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To intervene or not to intervene: Potential for targeted pesticide policy in Uganda

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ABSTRACT

Targeted state intervention is needed to tackle complex environmental problems. However, state intervention faces rejection by some actors because these problems are typically cross-sectoral, multi-actor, and conflictual. To explore why some stakeholders nevertheless favor state intervention as an approach to environmental risk prevention, the study examines the case of pesticide risk prevention in Uganda. Using a mixed-methods approach that combined an online survey and face-to-face interviews, stakeholders were asked about their agreement with different policy instruments. In general, the results indicate strong preferences for state intervention in risk prevention, but these preferences vary across actors and levels. Correlation and regression analysis reveal that high threat perception and agreement with precautionary action are associated with preferences for preventive state intervention. However, external drivers like forum participation and cross-sectoral collaboration do not exhibit the expected effects. Based on these findings, the study suggests how future policy making can be enhanced and clarifies which settings promote state intervention to address complex environmental problems.

1. Introduction

To protect humans and the environment from the negative effects of environmental degradation, state intervention is needed in the form of targeted policies to counteract complex environmental problems and reduce environmental risks. These policies must address the problem in question both before exposure (*risk prevention*) and after (*risk response*) (Seifert et al., 2019). However, any intervention for *risk prevention* is controversial and may face opposition during the decision-making process because it entails behavioral change for target groups (Metz and Ingold, 2014), requires collaboration across different policy domains (Wiedemann and Ingold, 2021), and/or introduces costs that are difficult to estimate (Murphy and Gouldson, 2000). As an understanding of stakeholder preferences is therefore crucial in assessing the potential of state intervention in this context, the present study addresses the following general question: *What drives stakeholder preferences for state intervention in environmental risk prevention?*

To explore the drivers of stakeholder preference in this context, I adopt an innovative nexus-based approach that links the problem, the solution, and the political context. This approach makes four contributions to the relevant literature. First, an integrative approach that links the problem to the solution distances the researcher from conventional categorizations of state intervention (Vedung et al., 1998). Given the uncertainties, cross-sectoral responsibilities, and conflicting interests inherent in complex environmental problems, it is important to understand these problem characteristics in order to formulate adequate policy solutions (Ingold et al., 2018). By beginning from the nature of the problem itself, the study avoids conventional assumptions about risk control and acknowledges the potential of preventive measures as alternative or additional provisions for sustainable environmental management (Metz and Ingold, 2014; Xanthos and Walker, 2017).

Second, in linking solution to context, I draw on theoretical concepts from various literatures. To elucidate stakeholder preferences, I consider drivers explored by environmental and social psychology, including

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individual factors like threat perception (Vlek and Steg, 2007) and beliefs (Lindenberg and Steg, 2007). Additionally, the collaborative governance literature examines external drivers such as social relations (Metz and Ingold, 2017; Metz et al., 2018). Finally, the Ecology of Games framework scrutinizes the role of policy venues or forums in shaping policy outputs (Lubell, 2013). As settings characterized by uncertainty and limited knowledge, exchanges within these forums can foster shared understanding and joint policy action in relation to a given problem (Fischer and Leifeld, 2015). Together, these different literatures support a holistic investigation of stakeholder preferences and of micro-, meso- and macro-level drivers that are often only considered in isolation.

Third, this research innovates on the complex environmental problem under investigation: I take pesticide management as an example to illustrate the need for problem-driven solutions in environmental management. Farmers use agricultural pesticides to enhance productivity and meet consumer demands, but these pesticides also pose a threat to environmental ecosystems and human health (Bonner and Alavanja, 2017; Hayes and Hansen, 2017). At a global scale, the risks of pollution are high, and 64% of global agricultural land is at risk of pesticide pollution (Tang et al., 2021). This is a complex problem (Allen, 2013) and solution-seeking necessarily involves multiple actors, values, and power constellations, requiring a multidimensional approach (Pedersen and Nielsen, 2017; Lee et al., 2019; Pedersen et al., 2020). In this context, targeted state intervention is considered necessary to protect natural resources and ensure sustainability.

A fourth and final contribution to the literature relates to the decision to investigate stakeholder preferences in the Global South, where the risks of pesticide use are especially pronounced because of the use of highly toxic or counterfeit products, a lack of protective equipment, and the unsafe disposal of empty containers (Rodenburg et al., 2019; Sharma et al., 2020). In many of these countries, however, pesticide risk prevention is neglected by policy makers, as the prevailing political narrative emphasizes agricultural intensification to ensure economic and food security. For that reason, an investigation of stakeholder preferences in the Global South invites reflection on policy solutions and theoretical assumptions that are currently of concern mainly in the Global North.

As an illustrative case study, I investigate stakeholder preferences and associated driver in Uganda to grasp the potential for state intervention in pesticide risk reduction. As a consequence of market liberalization and privatization of the agricultural sector, pesticide use and the distribution of the latter are ubiquitous in Uganda. In light of government passivity, non-governmental organizations (NGOs) and civil society organizations (CSOs) as well as private domain organizations have led most of the country's pesticide management and risk prevention initiatives (Isgren, 2016). In Uganda, pesticide use threatens environmental integrity, but it has proved challenging to find solutions that can secure the support of all stakeholders.

To collect the data, I used a mixed-methods approach, combining an online survey and face-to-face interviews to investigate stakeholders' individual attributes, including threat perception and agreement with overarching policy goals. To investigate external drivers, I looked at stakeholders' networks and extracted data on cross-sectoral collaboration; I also asked them about forum participation. To analyze the interplay between individual drivers and specific policy instruments, I used Spearmans rank-order correlations and regression analysis to investigate the influence of individual and external drivers on stakeholder preferences. The results are contextualized using qualitative data from the semi-structured interviews. By understanding how stakeholder attributes influence their preferences for state intervention, it was possible to identify aspects of the decision-making process that need to be strengthened to support holistic policy making and comprehensive land use management.

2. Complex environmental problems, solutions and the context

State intervention and the influence decision-makers exert over the addressees (also referred to as target group) (Hepburn, 2010) can best be captured via an investigation of policy instruments. Policy instruments are the 'active ingredients' of state intervention.[1] They are the tools or techniques that decision-makers have at their disposal to attain policy goals via a change in target group behavior (Howlett, 2014).

The instruments used to reduce environmental risks can be grouped according to different rationales (Mickwitz, 2003). The most prominent rationale is based on how coercive state intervention is, or in other words, a categorization of instruments according to the *restrictiveness* of state intervention (Vedung et al., 1998; Thomann, 2018). Policy scholars distinguish between three types of instruments of descending restrictiveness: regulatory or command-and-control (e.g. environmental quality or emission standards), economic or market-based (e.g., subsidies for pro-environmental behavior or taxes), and information or voluntary instruments (e.g. public awareness campaigns or guidelines about best agricultural practices) (Vedung et al., 1998; Kaufmann-Hayoz et al., 2001). However, when targeting environmental risks, there is a need to match instrument selection to the characteristics of the problem itself (Howlett, 2018; Krause et al., 2019). In other words, an additional grouping of instruments is based on the *target* of state intervention, or in other words, the phase in which environmental risks occur (e.g., inputs, process, or output) (Mickwitz, 2003; Schaub and Braunbeck, 2020).

Complex environmental problems appear on different scales, meaning that the ones causing the problem (i.e., polluters) are not necessarily the ones suffering from its effects (i.e. victims); the causes and effects are thus not equally distributed (Walls and Palmer, 2001). This conceptualization of environmental problems illustrates their complexity, where different sectors and stakeholders along the value chains of products need to be regulated to prevent and control risks. We can distinguish between preventive and reactive state intervention to address environmental problems (Bloemhof-Ruwaard et al., 1995; Blair, 2016), grouping policy instruments according to the targeted phase of a production process, value chain of a product, or environmental cycle. Even though research agrees that preventive state intervention is needed to effectively reduce environmental risks and to give justice to the complexity of environmental problems (Metz and Leifeld, 2018; Tosun et al., 2020), the potential for their introduction is limited for several reasons: First, preventive state intervention goes hand in hand with behavioral change (Landry and Varone, 2005; Metz and Ingold, 2017), which is why target groups and their representatives are opposed to preventive risk reduction. Second, complex environmental problems are related to uncertainty and contradictory problem frames (Cole et al., 2011; Fischer et al., 2017), which is why the long-term benefits of preventive problem solutions (Murphy and Gouldson, 2000) fall victim to the prioritization of non-environmental interests and successful lobbying for the benefit of short-term economic development. Third, due to uncertainty and increased environmental complexity, the costs of preventive state intervention are often difficult to estimate (Mantovani et al., 2017) and solutions to control risks at the end-of-the-pipe are introduced, as they entail less cross-sectoral collaboration and less behavioral change. Based on the underlying assumption that state intervention targeting risk prevention is less popular than state intervention targeting risk response, I focus on risk prevention as a strategy to target complex environmental problems in the remaining paper.

2.1. Linking solutions to the context

Different approaches have been proposed to better understand the potential for state intervention to tame complex environmental

[1] The terms (policy) instrument and (policy) measure are used interchangeably throughout this text.

problems, including the study of the context to which state intervention applies. This context is shaped by political constraints that are at work in the system under observation. These include key agents (i.e. policy actors or stakeholders[2]) (Gilabert and Lawford-Smith, 2012), and their attitudes and opinions regarding policy solutions at their disposal. In policy studies, this political constraint is often captured through an investigation of stakeholder preferences. These preferences for state intervention are crucial for the introduction of new policy solutions and are therefore important success factors when it comes to facilitating state intervention (Dermont et al., 2017; Tosun et al., 2020). Stakeholder preferences thus provide an opinion poll and inform about the potential of policy solutions to pass political decision-making in particular and of state intervention in general. Research shows, that in general, stakeholders' preferences for state intervention targeting complex environmental problems are high (Dietz et al., 2007; Metz and Leifeld, 2018; Metz et al., 2018), but some policy solutions face more opposition than others (Kammermann and Dermont, 2018). In a decision-making process, this can be fatal as stakeholders have the power to block these proposals and hamper state intervention (Keohane et al., 1998; Mickwitz, 2003). Stakeholders, in their role as bargaining and potential blocking agents in this process thus represent a crucial political constraint (Gullberg, 2013; Sager et al., 2020).

Complex environmental issues are highly contested and the actors involved in decision-making operate as representatives of subsystems with conflicting interests and goals (Kriesi and Jegen, 2001; Van Bueren et al., 2003; Weible, 2006). In this context, issues related to complex environmental problems concern a broader array of stakeholders (Bodin and Crona, 2009; Prell et al., 2009), including public and private actors[3](Adam and Kriesi, 2007; Ingold and Fischer, 2014; Weible and Cairney, 2018). To explain how stakeholder preferences come about, literature proposes to study micro-, meso- and macro-level drivers: At the micro-level, environmental psychology provides insights about the role of individual motivations, problem perception, or "problem diagnostics" (Vlek and Steg, 2007, 10) as well as goal frames (Lindenberg and Steg, 2007) to shape actors' attitudes. At the meso-level, collaborative governance literature emphasizes the role of social interactions as a driver for stakeholder preferences (Metz and Ingold, 2017; Metz et al., 2018). Lastly, stakeholders' opinions and preferences are impacted by the institutional setting that surrounds them, also referred to as "planning processes" or "policy venues" (Lubell and Fulton, 2007, 541) in the Ecology of Games literature. In this analysis, I, therefore, consider these three types of drivers that impact stakeholder preferences for state intervention.

3. Drivers influencing stakeholder preferences for state intervention

3.1. Micro-level: individual drivers

Behavioral studies have long investigated the effects of awareness and perceptions on pro-environmental behavior and claim that this investigation contributes to a better understanding of policy support (Dietz et al., 2007, 2013). In policy literature, research acknowledges that the salience of the problem at hand and the urgency that actors attribute to a policy issue influences preferences. A study on problem perception and support for different instruments in Israel has shown that the perception of the problem's causes has a greater effect on the preferred policy option than other factors, such as socio-demographic characteristics of the surveyed actors (Lahat, 2011). Furthermore, research in Switzerland has shown that in the case of flood risk management (Glaus et al., 2021) and micro-pollution (Metz and Ingold, 2017) actors' preferences towards targeted state intervention are positively influenced by their problem perception. When actors perceive a complex problem as a potential threat to the environment, they might be more inclined to prefer preventive state intervention to no action at all. The first hypothesis is as follows:

Hypothesis 1. Actors perceiving the complex (environmental) problem as an increasing threat tend to prefer state intervention in environmental risk prevention.

Furthermore, the goal frames of stakeholders shape their attitudes and preferences (Lindenberg and Steg, 2007). To be more precise, stakeholders align their preferences with underlying policy principles. Literature about beliefs, and more specifically, policy core beliefs (Weible, 2006; Weible and Sabatier, 2009) capture these principles, and actors are expected to align their preferences for state intervention with their stance on these policy core beliefs (Weible and Cairney, 2018). When it comes to complex environmental problems and risks arising from their occurrence, the precautionary principle is considered a fundamental approach to prevent risks. Complex environmental problems are highly uncertain (Meadowcroft, 2007), and decision-makers are confronted with inconclusive evidence. The precautionary principle embraces this uncertainty and gives the environment "the benefit of the doubt" (Cameron and Abouchar, 1991, 1) to act upon threats rather than hard facts. I, therefore, deduce the following hypothesis.

Hypothesis 2. Actors who are in favor of precautionary action tend to prefer state intervention in environmental risk prevention.

3.2. Meso-and macro level: external drivers

The complexity of environmental management is determined by the interdependent web of sectors, levels, and stakeholders operating in different sub-systems (Meadowcroft, 2007; Ingold, 2014). The collaboration between state and non–state actors across different policy fields is considered fundamental in environmental governance (Kenis and Schneider, 1991; Provan and Kenis, 2008; Velten, 2014; Hamilton and Lubell, 2018; Yi, 2018). There is a lively debate in the field of environmental governance scholarship regarding the influence that collaborative governance arrangements have on the final policy outputs and outcomes (Ansell and Gash, 2008; Gerlak and Heikkila, 2011). Due to the high potential for conflict and diverging policy goals, matters related to environmental risk reduction are prone to 'silo thinking' (Kaddoura and ElKhatib, 2017). However, collaboration outside the box and across different sectors has various positive effects on solving complex environmental problems (Newig et al., 2018). First, environmental risk reduction is an inherently cross-sectoral endeavor, and being exposed to different views, opinions, and problems faced by the collaboration partners, provides stakeholders with a more holistic understanding of the problem situation (Koppenjan and Klijn, 2004). Second, as mentioned before, complex environmental problems are often associated with high levels of uncertainty. Through cross-sectoral collaboration, actors might lower uncertainty through better access to political and technical information (Hamilton and Lubell, 2018). This leads me to the following hypothesis:

Hypothesis 3. Actors who collaborate across different sectors tend to prefer state intervention in environmental risk prevention.

Decision-makers have limited knowledge about the effects on humans or the environment, as well as the costs that result from unsustainable environmental management (Hamlyn, 2015). Conflicts regarding causes and solutions could arise, creating opposing coalitions in the policy process (Weible and Sabatier, 2009; Malkamäki et al., 2021). Exchange of information and positions is crucial when it comes to ameliorating this situation (Crow and Jones, 2018; Gerlak et al., 2018).

[2] The terms stakeholder and actors are used interchangeably throughout this text.

[3] The actors are collective actors, a group that includes government agencies; academia; environmental, health or agricultural organizations; NGOs; and interest groups that represent the target groups.

Policy forums can thus serve as arenas to facilitate exchange and shape policy actors' attitudes (Fischer and Leifeld, 2015; Fischer et al., 2017), which is why I have deduced the following hypothesis:

Hypothesis 4. Actors who participate in forums tend to prefer state intervention in environmental risk prevention.

4. Case, data & method

4.1. Uganda as the case to investigate the potential for preventive risk reduction

Countries in the Global South struggle to balance environmental protection with agricultural productivity (Pingali, 2012; Dabrowski et al., 2014). Increased pesticide use is caused by greater demand for food production and a growing need to export to foreign markets coupled with defective agricultural production, which leads to elevated pesticide use (Stadlinger et al., 2013; Jors et al., 2018) (for more details on case selection, see Supplementary Material (SM) Online). Uganda serves as an illustration of pesticide management contributing to environmental complexity and land use challenges. Ugandan agriculture is considered the backbone of the economy (Rwakakamba, 2009), contributing around 25% to the annual GDP and employing more than 70% of the Ugandan labor force (Karungi et al., 2011; Le Goff et al., 2022) (Figure 2 and 3 in SM Online). Ugandan agriculture is shaped by market liberalization and privatization (e.g. of agricultural extension). In this context, farmers can easily access pesticides, and pesticide promotion is ubiquitous (Isgren and Andersson, 2020). While pesticide use rates in Uganda are comparatively low, their growing use is considered alarming or even excessive (Kateregga, 2012; Andersson and Isgren, 2021).

In Uganda, pesticide risk reduction at the different stages of the pesticide management cycle (Figure 1 in SM Online for detail) is not well developed, and lacks comprehensive follow-up regulations to the established act (Wiedemann et al., 2022). Even more, pesticide-related issues are not a political priority, which is why the implementation of existing regulations and introduction of targeted state intervention are hampered (Winkler et al., 2019). Furthermore, decision-making related to pesticide risks is fragmented between government ministries and agencies. Pesticide governance is highly decentralized over the 135 districts, making local governments the protagonists of enforcement (Bazaara, 2003). Additionally, international organizations, as well as non-governmental organizations (NGOs) play a crucial role in sensitizing and educating smallholder farmers (Delgado et al., 2019), as well as advocacy work to influence decision-making (Isgren, 2018). Pesticide management and decision-making related to pesticide risk reduction is a multi-stakeholder process in Uganda, spanning over different domains (private and public), sectors (i.e. health, environment, and agriculture), and levels (i.e. subnational, national, and even international).

4.2. Data collection

To begin, I conducted a comprehensive analysis to identify stakeholders in the domain of pesticide risk reduction in Uganda and to define the boundaries of the network, including both state and non-state actors. Network studies commonly use decisional, reputational, and positional approaches (Knoke, 1993; Knoke et al., 1996) to more precisely identify stakeholders and their roles. The analysis identified 55 international, national, and sub-national stakeholders involved in decision-making related to pesticide risk reduction in Uganda (for details of network boundaries, see section 2.1.1 and Table 1 in SM Online). This list was validated in the pre-testing phase, which involved four expert interviews (see section 2.1.1 in SM Online). In gathering the data, the advantage of the chosen mixed-methods approach was that the qualitative interview data could be used to contextualize the quantitative survey findings, enabling me to interpret and discuss the results in greater depth. I designed a standardized questionnaire for the online survey and a semi-structured guide for the interviews (based on the questionnaire). Data gathering took place between October 2019 and July 2020. For the online survey, I solicited the participation of all identified national (n = 49) and international stakeholders (n = 4), and also approached all District Agricultural Officers (DAOs) (n = 83) and District Farmers' Associations (DFAs) (n = 14) where email or phone contacts were available (for more detail, see SM Online), yielding a total of 150 contacted stakeholders. At national level, 38 policy actors responded to the survey (71.7% response rate); at district level, 43 policy actors responded (44.3%), but two outliers were excluded from analysis (Table 1; for more detail, see Table 2 in SM Online). To complement the quantitative data, I conducted 17 semi-structured interviews, which included open questions beyond the confines of the online survey (see Table 1 and Table 2 in SM Online).

4.3. Operationalization of variables

As a dependent variable, I investigated **stakeholders' preferences for state intervention targeting pesticide risk prevention**. To gather preferences, I surveyed agreement with 15 different instruments, nine for preventive (see Table 2) and six for reactive risk reduction (see Table 4 SM Online), on a four-point Likert-scale (1 = strongly disagree, 2 = slightly disagree, 3 = slightly agree, 4 = strongly agree) (Table 3).

To capture preferences for preventive state intervention, I calculated an additive measure over the nine policy instruments facilitating risk prevention for each actor ranging from 1 to 4. Table 3 shows the operationalization of the independent variables as well as of the control variables. Additional information on the operationalization of the independent variables is provided in the SM Online (section 2.2).

4.4. Methods

For data analysis, I rely on a mixed-methods approach, combing the quantitative survey with qualitative interview data. Descriptive statistics were generated for the different policy instruments and stakeholder preferences across different combinations of actor variables (e.g., actor role and level). I then performed a Spearmans rank-order correlation to analyze overall risk prevention preferences and the effects of individual drivers on agreement with the nine policy instruments. Finally, regression analysis was used to assess the effects of individual and external variables for hypothesis testing. Because of the small sample size, the study was necessarily exploratory, and the findings cannot be generalized beyond the specific research setting.

All of these outcomes were supplemented by contextual insights from the interviews, which were transcribed verbatim and keyword coded for

Table 1
Survey and interview participation by actor type.

Actor type *(Variable name)*	**Survey** *(Total contacted)*	**Response rate**	**Interview**
Government ministry *(Gov. ministry)*	7 (8)	87.5%	3
Government agency *(Gov. agency)*	6 (10)	60%	4
Research institution *(Research inst.)*	5 (7)	71.4%	1
Association and interest group *(Int.group)*	5 (5)	100%	2
CSO/NGO *(NGO)*	12 (16)	75%	3
Pesticide distributor *(Pesticide dist.)*	3 (3)	100%	1
International organization	*(IO)* 0 (4)	0%	0
District Farmers' Association *(DFA)*	13 (14)	92.9%	1
District Agricultural Officer *(DAO)*	30 (83)	36.14%	2
Total	**81** ***(150)***	**54%**	**17**

Table 2
Policy instruments facilitating state intervention in pesticide risk prevention.

Policy instruments to facilitate state intervention (*Variable name*)	Restrictiveness
Ban importation and use of particular pesticides (*ban*)	High
Ensure a more restrictive approval process for synthetic pesticides (*app.syn*)	
Make the approval process for alternative/non-chemical products less restrictive (*app.alt*)	
Stricter registration and regular inspection of pesticide importers and distributors, including strengthened border control (*reg. inspect*)	
Establish a coherent system of displaying health and environmental risks on pesticide labels (*labels*)	
Tax for the purchase of pesticides (*tax.purch*)	Medium
Subsidize alternative farming practices (*subsidies*)	
Increase awareness through information campaigns all sectors of society (*info.camp*)	Low
Enhance farmer technical support systems to promote good agricultural practices (*tech.supp*)	

Table 3
Operationalization of the dependent and independent variables.

	Variables	Operationalization
DV	Preferences for state intervention	Additive measure of agreement with nine policy instruments targeting pesticide risk prevention [1–4]
H1	Threat perception	Additive measure of agreement with four different environmental threats being attributable to pesticide use in Uganda [1–4]
H2	Secondary policy belief	Agreement with the policy principle of precautionary action (1–4)
H3	Cross-sectoral collaboration	Level of diversity for actors' collaboration partners in their network across sectors (0–5)
H4	Forum participation	Participation in forums (0–6)
CV	Involvement	less than 25%/25%/50%/75%/more than 75% of portfolio of responsibilities dedicated to pesticide management (0–5)
CV	Representing the agricultural sector	Dummy variable 0/1 (no/yes)
CV	Representing district level	Dummy variable 0/1 (no/yes)
CV	Representing private domain	Dummy variable 0/1 (no/yes)

DV = dependent variable; H = hypothesis; CV = control variables.

systematic sorting. For present purposes, the most crucial keyword groups are *policy/regulation/law*, *environment/agriculture/health*, *farmers/polluters*, *conflict/collaboration*, *protection from/use of pesticides*, *threats/problems*, and *international/national/district*. Statements were then extracted by means of a keyword search and as signed to different topics (for more detail, see Table 3 in SM Online). In total, 83 relevant statements were extracted, and these provided further detail when interpreting and discussing the findings.

5. Results & discussion

5.1. Potential for state intervention in pesticide risk prevention

Fig. 1 summarizes stakeholder agreement with the nine policy instruments for pesticide risk prevention. What is striking at first glance is that agreement exceed 67.5% in every case, and a majority of instruments achieve more than 90% agreement.

However, 33% of these actors disagree with an economic instrument imposing a tax on pesticide products at purchase (*tax.purch*). This aligns with existing evidence that although stakeholders largely accept instruments that reduce environmental risk, instruments that incur a cost encounter the strongest opposition (Metz and Leifeld, 2018). In the Global South, market-based economic instruments–especially those related to taxation–are often considered difficult to enforce (Xie and Saltzman, 2000), because of a lack of monitoring or corruption (Bell and Russell, 2002). This instrument also encountered particular opposition from the interviewed stakeholders, as they felt it penalized the most vulnerable Ugandan farmers, who would continue to purchase the products in question, even at a higher cost (Interviews 1, 2, 10, 11). For instance, interviewees said they would not agree to measures that *squeeze* farmers (Interview 3) and that a tax would put economic and food security at risk (Interview 10). Interviewees also noted that a tax might not be the most effective option, as it might not have the desired impact; for example, people would not understand the tax as a means of disincentivizing the use of pesticides, or the money would be misused rather than redistributed (Interviews 10, 14).

As a politically feasible means of addressing issues related to pesticide management, the potential for state-led risk prevention is high. However, while this matter has been on Uganda's political agenda for a long time, the risks for consumers and society at large have only recently become an issue, following a comprehensive study of pesticide residues on tomatoes (Atuhaire et al., 2017; Sekabojja et al., 2021). Pesticide risk

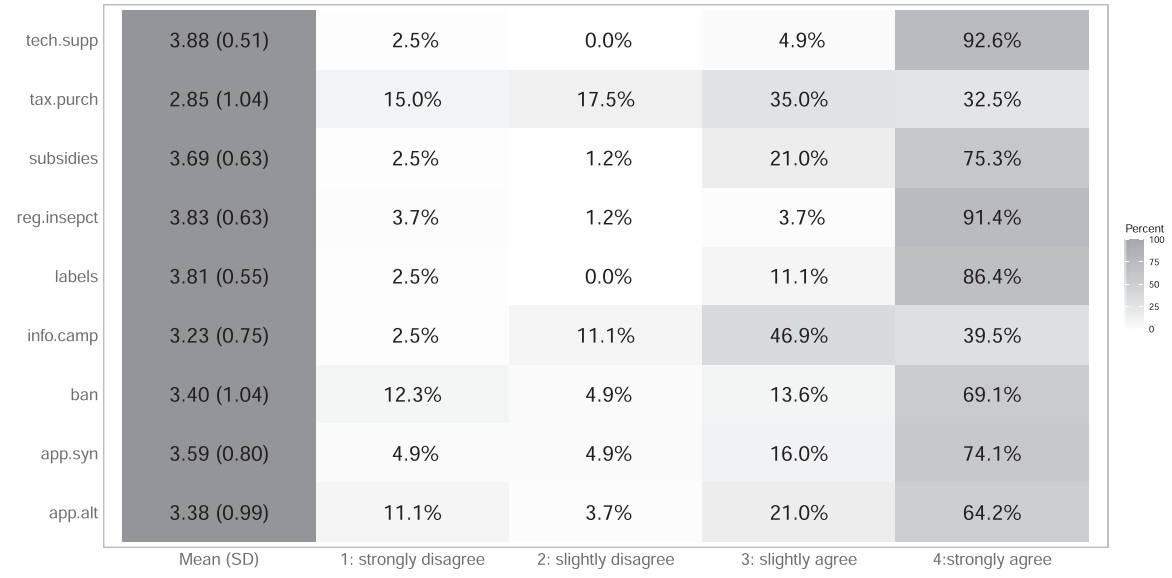

Fig. 1. Agreement with policy instruments facilitating pesticide risk prevention.

prevention can therefore be characterized as a "nascent" policy issue (Ingold et al., 2017), as stakeholders agree with state intervention and see the urgent need for action. Many interviewees supported this view (Interviews 8, 9, 10, 12, 13, 17) and emphasized their dissatisfaction with the current situation, which they attributed in part to a lack of coordination (Interview 1), political support (Interview 15), or regulation per se (Interview 13), as well as weak enforcement and noncompliance (Interviews 2, 4).

5.2. Breakdown of stakeholder preferences

To better understand stakeholder preferences regarding risk prevention, I combined a number of variables that capture stakeholder characteristics. Fig. 2 shows actors' preferences regarding state-led pesticide risk prevention by sector and decision-making role, and Fig. 3 shows actors' preferences by sector and domain. Stakeholders from five sectors (agriculture, environment, health, industry, cross-sectoral) responded to the survey; their roles were categorized as policy principal (ministry department leaders with decision-making power), secondary policy principal (government agencies involved or assisting in decision-making), policy implementation agent (DAOs), interest group (associations and NGOs advocating for groups and interests), or knowledge broker (research institutions) (see also (Glaus, 2021)).

Figs. 2 and 3 reveal two distinct trends. First, interest groups representing industry sector actors (e.g., pesticide distributors, umbrella organizations for pesticide distributors) exhibit the lowest acceptance of policy instruments. In Fig. 3, private stakeholders from the industry sector exhibit the weakest preferences (for more detail, see Tables 5–7 in SM Online). These actors operate along the pesticide management cycle and may identify as victims, associating these measures with financial burden and inflexibility related to enforcement (Landry and Varone, 2005). These stakeholders represent manufacturers, import and registration agencies, distributors, and farmers. To engage with risk prevention, these actors must take responsibility and accept that they are active contributors to the problem. The interviews underlined the need to penalize polluters rather than taxing products that harm farming communities. Interviewees claimed that fines, along with stricter application of the polluter-pays principle, would effectively pressurize certain polluters (Interviews 1, 5). Second, public stakeholders (i.e., policy principals) in the areas of agriculture and environment expressed the strongest preference for state-led pesticide risk prevention. In contrast, policy principals from the health sector exhibited the lowest preference for such measures among public stakeholders. The interviews confirmed that these programs and policies are not aligned with the health sector; for example, vector control or malaria protection measures were seen to interfere with pest control: "*You may find that some pesticides are being used in the nets for covering ourselves, yet in the field, for spaying, they are not allowed*" (Interview 8). As these problems are not regulated in a harmonized and consolidated way across the different sectors, there is conflict and confusion about responsibilities (Interviews 1, 3, 4, 10). To improve this situation, one proposed pathway is to include stakeholders from all sectors in a consultation process to reframe the problem and to adjust programs and coordination accordingly (Wiedemann et al., 2022). Interviewees also emphasized that interventions by private stakeholders should run in parallel with state interventions (see Mengistie et al., 2016): *"Government [.] cannot control everywhere [.] they don't have the capacity and also, they are not the business people"* (Interview 17). A typical example is the use of spray service providers by pesticide distributors to ensure that pesticides are applied by knowledgeable users (Interviews 1, 6). By mending conflicts, this complementary approach can enhance pesticide risk prevention.

I performed a bivariate analysis to investigate the relationship between acceptance of the nine risk prevention policy instruments (see Figure 1) and the two individual drivers (see Table 3). The results (Table 4) show a significant positive relationship between individual drivers and preferences for state intervention in risk prevention (overall preferences). This aligns with previous claims that problem perception and policy beliefs influence policy choice (Choi and Wehde, 2019; Glaus et al., 2021). On closer inspection, it becomes clear that these individual drivers are especially relevant in the case of restrictive policy instruments. In particular, stakeholders who exhibit high levels of threat perception are more likely to accept a comprehensive approach to risk prevention combining a ban (*ban*) and more restrictions on synthetic pesticides (*app.syn*) with monetary incentives (*subsidies*) for alternative practices like organic agriculture. Stakeholders who agree with precautionary action are more likely to favor greater restrictions on synthetic pesticides (*app.syn*) and fewer restrictions on alternative products (*app.alt*). While both variables have a strong effect on restrictions related to conventional pesticides, it seems clear that stakeholders are also more

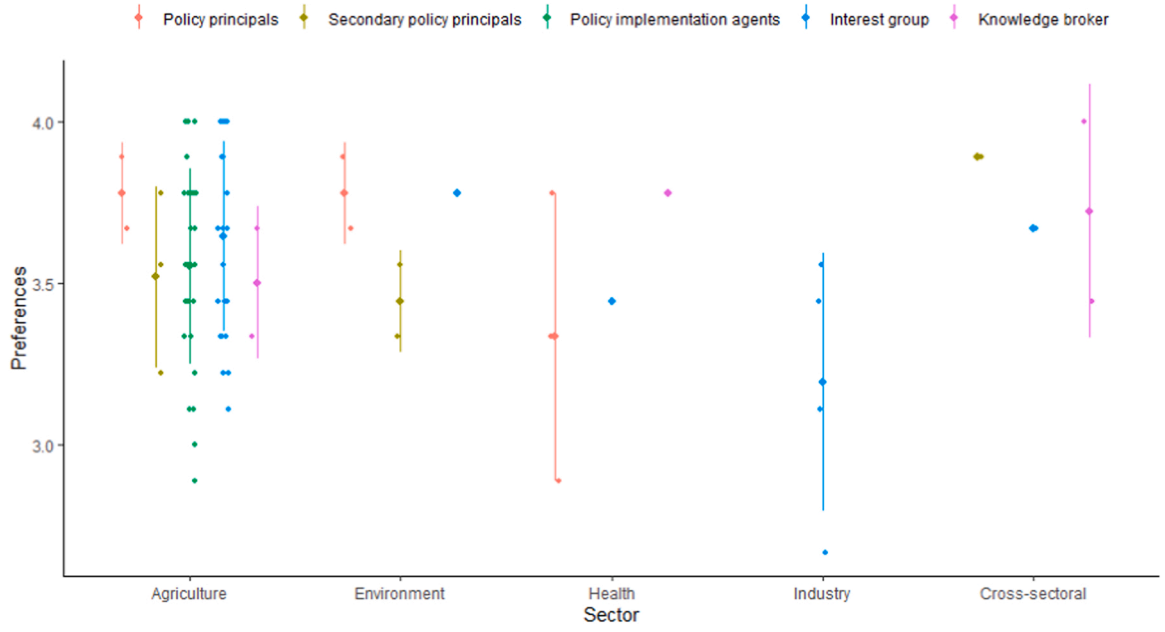

Fig. 2. Preferences regarding state intervention in risk prevention by sector and actor role.

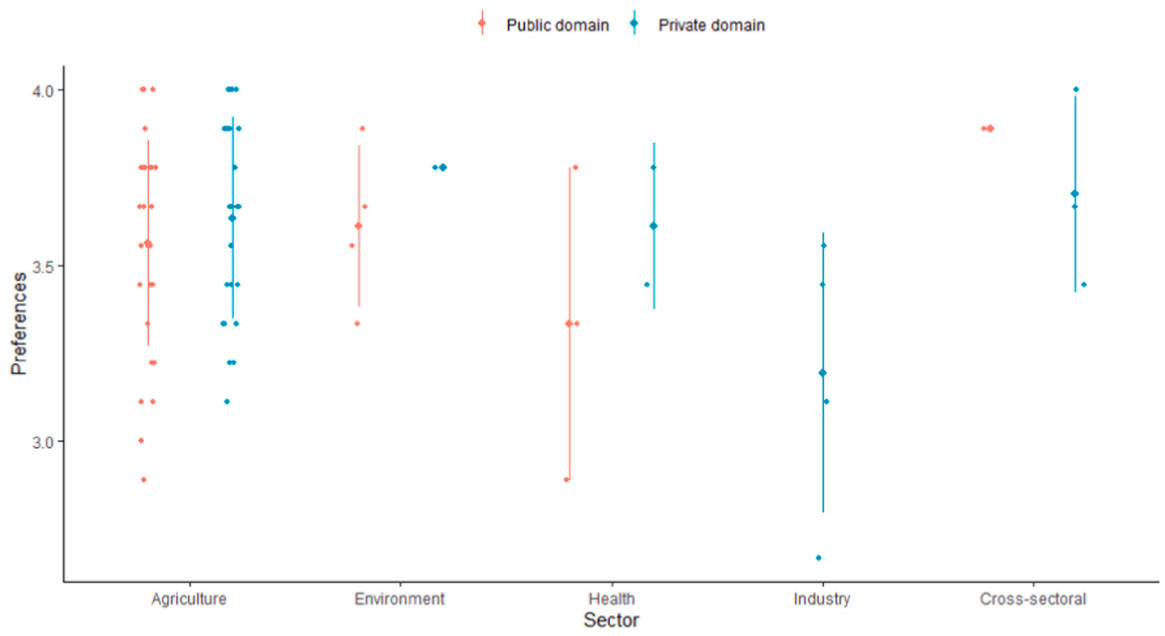

Fig. 3. Preferences regarding state intervention in risk prevention by sector and domain.

Table 4
Correlation coefficients of threat perception and agreement with the precautionary principle to agreement with policy instruments targeting pesticide risk prevention.

	threat perception	**secondary policy belief**
ban	0.24*	0.19
app.syn	0.36**	0.33**
app.alt	0.09	0.28*
reg.inspect	0.03	0.16
labels	-0.02	0.03
tax.purch	-0.04	-0.01
subsidies	0.25*	0.10
info.camp	-0.04	0.03
tech.support	-0.04	0.10
overall preference	0.24*	0.26*

Note: All correlations are Spearman's rank-order ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; $^{\cdot}p < 0.1$.

Table 5
Regression table.

	Model 1 individual drivers only	Model 2 all drivers	Model 3 district level only
Individual drivers			
Threat perception	0.10 (0.05)$^{\cdot}$	0.07 (0.03)*	0.17 (0.04)***
Secondary policy beliefs	0.16 (0.05)* *	0.11 (0.03)***	0.10 (0.04)*
External drivers			
Cross-sectoral collaboration		-0.06 (0.03)$^{\cdot}$	-0.07 (0.04)
Forum participation		-0.05 (0.03)	-0.10 (0.04)*
Control variables			
Involvement	0.05 (0.03)$^{\cdot}$	0.08 (0.04)*	0.02 (0.05)
Policy domain: agriculture	0.12 (0.09)	0.07 (0.04)$^{\cdot}$	
District level	-0.06 (0.09)	-0.05 (0.04)	
Private sector	-0.08 (0.07)	-0.03 (0.04)	0.02 (0.05)
Intercept	2.59(0.24)***	3.58 (0.03)***	3.58 (0.04)***
R^2	0.21	0.27	0.45
Num. obs.	79	79	41

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; $^{\cdot}p < 0.1$.

open to alternatives. In the interviews, alternatives were a hot topic, and one stakeholder noted the increasing interest in alternative products ". *because they are there. Its not true that there are no alternatives*" (Interview 4), a view accepted by the national government in adopting the National Organic Agriculture Policy in 2019 (Bendjebbar and Fouilleux, 2022). However, some stakeholders also stressed that more research is needed to promote open dialogue about alternatives to conventional pesticides (Interviews 1, 10). Values for Spearman's rank-order correlation and

Cronbach's alpha (0.68, CI: 0.54 0.77) confirmed the consistency of these results.

5.3. Explaining preferences for state intervention in risk prevention

A linear regression was performed to determine which drivers are associated with stakeholders' preference for state intervention for pesticide risk prevention. Table 5 shows parameter estimates for three models (with standard errors in parentheses). Model 1 reports the effects of individual drivers only; Model 2 includes both individual and external drivers; and Model 3 reports results for district stakeholders. Additionally, to ensure comparability of coefficients and to improve model convergence, the variables were scaled for regression analysis. (For more detailed results, see summary statistics in Table 8 and regression diagnostics in section 4 of SM Online.).

The results confirm that both individual and external drivers play a role in shaping stakeholder preferences. **Hypothesis 1** is confirmed by the marginally positive effect of environmental threat perception on preferences for risk prevention in Models 1 and 2. Actors who agreed that environmental threats related to air quality, drinking water quality, wildlife, and lakes are attributable to pesticide use and pesticide management tended to favor state intervention. This aligns with the view that problem awareness and problem perception foster stakeholder agreement with state intervention in general (Metz and Ingold, 2014) and with innovative forms of intervention such as sustainable policy instruments to reduce flood risk (Glaus et al., 2021). As problem awareness seems to be evolving, a more consolidated threat perception of decision-makers can muster support for state intervention.One interviewee noted the lack of awareness among high- level decision-makers: "*even the parliament need this sensitization. So the [lack of] awareness is actually not restricted to the poor family in the village. It is also lacking in our policy makers - the parliamentarians*" (Interview 1). Regarding **Hypothesis 2**, the results confirm that stakeholders' preferences align with underlying policy core beliefs. In Uganda, the Environmental Act established precautionary action as a guiding principle, and in a landmark decision in 2015, the Ugandan Supreme Court reaffirmed the importance of this principle for environmental protection. The basis for preventive action is therefore embedded in the regulatory framework, and the alignment between agreement with this principle and a preference for action confirms earlier findings (Metz, 2017). In particular, interviewees emphasized that precautionary actions like banning a hazardous pesticide could potentially be introduced in this high-dependency context, but only if an effective alternative is proposed (Interviews 1, 6, 9).

In relation to external determinants, **Hypothesis 3** must be rejected in light of the marginal negative effect in Model 2 indicating that stakeholders who collaborate with representatives of other sectors tend to oppose state intervention in preventive risk reduction. This result is surprising and counterintuitive because the literature suggests that stakeholders who "think outside the box" are exposed to a broader spectrum of opinions as they become familiar with different problem frames (Koppenjan and Klijn, 2004). Pesticide risk reduction can be characterized as a "nascent" policy issue; according to several interviewees, coordination and collaboration across policy fields and sectors is evolving but is not consolidated in the case of pesticide management: "*As long as we are running parallel programs, we can't succeed on that [in regulating pesticide risks]. We need to maybe make observations together, plan together, implemented together*" (Interview 4). Additionally, pesticide risk prevention is not a popular political strategy because it interferes with the production, registration, and distribution of agro-chemicals, and this lack of political desirability can diminish the effect of collaborative settings. As one interviewee noted, "*it takes a political step because you need to involve stakeholders widely to ensure that they buy in your idea. They must appreciate the risk, you're talking about*" (Interview 1).

Hypothesis 4 must also be rejected, as forum participation had an insignificant negative effect on stakeholders' tendency to favor state intervention. The control variables show two marginally significant effects in Model 2. First, the more involved stakeholders are (in terms of their portfolio and responsibility for pesticide management), the more likely they are to favor state intervention in pesticide risk prevention. Second, stakeholders representing the agriculture sector are slightly more inclined to favor state intervention.

Model 3 shows the regression analysis for district stakeholders only; effect directions remain the same, but **threat perception** has a highly significant effect on district stakeholder preferences. Local actors in particular play a fundamental role, as their ability to solve problems (Meyer and Konisky, 2007; Hirschi, 2010; Ingold, 2014; Newig et al., 2018) and their knowledge of and closeness to the problem and to target groups is vital for decision-making. Studies of pesticide regulation have emphasized that the inclusion of local actors contributes to a better understanding of the problem and the requisite actions (Karlsson, 2004; Isaac, 2012; Huici et al., 2017). While the interviewees stressed the need to raise awareness among national stakeholders, these results show that sub-national threat perception promotes acceptance of policy instruments, indicating that efforts to sensitize DFAs and district government officials to risk prevention should continue. **Forum participation** exhibits a marginally negative effect; the more district stakeholders participate in forums, the more likely they are to oppose state intervention. District stakeholders, who are close to farmers and understand problems of yield loss and economic hardship, regard pesticides as necessary to ensure food security (Interviews 2, 7). To enhance the potential for state-led pesticide risk prevention, exchanges on forums and other platforms should reflect the local context, including the perspectives of district stakeholders and farmers (Stein and Luna, 2021). Of the 49 forums referred to by interviewees, the most frequently mentioned body was the Agricultural Chemicals Control Board, a highly institutionalized entity. The Board's function is to oversee the registration of pesticides and to advise the Minister on policy adoption and implementation. In Uganda, where agricultural modernization and development has long shaped the political agenda and discourse (Hickey, 2005; Isgren, 2016), conventional agriculture is seen as the most innovative approach, and alternatives are considered backward and old. Actors who voice concerns about environmental degradation caused by conventional agriculture encounter hostility and are viewed as enemies of progress (Lyons and Westoby, 2014, 16). Forums like the Agricultural Chemicals Control Board and other platforms might be used to promote this rhetoric, and the promotion of agricultural growth and food security through the modernization of agriculture (Martiniello, 2015) might be prioritized over the promotion of targeted environmental risk prevention.

6. Conclusion

Targeted state intervention is needed to address complex environmental problems and to prevent risk. However, decision-makers may not support state intervention because of fears about the uncertainty, costs, and conflicts associated with political action. To investigate the potential for state intervention to prevent environmental risks, the present study explored stakeholder agreement with nine policy instruments targeting pesticide risk prevention in Uganda, where high levels of pesticide exposure have had detrimental effects on the environment and on human health. The results show that while there is generally strong support for state intervention, pesticide risk prevention remains a nascent policy problem, and regulation is still developing. The results mirror the current situation in Uganda; stakeholders are in favor of everything as long as action is taken to prevent risk. However, a closer look at the relevant policy instruments reveals that taxation measures are particularly controversial among stakeholders, as they are seen to impose an additional monetary burden on farming communities that are already suffering financial hardship. Instead, stakeholders favor promotion of the polluter-pays principle and its extension to manufacturers,

importers, and distributors to disincentivize pesticide use at every stage of the pesticide management cycle. Interest groups from the private sector and policy principals from the health sector exhibit a weaker preference for state intervention in this context. To address conflicts related to pesticide use, promotion of alternatives, and allocation of responsibilities, there is a need for inclusive and systematic coordination of the relevant narratives to promote government and private sector intervention for a more holistic approach to pesticide risk prevention in Uganda.

The present findings also suggest that stakeholders' individual attributes drive preferences for state intervention in pesticide risk prevention. Specifically, stakeholders are likelier to favor state intervention if they exhibit high threat perception, and agree with the precautionary principle. Closer inspection of the nine risk prevention policy measures reveals differences in the effects of individual drivers, which are significant in the case of highly restrictive measures that ban or restrict the use of synthetic pesticides and promote alternatives. However, external drivers did not have the expected effect on preferences, as cross-sectoral collaboration actually increases the likelihood of opposition to state-led pesticide risk prevention.

More generally, this research contributes to the policy literature in three ways. First, it corroborates the link between psychological determinants and stakeholder preferences, showing that stakeholders' preferences are not driven by rational choice alone but are shaped by complex mental models that call into question conventional explanations based on "homo economicus" (Burger et al., 2015). This presents an opportunity to raise awareness among farmers and local actors as well as national public actors who may not appreciate the risks of pesticides as against their benefits for agriculture. Since pesticide management was privatized in the 1990 s, the private sector has become a key player in the delivery of agricultural services (Martiniello, 2015; Isgren and Andersson, 2020), and NGOs have a crucial role to play in sensitizing farmers (Isgren, 2018). Scientific evidence must also play a part in raising awareness of these issues among national decision-makers and across society as a whole (Cairney and Oliver, 2020).

Second, state intervention and policy adoption do not happen in a vacuum; in other words, stakeholders are influenced by the surrounding social structures (Bressers and O'Toole, 1998; Metz, 2017). In this nascent policy field, the dynamics of environmental governance and collaboration differ from more established governance processes. The present findings invite discussion of how cross-sectoral collaboration can contribute to policy development and the underlying structural dynamics. While the literature suggests that friends or collaboration partners influence stakeholders' attitudes and behaviors, ongoing conflicts reflect a lack of trust in government and state intervention. In the Global South, private sector interventions to address complex environmental problems are the rule rather than the exception (Isgren and Andersson, 2020), and trust must be built in government and institutional venues to promote state intervention.

Finally, a better understanding of stakeholder preferences regarding state intervention makes it easier to predict the likelihood of policy adoption (Metz and Ingold, 2017; Glaus et al., 2020). While preferences in mature policy fields are already well-developed and consolidated (Stritch, 2015; Ingold et al., 2017) problem perceptions and beliefs exert a stronger influence in evolving fields. Focusing on individual drivers and policy instruments that facilitate state intervention enhances our understanding of preferences and potential pathways for action. In this comprehensive investigation of policy preferences, multivariate descriptive and correlation analyses helped to unravel how actors' characteristics influence responses to specific policy instruments. While the small sample size precluded generalization, qualitative interview data helped in interpreting and contextualizing the results and identifying potential pathways for pesticide risk prevention policy in Uganda.

In the broader context of pesticide risk reduction, conventional top-down policy making has been replaced by multi-stakeholder governance (Möhring et al., 2020). Working along different pathways that include advocacy and implementation, these stakeholders play a key role in helping or hindering decision-making and negotiating in relation to state intervention (Sager et al., 2020). Understanding stakeholders' preferences as political catalysts or constraints when addressing complex environmental problems can contribute to a paradigm shift from ignoring such problems and shifting responsibility to actors along the value chain to actively engaging these actors in collective action in pursuit of more sustainable production processes (Seifert et al., 2019).

In acknowledging the need for further research on potential state intervention, it seems clear that stakeholder preferences should be explored alongside other political constraints like public support or financial resources. It remains an open question whether state intervention in preventive risk reduction is effective or feasible in practice, and future research should incorporate performance measures such as political feasibility and policy effectiveness. While the present case study generates contextual knowledge of the potential for state intervention in pesticide risk reduction in Uganda, its main limitations are the lack of data on international stakeholders and the difficulty of accessing remote district actors. Future research must address these stakeholders' problem frames and preferences, as they play a crucial role in policy adoption (e.g., through by-laws and ordinances) and implementation (e.g., by providing extension services to farmers). As these stakeholders are often difficult to reach, conventional research methods should be complemented by participatory elements, working with local NGOs and interest groups to establish links with these stakeholder groups. Participatory research of this kind would facilitate collection of qualitative data about collaboration networks, knowledge exchange, and narratives as the basis for future analyses that enable social scientists to capture the complexity of processes like policy formulation and implementation.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.envsci.2022.01.003.

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