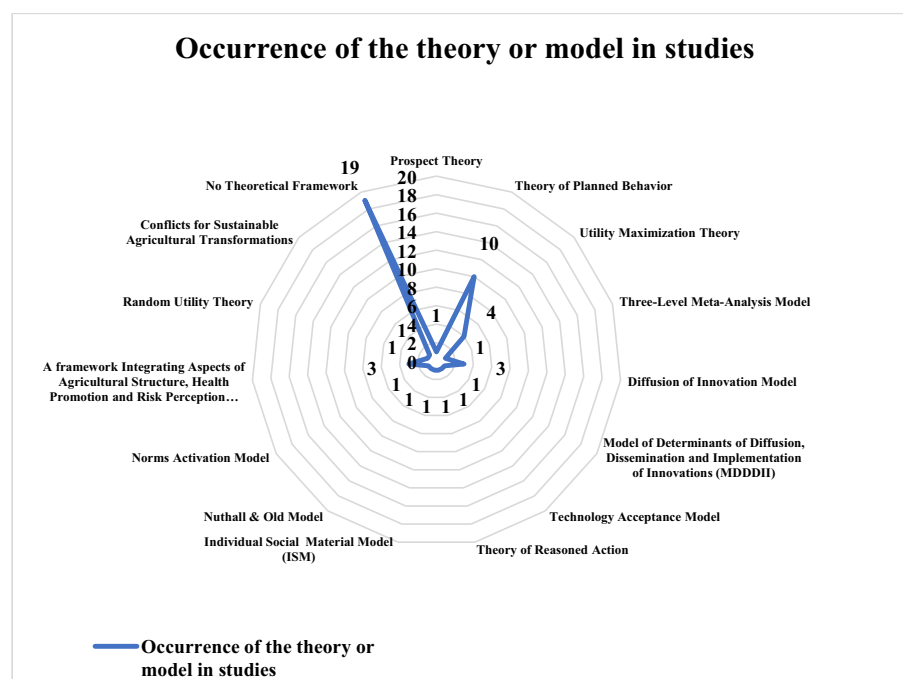


Fig. 3 Theoretical frameworks used in the journal's studies. Source: Construction of authors from the metadata base (2026)

studies combined theoretical frameworks to study the adoption of agricultural practices that reduce pesticide use. These results suggest that the adoption of alternative practices to pesticides is more complex than it may initially appear.

4.2 Factors determining the adoption of alternative practices to synthetic pesticides

4.2.1 Sociodemographic factors

Several studies in our corpus have investigated the influence of farmers' and farm characteristics on the adoption of alternative practices to synthetic pesticides (Table 2).

The main variables studied are the size of the farm, the farmer's age, their experience in agriculture and their education. The studies highlight that these factors are all linked to the adoption of alternative practices to synthetic pesticides. According to these studies, the level of education and experience in agriculture are positively linked to the adoption of alternative practices: the more educated and experienced a producer is, the more inclined he or she is to reduce pesticide use [61, 63, 67].

On the other hand, the direction of the influence (positive or negative) of the farm size of and the farmer's age is not a consensus among the studies in our corpus and depends on the context. The farm size in terms of area is the most studied in the 39 studies [59, 61, 68, 69]. Although the direction of the relationship of this variable is not a consensus among the 24 studies that have studied it, 15 of them revealed that small farms will be more likely to adopt alternative practices to pesticides [58, 67, 68, 70].

[44] nuanced these results and concluded that unlimited access to land goes hand in hand with a reduction in pesticides, particularly through the adoption of precision agriculture practices. Meanwhile, large farms favor chemical control for management, labor, and efficiency reasons [65, 71].

In relation to age, some results show that younger farmers are more in favour of alternative practices due to their ecological awareness, while other studies suggest that older farmers, with more experience, are more open to these techniques [16, 17, 72]. Furthermore, other factors are also highlighted, notably the existence of a new generation of

Table 2 Sociodemographic factors (farmers' and farm characteristics) influencing the adoption of alternative practices to synthetic pesticides. Source: Authors (2026)

Factors	# Studies/39	Influence	
		Positive	Negative
<i>Farmer's characteristics</i>			
Age ¹ (young, old)	16	7	9
Education ² level	16	15	1
Years of experience in agriculture	11	11	–
Gender	5	3	2
Ethnicity and language	4	Depending on origin/ language	
<i>Farm's characteristics</i>			
Size (small area)	24	15	9
Income from agricultural business	7	7	–
Labor (available and numerous)	7	7	–
Land status	5	3	2
Climate/climatic hazards	5	–	5
Access to production resources (land, equipment)	5	5	–
Existence of a new generation of farmers	3	3	–

¹The age variable has been modeled in different ways in studies: continuously [44, 59, 61–64] in intervals [29, 62, 65–67]

²Education has been modeled differently across studies, either in a binary way, i.e. high level or not [59, 61, 63]; or according to several levels, such as illiterate, primary, secondary, university [27, 66, 67]

farmers on the farm [60, 73] and the availability of labor [41, 74] considered as factors encouraging these practices. Other variables, such as ethnicity and language, also influence the adoption of these practices, although they have been little studied. For example, Indigenous peoples in America and Australia have a deep understanding of insect pests, allowing them to adopt natural solutions without pesticides [75].

4.2.2 Factors related to professional networks and support

The adoption of alternative practices to pesticides is linked to access to information, training and professional support as shown in Table 3 [17, 27, 39, 76]. These elements facilitate the dissemination of knowledge and encourage the transition to sustainable agricultural methods.

4.2.2.1 Access to information and training on the use of pesticides and on alternative practices

Access to information is essential in the process of adopting agricultural innovations [77]. Of 39 studies, 33 show that training on pesticides and their alternatives encourages their reduction. Several stakeholders are involved in encouraging the adoption of a new agricultural practice such as IPM. First, there are those who disseminate information, such as governments, producer associations, and advisory services, including agri-environmental advisory clubs in Canada and the Farmer Information Service in Europe [5, 17, 78]. In their studies carried out in Quebec [17, 27, 79], and [28] found that the amount of information received by farmers from multiple sources influences the decision to adopt Integrated Pest Management practices. Authors like [2] emphasize that well-informed growers can be well prepared to deal with pest problems and that researchers and extension professionals need to stay abreast of pest problems and their management trends when developing and disseminating new strategies.

4.2.2.2 Membership in an advisory club or agricultural organization

Membership in an advisory club is a key factor in the adoption of alternative practices. Out of 39 studies, 19 show that it encourages farmers to adopt these methods [79, 80]. This allows them to make the decision whether or not to adopt these practices while being aware of their relative advantages [17]. Similarly, the degree of proximity and the level of trust granted by the farmer to his informant are determining elements in the adoption of IPM practices [78, 81]. Indeed, pesticide suppliers, in order to make their business profitable, release more information on these products than on the benefits of alternative practices, which is detrimental to the adoption of alternative practices [31, 78].

Table 3 Factors linked to networks, professional and financial support determining the adoption of alternative practices to synthetic pesticides. Source: Authors (2026)

Factors	# Studies/39	Influence	
		Positive	Negative
<i>Access to information and networks</i>			
Access to information (government, associations, etc.)	33	33	–
Membership in an organization	19	19	–
Proximity of informants	2	2	
Level of trust of farmers in their informant	2	2	–
<i>Professional and financial support</i>			
Number of advisors trained (advisor training)	2	2	–
Access to university research results	7	7	–
Access to financial support programs	4	4	–

In addition to these factors, some studies have highlighted the training of specialists who disseminate knowledge to farmers as an important factor. In other words, the training of agricultural advisors influences the adoption of alternative practices to pesticides [17, 78]. For illustration purposes, [17] emphasize that the insufficient number of trained advisors independent of pesticide companies constitutes a major obstacle to the progress of the adoption of IPM in Quebec.

4.2.2.3 Access to academic and government research results and financial support Access to university and government research results for farmers increases their likelihood of adopting IPM practices [41, 60, 76, 82]. Of the 39 in the corpus, 7 studies analyzed the influence of access to the results of university and government research, and all conclude that it is an incentive for the adoption of alternative practices to pesticides. Farmers who benefit from financial support or subsidies to adopt ecological practices adopt alternative practices to pesticides in greater numbers compared to their non-beneficiary counterparts [42, 44, 60, 72]. Taken together, these results indicate that professional networks and support operate as a distinct lever of adoption rather than as a secondary correlate of socio-demographic profiles. Advisory services, peer networks and knowledge-exchange arrangements shape not only whether information reaches farmers but also how credible and actionable that information is perceived to be, and the independence of advisors from pesticide suppliers appears decisive for orienting it towards alternative practices [77]. Strengthening the density, independence and continuity of these networks therefore emerges from the corpus as one of the most actionable entry points for supporting the transition.

4.2.3 Psychosocial factors

Several psychosocial factors are linked to the decision-making of farmers regarding the use of pesticides or the adoption of IPM practices, mostly the social influences and the farmer's perception of the advantages and disadvantages of the practices.

4.2.3.1 Social influences The studies consulted include in these social norms the judgments of others (peers, neighbors, family, etc.) and the social pressures exerted on farmers [60, 74, 83, 84].

Among 39 studies, 37 conclude that they are correlated to the adoption of alternative practices to synthetic pesticides. To this end, the judgment of neighbors has a positive or negative effect on the adoption of practices depending on the nature of the comments [27, 28], as well as the social pressure he perceives from his peers [42, 84], the perception of the opinions of his family, colleagues or networks [75, 83], or the existence of conflicts between those who use pesticides and those who were against their use [60]. More specifically, peer rejection of the idea of treating fields mechanically will hinder the adoption of this practice [74]. Negative feedback from neighbors and society about glyphosate-based products will encourage farmers to reduce their use [58, 84]. The fact that a farmer does not want to be stigmatized and wants to be judged as a "good farmer" will encourage him or her to change practices [84]. On the contrary, a producer worried about being judged for not having "clean fields" will tend to use synthetic pesticides [27, 65].

Social pressures can also come more broadly from society and industry stakeholders, for example negative reactions from the media and society to chemical herbicides [59, 61, 74] and negative feedback from processors, consumers and retailers on glyphosate-based herbicides [70]. In the meta-analysis of [43] the authors found an effect size (Pearson correlation coefficient r) equal to 0.3 of the social norms variable, which means a strong influence on the adoption of pesticides or alternative practices.

4.2.3.2 Perception of the advantages and disadvantages of the practices The variables beliefs and attitudes, perceived usefulness of the practice, perceived loss of time related to the practice, compatibility with the values and practices already adopted by the farmers and relative advantages have been designated by some authors as factors that are related to the adoption of pesticides or their alternative practices (Table 4).

In the analyzed studies, attitudes and beliefs generally refer to the evaluations, expected results, advantages and disadvantages perceived by farmers of pesticides or IPM practices.

Attitudes can be positive or negative [40, 44, 58, 68, 70]. A farmer who has a positive attitude towards IPM, who perceives financial and environmental benefits and ease of use, will tend to adopt it [38, 57, 85].

Relative advantage which is described by the authors as the advantages of agricultural practices over existing ones in terms of efficiency or profitability [37, 39, 44] was also found as a factor in adoption in sixteen of the 39 studies in the corpus. The effectiveness of practices can also include environmental or health benefits [39]. The perceived usefulness of the practice can be defined by the fact that the farmer perceives the alternative practice as being useful to him [42, 60, 84]. Seventeen studies from the analyzed corpus found that this variable influences the adoption of alternative practices to pesticides.

At the same time, fifteen studies from the corpus studied emphasize the waste of time as another factor discouraging the adoption of these practices [31, 38, 60, 74].

Also, other researchers add the compatibility of the practice with the farmers' values as a determining factor. Specifically, when the producer is comfortable using a practice already or can rely on his experience in agriculture to understand how it works, or when the practice has meaning for him, the latter is likely to adopt this practice [39, 40, 42]. This variable (compatibility) was found in 8 studies.

4.2.4 Risk perception and adoption of pesticide reduction practices

The review highlights that the perception of risks related to yields, economy, health and the environment is related to the adoption of alternative practices to pesticides (Table 5).

Table 4 Perception of the advantages and disadvantages of practices influencing their adoption. Source: Authors, 2026

Perception of the advantages and disadvantages of pesticide reduction practices	# Studies/39	Influence	
		Positive	Negative
Attitudes and beliefs	17	–	–
Relative advantage	16	16	–
Time lost related to practice	15	–	15
Perceived usefulness of the practice	17	17	–
Compatibility with values and practices	8	8	–

Table 5 Perception of risks influencing the adoption of alternative practices. Source: Authors, 2026

Risk perception and adoption of pesticide reduction practices	# Studies/39	Influence	
		Positive	Negative
Economic risks (fear of reduced margins)	35	–	35
Production risk (fear of reduced yields)	24	–	24
Health risks linked to pesticides (fear of human diseases)	19	19	–
Environmental risks (ecological)	27	27	–
Preservation of biodiversity	16	14	2

Table 6 Other perception factors influencing the decision to reduce pesticides. Source: Authors, 2026

Variables of perception of control and ease of practices	# Studies/39	Influence	
		Positive	Negative
Perceived ease of use	17	17	–
Perceived control over practice	8	8	–
Perceived complexity of the practice	23	–	23
Ease of testing the practice/Testability	2	2	–
Practice anxiety	8	–	8
Ability to see practice results/Observability	7	7	–

4.2.4.1 Perception of economic and production risks In this study, economic risk is defined as the perception of a positive or negative financial outcome associated with the adoption of sustainable agricultural practices. Of the 39 studies analyzed, 35 address economic risks and 24 production risks. It appears that the perception of an anticipated drop in yields is holding back the adoption of IPM practices [60, 73, 76, 83]. Similarly, the fear of a decrease in profit margins pushes farmers to favor pesticides [16, 43, 71, 73].

Thus, the idea that pesticides guarantee good performance and increased profitability promotes their use [60, 72, 75, 83]. Economic risk from pests is a major motivation for pesticide use [5, 38, 74, 79]. This shows that pesticide use depends on individual farmers' risk perception.

4.2.4.2 Perception of risks to human health, the environment and biodiversity In addition to economic considerations, farmers also integrate health and environmental risks into their decisions. Among the 39 studies, 19 analyzed the perception of health risks, 27 environmental risks, and 16 biodiversity risks.

Indeed, the fear of illness for themselves and their loved ones is a determining factor [38, 71, 74, 76], as well as their ecological convictions (soil, air, water, etc.) encourage the adoption of alternative practices to pesticides [44, 63, 71]. Some studies show that the desire to preserve biodiversity, particularly beneficial insects, also encourages limiting the use of pesticides [41, 43]. However, this same concern may hinder the adoption of certain alternative practices such as biological control, which may affect other non-target species [31, 60]. The adoption of alternative practices to pesticides relies on a complex balance between farmers' economic and environmental perceptions.

4.2.5 Perception of control and ease

The review showed that the following variables of perception of farmers: perceived ease of use and control over the practice, complexity of the practice, feeling of anxiety related to the practice, ease of testing the practices, and observability of the results of the practice are related to adoption (Table 6).

Indeed, seventeen of the 39 studies investigated the perceived ease of use of practices which is defined as the perception of the ease (or difficulty) of adopting agricultural practices [37–39]. Farmers who feel able to adopt a practice without difficulty are more likely to do so [43, 44]. Furthermore, they adopt practices if they anticipate positive impacts, if they are simple to understand and use, require less time and physical effort, or require less labor [37, 69, 76, 86]. Perceived complexity represents the ease or difficulty perceived by the producer in understanding and applying the agricultural practice of pesticide reduction [38, 40, 60, 76].

This factor was highlighted in 23 studies (58.97% of the analyzed corpus), where the authors attest that a practice perceived as complex will be less adopted by the farmer.

Furthermore, perceived control is also highlighted as a major factor. [43] defined it as the perception of the ability to adopt sustainable agricultural practices. Thus, in the eight studies that mentioned this factor, the authors emphasize that farmers reduce pesticide use when they perceive they could adopt alternative practices [42, 70, 82, 86].

Similarly, eight studies in the corpus investigated anxiety and self-efficacy and show that farmers who feel anxiety about alternative practices to pesticides do not adopt them or end up abandoning them [37, 62, 65]. On the other hand, those who feel capable of carrying out IPM practices (self-efficacy) will tend to adopt them [44, 60, 62, 82].

By testability, the authors refer to the possibility of trying the alternative practice to pesticides and the ease with which the producer can try it [69, 84].

Two studies from the analyzed corpora found that farmers will more easily adopt a practice when they can test it beforehand, while seven studies found the observability of their results as an incentive for adoption. These results are consistent with the findings of recent reviews and Rogers' thesis on innovation [43, 44, 87, 88]. This literature indeed shows that the perceived attributes of innovation are part of the criteria of the person who makes the decision to innovate or reject new ideas, technologies or practices [87].

4.2.6 Intentions, resistance to change, and adoption of pesticide reduction practices

The intention of the farmer can be defined as his or her plan to commit to using pesticides or to adopt alternative practices [43, 67].

In the set of documents analyzed, five studies investigated intention and found it to be a variable that increases the likelihood of adopting pesticide reduction practices [67, 82, 83].

Another factor that has been revealed to exert a negative influence on the adoption of alternative practices to pesticides is resistance to change, revealing, according to some authors, the status quo bias [38, 44]. Status quo bias refers to the fact that the farmer will perceive any change as a loss and therefore prefer to maintain their traditional pest control practices. Four of the studies analyzed found these phenomena as a reason for not adopting alternative practices to pesticides [38, 44, 60, 70].

4.2.7 Summary of identified factors

4.2.7.1 Importance of factors in the literature To estimate the relative importance of each factor examined in the literature, the percentage of studies concluding that the factor influenced the adoption of alternative practices to synthetic pesticides was calculated (Fig. 4). The hierarchical analysis of the results obtained shows that social influences (94.87% of the corpus studied), economic risks (89.74%) and access to information (84.62%) are the most studied and are found to be related to the adoption of alternative

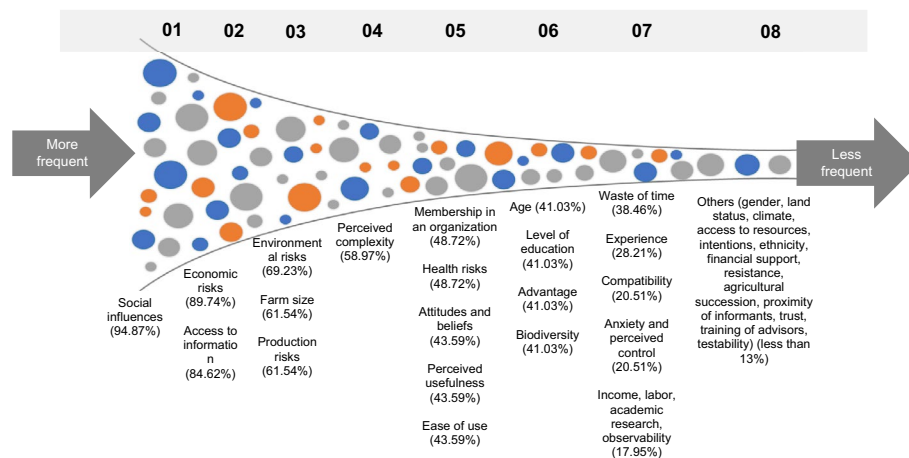


Fig. 4 Prioritization of factors determining the adoption of alternative practices. Source: Summary of the results presented above

practices to pesticides. On the other hand, gender, land status, trust or even testability are much less frequently cited (5.13%) in the corpus studied.

4.2.7.2 Factors according to the type of influence The analysis of factors influencing the adoption or rejection of alternative practices reveals a tripartite typology according to the nature of their influence. On the one hand, certain factors exert exclusively a negative influence, notably the perception of economic risks (linked to the reduction of margins), production risks, perceived complexity, perception of loss of time, anxiety about the practice and the climate, perceived as major obstacles to adoption. On the other hand, among the factors acting only positively identified by the studies analyzed, we find essentially access to information, environmental risks, belonging to an organization, health risks, as well as ease of use, perceived advantages or even agricultural experience and access to research. Finally, factors that have a dual influence—sometimes positive, sometimes negative—depending on the corpus analyzed include social influences, attitudes and beliefs, education level, gender, farm size, land tenure status, biodiversity preservation, and age, although the latter is mostly perceived as a hindrance. This entire categorization is illustrated in Fig. 5.

5 Discussion

The results of the analysis of the 39 studies show a gradual increase in scientific interest in the adoption of alternative practices to pesticides, with a strong acceleration from 2019, and a concentration in Northern countries (EU, United States, Canada). These results underline the growing importance given to this issue in industrialized agricultural contexts faced with health and environmental issues [5, 56].

Regarding the main factors determining the adoption of alternative practices to synthetic pesticides, the study highlights several factors divided into several categories, psychosociological factors, factors linked to professional networks and support as well as sociodemographic characteristics of farmers and their businesses.

The study results also place particular emphasis on psychosocial factors among which social influences and farmers' risk perceptions rank among the most frequently identified determinants. The study identifies social pressure from peers and farming communities

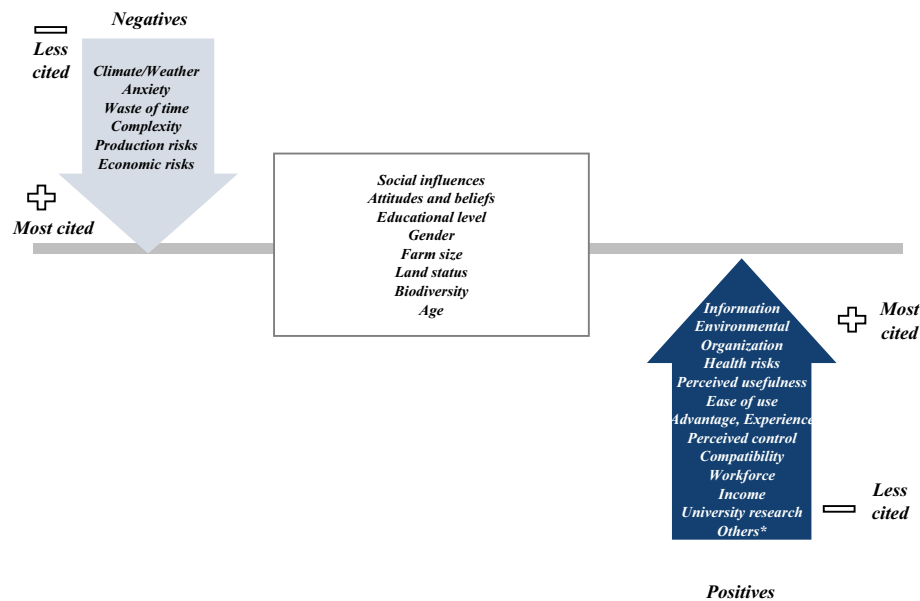


Fig. 5 Typology of factors according to the nature of their influence. Others*: Access to resources, existence of a new generation of farmers, trust, financial support, ease of testing, observability, intentions, resistance, land status, gender

as a determining factor in the decisions of farmers, who seek to maintain a valued image of “good farmer” [84]. This phenomenon can be a powerful lever to encourage the transition towards more sustainable practices, but it can also constitute a brake when adherence to conventional practices is perceived as a dominant standard of synthesis [27].

In addition to the social influences, the study reveals that perception of economic risks and production, represent also determining lever in farmers’ decision-making. In these conditions marked by the overestimation of economic risks by certain farmers, it is crucial to improve communication between the scientific world and farmers, by setting up suitable extension systems and decision-making tools based on empirical data [42, 79]. By strengthening the dissemination of knowledge and providing economic support, it would be possible to reduce these misperceptions and accelerate the transition to more environmentally friendly agricultural practices.

Although they are moderately studied, this research also highlighted the importance of other factors such as risks relative to the environment and human and animal health, farmers’ perceptions of the advantages and disadvantages of practices and their perceptions of control and ease of practices. Given that perceived characteristics of practices emerged as important factors in adoption, future research should develop and disseminate practices that farmers find advantageous over those they are using or replacing. Ideally, these practices should be compatible with existing infrastructure among farmers and with their values and those of their peers. They should also be less complex to use, testable, and generate positive and visible results for farmers.

In addition, individual beliefs and attitudes are factors that modulate the acceptance of alternative practices. In other words, when a farmer clearly perceives the economic and environmental benefits of these practices, he is more inclined to adopt them [89]. However, if these benefits are deemed uncertain or if the new methods are perceived as too complex, adoption may be compromised [57]. These results highlight the need for personalized support, including real-life demonstrations and tailored training, to reduce

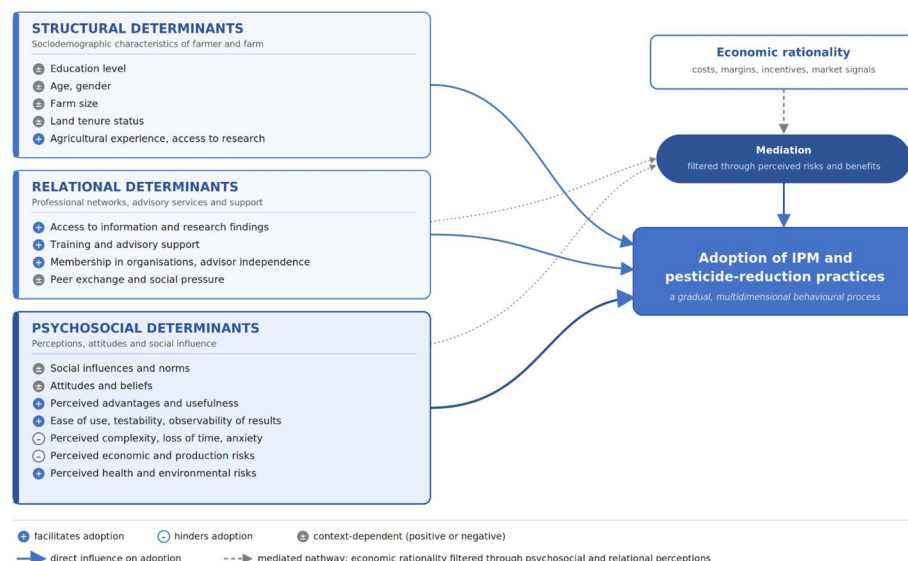


Fig. 6 Conceptual synthesis of the determinants of Integrated Pest Management adoption in OECD countries. Source: Construction of authors (2026), based on the 39 reviewed studies and the Intervention Mapping taxonomy

risk perception and build farmers' confidence in these alternative solutions. Thus, an approach integrating economic, technical, and psychosocial factors would be more effective in promoting the transition to less pesticide-dependent agriculture.

Taken together, these results point to a socio-technical and relational reading of adoption rather than a purely economic one. Economic considerations, namely costs, margins and incentives, rarely act on farmers directly; their influence is filtered through psychosocial and relational determinants, in particular the perception of economic and production risks, the perceived advantages of the practice, and the advice circulating within professional networks. In this sense, psychosocial and relational factors mediate economic rationality: the same economic signal can encourage or discourage adoption depending on how it is perceived and on the relational setting in which it is interpreted. This relational and perceptual mediation is summarised in Fig. 6, and it carries a direct policy implication, namely that instruments acting only on prices or subsidies are likely to underperform unless they are paired with advisory support and with interventions that address how risks and benefits are perceived.

However, beyond these factors, the study also highlighted other key determinants, namely the influence of professional networks and support, in other words, relational factors. Specifically, access to information and the results of academic research allow farmers to better assess the risks and benefits of pesticide alternatives, thus reducing the uncertainties associated with change [17, 78]. Membership in advisory clubs or agricultural organizations also promotes the dissemination of innovations by providing a structured framework for exchange where farmers can share their experiences and benefit from technical support [79]. To counter the influence of these factors, it is essential to strengthen training and awareness programs, which enable farmers to acquire solid knowledge about alternatives and to have greater confidence in their effectiveness among peers [5]. These results corroborate the conclusions of recent reviews that have demonstrated the important role played by knowledge access in the reduction of synthetic pesticides [38, 43, 44].

Finally, in terms of sociodemographic factors, the study shows that these factors contribute to farmers' decisions, but their influence on the adoption of alternative pesticide practices remains nuanced. Thus, the positive influence of the level of education confirmed by [61, 67] and [63], allows us to hypothesize that access to technical information and familiarity with agricultural dynamics strengthen farmers' adaptive capacity. However, the ambivalence of the influences of factors such as farm size and farmers' age reflects differentiated logics in terms of adoption of alternative practices. Indeed, small farms are more flexible and compatible with these practices [58] while large farms are often also under the constraint of optimizing productivity and inputs [71]. This finding highlights the need to target farmers in promoting the adoption of these practices according to their sociodemographic and farm profiles, as also shown by other studies [90, 91]. In addition, there are other contextual factors (indigenous knowledge and agricultural succession), thus calling for better consideration of socio-cultural and intergenerational dimensions in strategies for transitions towards more sustainable agriculture [92–94].

Considering all the above, it is important to note that our results essentially highlight that the adoption of pesticide reduction practices is, in addition to sociodemographic determinants, linked to psychosocial factors, particularly social influences and risk perceptions, as well as professional support and networks. Psychosocial factors that can lead to behaviour change have been the subject of extensive studies in the field of social psychology by authors such as [45] who have drawn heavily on [95] and [96]. These authors argue that after identifying determinants and beliefs that are linked to a behaviour that one wishes to modify (e.g., pesticide use) and the population concerned (e.g., farmers), effective and compatible intervention methods and policies can be put in place. Thus, if we are interested in modifying or impacting the role played by social influences on the adoption of pesticide reduction practices, it is important to provide farmers with information regarding other farmers' approval of pesticide use or the adoption of alternative practices. Another solution would be to help farmers develop the skills to resist the social pressure of their peers to use pesticides through effective awareness-raising. Political actors can also raise awareness and educate farmers about the consequences of pesticide use, including through more engaging and interactive formats.

To positively impact attitudes and perceptions of risks and practices among farmers, it is important for agricultural policy actors to disseminate accurate information on the consequences of pesticide use or the adoption of alternative practices in terms of profitability, health, or environmental degradation. It is also necessary to provide information on the personal benefits and costs or risks associated with adopting alternative practices. Actors supporting farmers could also relay gain-oriented messages, highlighting the advantages of adopting IPM practices, or loss-oriented messages, highlighting the disadvantages of not adopting alternative practices. It is also important to elicit negative emotional reactions among farmers to discourage their motivation to adopt pesticides or to encourage awareness of the negative impact of pesticides and the positive impact of IPM practices.

To enhance the role of professional networks and support on the adoption of IPM practices, policymakers must work to strengthen ties within networks by providing information, training, and support. They can facilitate the association of members of certain support networks with those of new networks through mentoring programs,

sponsorship systems, and self-help groups. Within communities, a few farmers can be trained and informed about pesticide use or the adoption of Integrated Pest Management practices to serve as relays and credible sources of information. It is worth noting that international organizations recognize the importance of supporting a range of services that strengthen support, research, knowledge transfer, and extension services to achieve behavioural changes in agriculture in general [97] and the use of synthetic pesticides [17, 31]. However, these services would benefit from being more effectively funded in most jurisdictions.

5.1 Limitations of our review

Our review has limitations that should be considered in future literature reviews on pesticide reduction and the adoption of integrated pest management practices.

As typical in scoping reviews, no formal quality appraisal was conducted, which implies that studies with varying methodological robustness contributed equally to the synthesis.

In addition to the dichotomous nature of the adoption variable found in the majority of our studies and the heterogeneous nature of risk, which was not considered in several studies in the corpus and could impact the factors influencing the adoption of integrated pest management practices, our research has other limitations. We only considered the period from 2008 to 2024. Future research could conduct reviews of studies covering longer periods.

In some studies, in our corpus, perception variables were represented by a sentence or modelled binary instead of being measured by a scale, for example, a “like” scale. A review including only references with these variables measured in this way might yield different results (factors). We only included research written in French and English. Future reviews would benefit from including references written in other languages.

Given that our study focused on OECD countries, regions such as Africa and parts of Asia were excluded from our corpus. A review incorporating research documents from these areas would surely provide a more comprehensive overview of the factors influencing the adoption of alternative practices to pesticides in agriculture. Finally, other limitations of our study that can be cited are heterogeneity of methodologies of the included studies, the absence of meta-analysis, no causal inference, the possible presence of publication bias, and the potential exclusion of some grey literature. Consistent with the scoping review methodology, which aims to map the breadth of available evidence rather than to weigh it, we did not carry out a formal appraisal of the methodological quality or risk of bias of the included studies. The results should therefore be read as a synthesis of the determinants reported across the corpus, without ranking the studies according to their methodological robustness.

6 Conclusion

This study provided an in-depth overview of the work on the adoption of alternative agricultural practices to pesticides. Indeed, this review offers a structured understanding of current knowledge on the main factors determining the adoption of these practices. Specifically, the adoption of these practices remains a dynamic, gradual, and multidimensional process, influenced by a multitude of sociodemographic, psychosocial, economic, environmental, and institutional factors. Therefore, it is crucial to consider the

transition to alternative practices to pesticides not only from a technical perspective, but also across these different dimensions.

Furthermore, to ensure effective support for farmers in the transition to these alternative practices, the study highlights the need to strengthen outreach mechanisms, promote local knowledge, and design more inclusive and differentiated policies. As a perspective, future research would benefit from mobilizing integrative theoretical frameworks and methods that consider the diversity of adoption trajectories and risk perceptions. In fact, it should be emphasized that, based on the various factors identified in this scoping review, future research should focus on developing a unifying framework that includes all the factors identified to examine potential causal relationships between them. Such an approach could notably rely on existing analytical frameworks such as those of [98] or [99].

At the same time, expanding the corpus to non-English-language publications and less represented geographical areas (Asia and Africa) could also be a lever for refining the understanding of dynamics.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1007/s44279-026-00731-z>.

Supplementary file1 (DOCX 26 KB)

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Ethics approval was not required for this study.

Consent for publication

All authors have read and agreed to the published version of the manuscript.

Competing interests

The authors declare no competing interests.

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