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Pesticide retailers' preferences for sustainability standard attributes: evidence from Nepal

Justice A. Tambo and Keith A. Holmes
CABI, Delémont, Switzerland
Vinod Pandit
CABI, New Delhi, India
Shah Faisal
CABI, Rawalpindi, Pakistan, and
Dilli Ram Sharma
Plant Protection Society Nepal, Kathmandu, Nepal

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Abstract

Purpose – Voluntary sustainability standards (VSSs) are considered one of the potential mechanisms for promoting agricultural sustainability and mitigating environmental problems, such as pesticide risks. While consumer and farmer preferences for sustainability standards have been well documented in the literature, the preferences of other important agri-food supply chain actors (such as input suppliers, traders, processors and retailers) have received much less attention. In this paper, we investigated pesticide retailers' perspectives on a hypothetical VSS scheme intended to promote environmentally friendly plant protection products.

Design/methodology/approach – We conducted a discrete choice experiment among 538 pesticide retailers in Nepal. Mixed logit models were used to estimate pesticide retailers' preferences for VSS attributes.

Findings – Pesticide retailers prefer VSSs that provide training opportunities, with a greater value attached to face-to-face training than e-learning. We found evidence that the potential to minimise the risks of pesticides to human and environmental health through VSSs is highly appreciated by the pesticide retailers. However, the results suggested that the retailers perceive a competitive disadvantage from selling only lower-risk pesticide products; hence, there is a lack of support for restricting the sale of highly hazardous pesticides, particularly among those currently selling biopesticide products.

Research limitations/implications – Pesticide retailers value VSSs as a potential mechanism to minimise the risks of pesticides to human health and the environment.

Originality/value – Our study focused on pesticide retailers, who are an important yet often-overlooked agribusiness actor in the sustainability standard literature. We highlighted some potential strategies for incentivising the uptake of environmentally friendly pesticides.

Keywords Pesticide risks, Pesticide retailers, Voluntary sustainability standards, Sustainable pest management, Nepal

Paper type Research article

1. Introduction

Recent decades have witnessed a rapid increase in pesticide sales and use globally, partly driven by frequent outbreaks of crop pests (FAOSTAT, 2023; Shattuck *et al.*, 2023). Unfortunately, some of the pesticides used by farmers are highly hazardous and are often applied indiscriminately, thereby posing serious risks to human and environmental health (Bhandari *et al.*, 2018; Kaur *et al.*, 2024). This has stimulated calls for the promotion of less hazardous pesticides and environmentally sound pest management methods, such as

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integrated pest management (IPM). Consequently, there is a growing body of literature examining motivations, intentions and willingness to reduce pesticide use and adopt IPM or other pesticide risk reduction strategies, especially at the farmer level (e.g. Chèze *et al.*, 2020; Bakker *et al.*, 2021; Abdollahzadeh *et al.*, 2024; Raimondo *et al.*, 2024).

Pesticide retailers can play a pivotal role in reducing the risks of pesticides to human health and the environment, given that they are an important source of knowledge and advice on pesticides and pest management for many farmers in the Global South, including Nepal (Bhandari *et al.*, 2018; Tambo *et al.*, 2024a). However, they may lack the knowledge and motivation to provide appropriate advice on IPM and pesticide risk reduction to their customers (Sharma *et al.*, 2013; Lekei *et al.*, 2014; Vaidya *et al.*, 2017). In this article, we assess pesticide retailers' preferences for some attributes of voluntary sustainability standards (VSSs) as a mechanism for reducing pesticide risks.

VSSs are "standards specifying requirements that producers, traders, manufacturers, retailers or service providers may be asked to meet, relating to a wide range of sustainability metrics, including respect for basic human rights, worker health and safety, the environmental impacts of production, community relations, land use planning and others" (UNFSS, 2013). VSSs are increasingly recognised as an important tool for solving key sustainability challenges, including pesticide risk reduction (Meemken *et al.*, 2021; UNFSS, 2022; van der Ven, 2022). Several major VSSs in the agricultural sector, such as Fairtrade, GlobalGAP, Organic and Rainforest Alliance, require compliance with pesticide regulations, including a ban on the use of hazardous pesticides. A number of studies have also shown that VSSs promote the use of environmentally friendly agricultural practices (Blackman and Naranjo, 2012; Kleeman and Abdulai, 2013; Ibanez and Blackman, 2016) and reduce the incidence of pesticide poisoning among farmers (Asfaw *et al.*, 2010; Sellare *et al.*, 2020). Nonetheless, VSS uptake is low in many developing countries due to challenges such as lack of incentives to adopt VSS schemes, certification costs, socio-political resistance to VSSs, and lack of inclusion of developing-country actors in VSS governance structures (UNFSS, 2022).

Given the recognition that stakeholders' concerns and inputs are crucial for designing new VSSs and the revision of existing ones (van der Ven, 2022), one strand of the literature on VSSs has focused on understanding individual preferences and attitudes towards sustainability attributes and VSS-certified products. However, previous studies have largely concentrated on farmers (e.g. Meemken *et al.*, 2017; Van den Broeck *et al.*, 2017; Hannus *et al.*, 2020; Lemeilleur *et al.*, 2020; Praneetvatakul *et al.*, 2022) and consumers (e.g. Gatti *et al.*, 2022; My *et al.*, 2018). The perspectives of pesticide retailers have generally been overlooked in the VSS literature despite their importance in agri-food supply chains and their potential role in meeting VSS requirements regarding pesticide risk reduction. As noted in the review by Meemken *et al.* (2021), research on sustainability standards should ideally focus on other agri-food supply chain actors beyond the often-studied farmers and consumers.

We aim to contribute to addressing this gap in the literature by examining the willingness of pesticide retailers to participate in a hypothetical VSS scheme that is aimed at reducing pesticide risks and protecting human and environmental health. In particular, we explore pesticide retailers' preferences for selected VSS attributes, such as pesticide sale restrictions, training modalities, quality assurance and inspection, health and environmental risks of pesticides and certification costs. The assumption is that pesticide retailers will show positive attitudes towards VSS related to pesticide risk reduction because they can gain a competitive market advantage through the sale of certified and environmentally friendly pesticides and the provision of plant health services to their customers. Given the potential risks of pesticides to human health, it is also possible that pesticide retailers may show strong interest in VSSs in order to protect their own health. Moreover, pesticide retailers who are environmentally conscious may value VSS attributes that promote ethical purchasing and sustainable agricultural practices.

Our analysis is based on data from a representative survey of pesticide retailers across all seven provinces of Nepal. Nepal is an interesting case to study, given the increasing trend in the sale and use of pesticides in the country (the quantity of pesticides imported into the country has nearly doubled in the past decade) (PQPMC, 2022). Moreover, there are reports suggesting that the Government of Nepal is keen on promoting sustainable crop protection solutions, for instance, through the banning of 24 highly hazardous pesticides in the past 2 decades and the prioritisation of IPM as a major strategy for pest management in the country (Adhikari *et al.*, 2019; PQPMC, 2022). Nonetheless, there have been some reports of poor pesticide practices among pesticide retailers in the country, including sales of banned, expired and fake products (Sharma *et al.*, 2013; Bhandari, 2021).

It should be noted that there is no existing pesticide retailer-focused VSS in Nepal or elsewhere that is geared towards pesticide risk reduction. Thus, our study does not examine preferences for actual VSS schemes. Instead, we aim to understand pesticide retailers' perspectives on various attributes of a hypothetical VSS scheme and their willingness to restrict the sale of dangerous pesticides and contribute to environmental sustainability. The findings of the study can provide useful insights into the features of VSSs that are particularly liked or disliked by private-sector input retailers, which can be helpful in improving the design of VSSs in food supply chains.

2. Data and methods

2.1 Data collection

The data used in this study came from a survey of 538 pesticide retailers in Nepal. The survey was conducted in September–November 2022 across all the seven provinces and three ecological regions of Nepal. [1] We purposively selected representative districts in each province based on the distribution of pesticide retail shops across the country. In total, the survey covered 39 out of the country's 77 districts (Figure A1 in the Supplementary Material). In each chosen district, between 10 to 20 pesticide retailers were randomly selected for interviews. The study districts and the number of pesticide retail shops selected from the seven provinces are presented in Table A1 in the Supplementary Material. In terms of ecological regions, the data comprised of 293, 230 and 15 pesticide retailers from the Terai, Hill and Mountain regions, respectively. The majority of Nepalese pesticide retailers are concentrated in the Terai region and Kathmandu Valley (Hill region) where most vegetables and fruits are grown (Yadav and Lian, 2009); hence, this explains the relatively small number of sampled retailers from the Mountain region. In fact, about 94% of the country's population live in the Terai and Hill regions (National Statistics Office, 2023).

All selected pesticide retail shops were visited for face-to-face interviews with retailers who regularly attend to customers. All the interviewed pesticide retailers gave their consent to participate in the survey. The interviews were conducted by a team of 13 local enumerators who were trained by the researchers. Data were collected using a tablet-based questionnaire programmed on Open Data Kit platform. The questionnaire was pre-tested with a sample of pesticide retailers in Shankharapur municipality. The questionnaire included questions on pesticide retailers' socio-demographic characteristics, shop characteristics, including types of products sold, knowledge of and attitudes towards biopesticides and IPM, training needs and access to institutional support services, as well as a hypothetical choice experiment to elicit preferences for VSS attributes. In addition to the interviews, the enumerators conducted shop observations to record the types of products sold and to check for regulatory compliance.

2.2 Choice experiment design

We used a discrete choice experiment (DCE) method to elicit and analyse the pesticide retailers' preferences for a hypothetical VSS scheme. The DCE is a popular approach for studying individual stated preferences for actual or hypothetical products and services (Hensher *et al.*, 2015). In our DCE, pesticide retailers were asked to make choices among several alternatives (choice sets) containing a number of attributes with varying attribute levels of VSSs. Following the random utility framework (McFadden, 1973), it is assumed that the pesticide retailers will evaluate the VSS attributes, and then decide whether or not to participate as well as the combinations of attribute levels that yield the highest personal utility.

The first step in conducting the DCE is to identify relevant attributes of the VSS and levels of those attributes. Guided by best practices (Lagarde and Blaauw (2009; WHO, 2012), the identification and selection of attributes were informed by literature review as well as group discussions and interviews with relevant stakeholders in Nepal. First, several potentially relevant VSS attributes were identified based on insights from agro-input dealer certification schemes (Holmes and Ogunmodede, 2023) and a review of the literature on preferences for sustainability standards in the agri-food supply chain, which has mostly focussed on farmers (e.g. Meemken *et al.*, 2017; Van den Broeck *et al.*, 2017; Praneetvatakul *et al.*, 2022). The final set of attributes for inclusion in the DCE were selected after consultation with crop health and pesticide experts, as well as group discussions with a sample of pesticide retailers and managers of the pesticide regulatory authority in Nepal. To reduce the complexities of the choice sets and cognitive overload on the interviewed pesticide retailers, the number of attributes was restricted to six (see Table 1). Following a study on the design of sustainability standards (Meemken *et al.*, 2017), these six attributes include a package of requirements (i.e. pesticide-sale model, training model, quality control and investment cost) and expected benefits (income effect and health and environmental risks) of VSSs for the pesticide retailers. For a detailed description of the six attributes, see the choice experiment protocol in the Supplementary Material.

Given that the six VSS attributes in Table 1 have 3, 3, 2, 6, 2 and 4 attribute levels respectively, a full factorial design will generate $3 \times 3 \times 2 \times 6 \times 2 \times 4 = 864$ VSS profiles. This implies $(864 \times 863)/2 = 372{,}816$ possible choice sets, which are not practically feasible to present to the respondents. We therefore used a D-efficient design with zero priors to generate a subset of VSS profiles using the dcreate procedure in Stata (Hole, 2017). Specifically, we developed 18 choice sets, with each choice set having different combinations of the attribute levels. We checked that none of the 18 choice sets had an unrealistic or a dominant VSS profile.

Table 1. VSS attributes and attribute levels used in the choice experiment

Attributes	Attribute levels
Pesticide-sale model	Sale of registered products
	Sale of only registered low-risk products (LRPs)
	Sale of only registered LRPs + service provision
Training model	No training
	Virtual training
	Face-to-face training
Quality control	Scheduled inspection + record keeping
	Unannounced inspection + record keeping
Income effect	None, 2%, 4%, 6%, 8%, 10%[a]
Health and environmental risks	Low, High
Investment costs	4,000, 6,000, 8,000, 10,000 NPR[b]

Note(s): [a]These income percentages were determined based on a group discussion with a sample of pesticide retailers and regulators on the range of additional income that could be earned from a VSS, given its features and the current profit margins from pesticide business., [b]NPR denotes Nepal Rupees. 1 USD = 130 NPR at the time of the survey. The investment cost levels were set around the amount (5,000–7,000 NPR) that pesticide retailers in Nepal sometimes have to pay in order to participate in the country's mandatory certification course. During a discussion with representatives from the Plant Quarantine and Pesticides Management Center (PQPMC) and the Pesticide Entrepreneur Association of Nepal (PEAN), we verified that these amounts are realistic and acceptable
Source(s): Authors' own work

The 18 choice sets were divided into three blocks of six choice sets each. The interviewed pesticide retailers were randomly assigned one block, and thus, each respondent was asked to complete six choice sets that were presented to them in a random order by an enumerator. The choice sets were presented on choice cards, an example of which is illustrated in Figure A2 in the Supplementary Material. Each card shows three options, labelled A, B and C. Options A and B always reflect VSSs with variations in attributes, while Option C reflects the pesticide retailing system without a VSS (i.e. a status quo option). The status-quo option captures the pesticide retailers' preferences that are unobservable and prevents the bias of forcing respondents to choose a VSS with specified attributes even if they dislike it. After providing detailed explanations on the purpose of the experiment, the six attributes and their levels, and the hypothetical setting, the respondents were asked to choose their most preferred option from the three options on each of the six choice cards.

2.3 Estimation methods

Prior to examining preferences for VSS attributes, we analysed the characteristics of the pesticide retailers and their shops using descriptive statistics. We then used a mixed logit model to estimate the pesticide retailers' preferences for VSS attributes. The mixed logit model accounts for heterogeneity in preferences across respondents and relaxes the restrictive assumption of independence of irrelevant alternatives (IIA), unlike alternative models such as the conditional and multinomial logit models (Train, 2009). We estimated the following utility function:

$$\begin{aligned} U_{ijt} = {} & \beta_0 ASC + \beta_1 LowRiskProducts_{ijt} + \beta_2 LRPs\&Services_{ijt} + \beta_3 VirtualTraining_{ijt} \\ & + \beta_4 FaceTraining_{ijt} + \beta_5 UnannouncedControl_{ijt} + \beta_6 ExpectedIncome_{ijt} \\ & + \beta_7 LowHealthEnv_{ijt} + \beta_8 InvestCost_{ijt} + \mu_{ijt} \end{aligned} \tag{1}$$

where U is the utility that a pesticide retailer i derives by choosing alternative j on choice set t; βs are the parameters to be estimated; and μ denotes a random error term. ASC is the alternative specific constant and is equal to 1 for the op-out alternative and 0 for the two VSS profiles in each choice set. The expected income effect and investment cost attributes were specified as continuous variables, while the remaining attributes were dummy-coded, in line with suggestions by Mariel *et al.* (2021) and Hu *et al.* (2022).

Three different models were used to estimate Eq. (1). In the first model, the investment cost attribute was treated as fixed with the assumption that every pesticide retailer is likely to prefer lower investment costs for participating in voluntary standards, while all the other attributes had random coefficients. Such a specification allows a direct estimation of willingness to pay (WTP) in preference space (Hole and Kolstad, 2012). However, considering that the assumption of a fixed investment cost is potentially restrictive, we estimated a second model in which all the attributes (including investment cost) were treated as random, and thus preferences for the attributes are considered to vary across the pesticide retailers. We estimated the mixed logit models (models 1 and 2) using maximum simulated likelihood with 500 Halton draws (Hole, 2007). When estimating the two mixed logit models, it was assumed that the pesticide retailers had considered all the six attributes when making their choices. However, studies have shown that respondents in choice experiments may ignore some attributes when making their choices (commonly referred to as attribute non-attendance), potentially leading to bias parameter estimates (Hensher, 2006; Kragt, 2013). Hence, we estimated a third model in which attribute non-attendance was taken into account by applying the endogenous attribute attendance model (Hole, 2011). Following Hole and Kolstad (2012), the goodness-of-fit of the three models was compared using information criteria, such as Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and log likelihood.

Finally, we used the coefficients estimates of equation (1) to compute pesticide retailers' willingness to pay (WTP) for the attributes of the VSS as follows:

$$WTP_{attribute} = \frac{\beta_{attribute}}{-\beta_8} \quad (2)$$

where $\beta_{attribute}$ is the estimated parameter of the attribute for which the WTP is computed and β_6 is the estimated investment cost coefficient. The WTP estimates translate into monetary terms the utilities that pesticide retailers gain from the VSS attributes.

3. Results and discussion

3.1 Pesticide retailer characteristics

A majority (84%) of the respondents were male pesticide retailers, with an average age of about 42 years, 13 years of formal education and 13 years of experience in agro-input dealership (Table 2). Nearly half of the pesticide retailers were members of an agro-input dealer association, particularly the Pesticide Entrepreneur Association of Nepal (PEAN). Most of the pesticide retailers were aware of biopesticides, but less than half of them had at least a vague idea about IPM. Roughly a quarter of the pesticide retailers had experienced acute pesticide poisoning symptoms, such as headache, sneezing, eye irritation, skin irritation and nausea.

Table 2 shows that 95% of the pesticide vendors were licensed with the regulatory authority (PQPMC), which is a requirement under Nepal's Pesticide Management Act, 2019. Thus, a large majority of the pesticide retailers in our sample qualify to sell pesticides in the country. Moreover, 95% of the pesticide retailers have attended the mandatory training course for pesticide retailers. This contrasts with evidence from some African countries indicating that many agro-input dealers do not possess the necessary certification and have not had the required training (Odame and Muange, 2011; Lekei *et al.*, 2014; Tambo *et al.*, 2024b). Nearly 88% of the retailers reportedly kept records of business transactions. Maintaining proper records of pesticide transactions, including the price and quantity traded is mandatory for pesticide retailers in Nepal, as emphasised in the country's Pesticide Management Act 2019 (GoN, 2019).

Table 2. Pesticide retailer and shop characteristics

	Mean	SD
Age of pesticide retailer (years)	41.86	11.42
Gender of pesticide retailer (1 = male)	0.84	0.37
Education of pesticide retailer (years)	12.55	2.40
Pesticide retailing experience (years)	12.79	8.99
Membership in agro-dealer association (1 = yes)	0.48	0.50
Registered with PQPMC (1 = yes)	0.95	0.21
Attended pesticide training course (1 = yes)	0.95	0.23
Has a pesticide trading license (1 = yes)	0.94	0.23
Aware of biopesticides (1 = yes)	0.95	0.23
Aware of IPM (1 = yes)	0.45	0.50
Keeps records of business transactions (1 = yes)	0.85	0.36
Sells at least one biopesticide product (1 = yes)	0.65	0.48
Sells at least one high-risk pesticide product (1 = yes)	0.96	0.19
Sells PPE items	0.45	0.50
Staff has suffered pesticide-related illness (1 = yes)	0.26	0.44
Number of observations	538	

Source(s): Authors' own work

All the surveyed agro-input shops were selling seeds and pesticides, including insecticides, herbicides and fungicides. Almost 80% of these shops also stocked fertilizers, and tools and equipment. Worryingly, only 45% of the shops were selling personal protective equipment (PPE) items. Thus, more than half of the retailers were selling pesticides without the necessary apparel that can protect their customers against pesticide exposure. They are therefore violating a provision in the Pesticide Management Act of Nepal, which states that: "any person or institution that sells or distributes pesticides shall put on sale safe pesticides and also safe attire to be worn while using and disposing the pesticides". The lack of availability of PPE in local shops has often been cited as one of the major reasons for their limited use among smallholder farmers in Nepal and elsewhere (Bhandari *et al.*, 2018; Tambo *et al.*, 2021).

Almost all the agro-input shops were selling at least one pesticide product that can be considered as a high-risk product. The most stocked high-risk products include mancozeb and chlorpyrifos, which were found in more than 80% of the shops (Table A2 in the Supplementary Material). Roughly half of the shops also had stocks of carbendazim, abamectin and paraquat. Aluminium phosphide was being sold in about a quarter of the shops, even though it is a banned pesticide in Nepal (PQPMC, 2022). Other banned and high-risks products found in a few shops include endosulfan, monocrotophos, triazophos, chlordane, aldrin, phorate and carbofuran. This is in line with evidence that banned pesticides were still in use in Nepal, partly due to smuggling of pesticides across porous borders (Bhandari *et al.*, 2018; Bhattarai *et al.*, 2019; Utyasheva *et al.*, 2021). Unfortunately, these banned pesticides are the most frequently used for fatal self-poisoning, which constitutes about a quarter of suicide cases in Nepal (Utyasheva *et al.*, 2021).

While all the 538 agro-input shops visited across the country sold synthetic pesticides, 65% of them were also selling environmentally friendly biopesticides, such as azadirachtin, *Trichoderma viride, Trichoderma harzianum* and *Bacillus thuringiensis*. The pesticide retailers cited a lack of demand from farmers and unawareness as the main reasons for not stocking biopesticides in their shops (Figure A3 in the Supplementary Material). Similar reasons have been identified as challenges for the limited sale and use of biopesticide products in Nepal and Kenya (Adhikari *et al.*, 2019; Constantine *et al.*, 2020). These bottlenecks to biopesticide sales and uptake need to be given attention to if the potential health and environmental benefits associated with biopesticides are to be realised. Policy efforts to tackle these challenges and promote investments in biopesticides could include subsidy schemes, sustainability standards, training and awareness-raising interventions, and improved regulatory systems, such as regional harmonisation of pesticide regulations (Day *et al.*, 2022).

3.2 Preferences and willingness to pay for VSS attributes

Table 3 presents three different estimation results of the pesticide retailers' preferences for VSS attributes. Model 1 is a mixed logit model in preference space in which all the attributes have random coefficients except the investment cost coefficient, which is fixed. In model 2, all the attributes (including investment cost) are treated as random. Model 3 is an EAA model which accounts for attribute non-attendance. The goodness-of-fit results reported in the lower part of Table 3 show lower log-likelihood, AIC and BIC values for models 1 and 2 (and are thus better performing models) compared to model 3. This is possibly because unlike models 1 and 2, the EAA model (model 3) does not account for preference heterogeneity. The statistical significance of the standard deviation parameters in Table 3 further confirms the existence of heterogeneity in the pesticide retailers' preferences. The results also show that model 2 outperforms model 1 on all three measures of fit, indicating that the model goodness-of-fit improves when the investment cost attribute is treated as a random variable. Thus, model 1 where investment cost is assumed to be fixed is too restrictive. We find fairly similar results across the three models in terms of sign and significance of the mean parameters.

The estimated coefficient on the ASC variable is negative and statistically significant at the 1% level, indicating that the pesticide retailers have a generally negative attitudes towards

Table 3. Model estimates of preferences for VSS attributes

	Model 1	Model 2	Model 3
Mean parameters			
ASC	−2.097*** (0.244)	−3.976*** (0.529)	−1.936*** (0.259)
Sell only low-risk products (LRPs)[1]	0.250 (0.250)	0.250 (0.248)	0.587 (0.580)
Sell only LRPs + diagnostic services[1]	0.506* (0.265)	0.435* (0.258)	0.784 (1.363)
Virtual training[2]	0.529*** (0.178)	0.569*** (0.175)	0.820*** (0.311)
Face-to-face training[2]	0.759*** (0.212)	0.794*** (0.214)	1.199** (0.566)
Unannounced inspection[3]	−0.286*** (0.082)	−0.237*** (0.078)	−0.449** (0.193)
Expected income effect	0.072** (0.029)	0.048* (0.028)	0.159*** (0.058)
Low health and environmental risks[4]	1.720*** (0.291)	1.571*** (0.280)	2.819*** (0.302)
Investment costs (100 NPR)	−0.006* (0.003)	−0.005* (0.003)	−0.017*** (0.005)
Standard deviations			
Sell only low-risk products (LRPs)	0.115 (0.204)	0.027 (0.198)	
Sell only LRPs + diagnostic services	1.056*** (0.174)	0.927*** (0.170)	
Virtual training	0.462** (0.193)	0.115 (0.418)	
Face-to-face training	−0.844*** (0.171)	−0.818*** (0.148)	
Unannounced inspection	0.870*** (0.114)	0.781*** (0.122)	
Expected income effect	0.146*** (0.022)	0.029 (0.094)	
Low health and environmental risks	1.751*** (0.144)	−1.740*** (0.155)	
Investment costs (100 NPR)		0.010* (0.005)	
Log likelihood	−2075.602	−2050.47	−2112.52
AIC	4183.204	4136.94	4253.05
BIC	4298.056	4266.15	4353.54
Observations	9,684	9,684	9,684

Note(s): ***, **, and * denote 1%, 5%, and 10% statistical significance levels, respectively. Standard errors are in parentheses, [1]Reference category is sale of any registered product., [2]Reference category is no training provided., [3]Reference category is unannounced annual inspection., [4]Reference category is high health and environmental risks

Source(s): Authors' own work

maintaining the status quo. Results from all three models show that the requirement of selling only registered lower-risk products does not affect the pesticide retailers' utility significantly. This implies that the pesticide retailers are indifferent between selling registered pesticide products (including high-risk products) and selling only registered lower-risk products. The positive and significant coefficient on "sell only LRPs + diagnostic services", however, indicates that the pesticide retailers may be willing to accept to sell only lower-risk registered products if they are provided with the capacity to offer plant health diagnostic and advisory services to their customers, but the coefficient is only significant at the 10% level. Taken together, the results suggest that the pesticide retailers are not very keen on shifting to the sale of only lower-risk pesticide products.

The coefficients on the two training attribute levels (face-to-face and virtual training) are both positive and highly significant, indicating that the pesticide retailers perceive that they would gain utility from VSSs that provide training opportunities. This is unsurprising considering that training can enhance their capacity to provide additional and improved services to their clients, which in turn can lead to an increase in customers and product sales. A study in Nepal has shown that providing training to pesticide retailers resulted in a significant increase in knowledge on pesticide risks and a reduction in sales of unregistered pesticides (Vaidya *et al.*, 2017). We find a negative and significant coefficient for the shop inspection attribute, indicating that the pesticide retailers prefer record keeping with scheduled rather than unannounced inspection of shops for ensuring compliance with quality assurance standards, which is to be expected. The results in Table 3 also demonstrate that the pesticide retailers are concerned about the health and environmental risks of pesticides, and achieving a reduction in these risks has a positive effect on their utility. The investment costs coefficient has the expected negative sign, indicating that the pesticide retailers prefer VSSs with lower participation costs, which include training and quality control costs.

The parameter estimates in Table 3 were used to compute the pesticide retailers' WTP for a change in different VSS attributes, and the results are presented in Table 4. The monetary WTP values can be interpreted as the indicative amount of money that pesticide retailers are willing to pay to participate in a VSS that includes the specified attribute. Given the well-known hypothetical bias that are associated with stated preference data, the exact WTP values need to be interpreted with some caution. Nonetheless, at least they give an indication about the relative importance the pesticide retailers attach to the different VSS attributes. We find major differences in the magnitudes of the WTP estimates across the three models, with substantially lower estimates from model 3, which does not control for preference heterogeneity. The relative importance of the attributes is however similar across the three models.

Focussing on the estimates from the more realistic model (model 2), the results show that pesticide retailers are willing to pay nearly 10,000 NPR per year to participate in a VSS that allows the sale of registered lower-risk products and the offering of crop pest diagnostic and advisory services to farmers. They are also willing to pay roughly 13,000 NPR annually for a VSS that provides an online training course on crop protection. Interestingly, they are willing to pay 5,000 NPR more if the training is delivered face-to-face rather than electronically. With increasing access to the internet and smartphones, coupled with time pressure on private pesticide retailers and in the wake of the Covid-19 pandemic, one could expect that the often-busy pesticide retailers may attach a higher value to an online training course that will allow self-regulated learning. The greater preference for in-person training is however not surprising, given that that only 32% of the pesticide retailers in our sample had ever participated in an e-learning course. Moreover, a face-to-face model of training can allow a better understanding of the training content and the acquisition of practical pest diagnostic skills, as well as interaction and networking with fellow pesticide retailers. It is also possible

Table 4. Willingness to pay estimates (NPR)

Attribute	Model 1	Model 2	Model 3
Sell only low-risk products (LRPs)	4022.58 (−3613.17, 11,658.33)	5699.10 (−5455.13, 16853.34)	3518.66 (−1855.13, 8892.45)
Sell only LRPs + diagnostic services	8158.42 (−2800.28, 19,117.13)	9907.39 (−7000.89, 26,815.66)	4701.36 (−9359.13, 18761.84)
Virtual training on pesticides	8522.69 (−74.04, 17119.41)	12,982.76 (−4752.37, 30717.88)	4918.82 (1550.70, 8286.93)
Face-to-face training on pesticides	12238.24 (1243.69, 23232.79)	18100.39 (−5184.75, 41385.53)	7189.09 (−2544.62, 16922.80)
Unannounced inspection	−4613.36 (−9170.62, −56.11)	−5411.03 (−12967.81, 2145.74)	−2692.22 (−4194.16, −1190.28)
Expected income effect	1154.02 (253.26, 2054.77)	1101.23 (−110.09, 2312.56)	950.67 (498.40, 1402.95)
Low health and environmental risks	27718.12 (−1176.94, 56613.17)	35820.95 (−17340.09, 88981.99)	16902.59 (8264.54, 25540.65)

Note(s): Numbers in parentheses are 95% confidence intervals using the delta method
Source(s): Authors' own work

the retailers perceive that it would be more costly to organise a face-to-face training than virtual training, and thus the relatively higher WTP value for face-to-face training reflects this perspective.

The negative WTP value for the quality control attribute means that pesticide retailers would be willing to pay an annual fee of 5,411 NPR to avoid having their shops inspected for quality assurance purposes without prior notification. Put differently, the retailers are willing to pay this amount for a scheduled (rather than unannounced) inspection of shops for compliance with VSS requirements. We also find that the average pesticide retailer would be willing to pay 1100 NPR per year if VSS participation is associated with a 1% increase in income from pesticide business. Finally, the health and environmental risks attribute is associated with the highest annual WTP estimate of 36,000 NPR, suggesting that pesticide retailers highly value VSSs aimed at reducing pesticide risks.

Our results are comparable to those of other studies that have examined preferences for VSS attributes among some agri-food supply chain actors (Meemken *et al.*, 2017; Van den Broeck *et al.*, 2017; Gatti *et al.*, 2022; My *et al.*, 2018; Praneetvatakul *et al.*, 2022). For example, Meemken *et al.* (2017) found that Ugandan coffee farmers have positive attitudes towards sustainability standards but dislike restrictions on pesticide use. Praneetvatakul *et al.* (2022) also observed that vegetable farmers in Thailand are interested in adopting ecolabels signalling environmentally-friendly pest management. In Vietnam, My *et al.* (2018) showed that health- and environmentally conscious consumers are willing to pay higher premiums for certified sustainably-produced rice.

A legitimate question is that if the pesticide retailers in our sample place a high value on pesticide risk reduction, why are they not highly supportive of the requirement to sell only registered lower-risk products. As shown earlier, the demand for lower-risk pesticides (such as biopesticides) is low and irregular, while high-risk pesticide products (such as chlorpyrifos) are among the most highly demanded pesticide products in Nepal. Hence, a restriction on the sales of high-risk products will imply a loss of customers to competitors who may not participate in VSSs. Moreover, due to weak border controls, customers may be able to access the restricted high-risk products from neighbouring countries (Bhandari *et al.*, 2018), potentially leading to revenue losses for the pesticide retailers who will choose to participate in VSSs. However, if the scheme facilitates access to additional income-generating activities, such as pest diagnostic and advisory services, the pesticide retailers may be willing to comply with the requirement of selling only registered low-risk products. This is further buttressed by the result on the "expected income effect" attribute in Table 3, which shows that the pesticide retailers have a positive preference for a VSS that increases income from crop protection business.

3.3 Preference heterogeneity

In this section, we explore two sources of preference heterogeneity. [2] First, we examine whether there is spatial heterogeneity in pesticide retailers' preferences for the attributes by estimating separate mixed logit models for the Terai (lowland) and Hill ecological regions of Nepal. [3] The results are presented in Table A3 in the Supplementary Material. The significantly negative ASC coefficients indicate that pesticide retailers in both ecological regions have a positive general attitude towards VSSs. Pesticide retailers in both the Terai and Hill regions have a positive attitude towards a reduction in the risks posed by pesticides to humans and the environment. However, regardless of their location, the pesticide retailers are indifferent between selling registered high-risk and low-risk pesticide products. They exhibit a similar significant preference for face-to-face training compared to no training on pesticides, and dislike unannounced quality control inspections. However, while pesticide retailers in the Hill region prefer to receive virtual training on pesticides as compared to no training, their counterparts in the Terai region are indifferent between virtual and no training on pesticides. In other words, the retailers in the Terai region do not see a value in participating in pesticide training if it is delivered via e-learning. Perhaps this is due to differences in access to resources needed for e-learning, such as internet facility and smartphone or laptop, given that the Hill region includes the Kathmandu valley, which is the country's most urbanised area. We also find spatial heterogeneity in preferences for attributes related to income and investment cost. Pesticide retailers in the Hill region prefer a VSS with a lower investment cost and a higher income effect, while those in the Terai region are indifferent about the levels of costs and potential income gains associated with participating in a VSS.

We also examine whether the pesticide retailers' preferences for the VSS attributes are influenced by previous experience in selling biopesticides, which are lower-risk plant protection products. The results in Table A3 indicate that both sellers and non-sellers of biopesticides have positive attitudes towards the VSS. They both expressed interest in participating in pesticide training (either virtually or in-person) and perceive that they can derive utility from reducing pesticide risks on human and environmental health. Interestingly, the retailers who currently sell biopesticide products are indifferent towards the pesticide-sale model attributes. Thus, they do not show willingness to shift from the sale of registered pesticide products to the sale of only registered lower-risk products, even if combined with service provision. Conversely, the retailers who have not dealt with biopesticide products express a significant preference for selling only registered lower-risk products, particularly if combined with having the capacity to diagnose crop pest problems and provide advisory services to their customers. This finding is understandable considering that low farmer demand is a major obstacle to the supply of biopesticides, as shown in Figure A3 and in other studies (Constantine *et al.*, 2020). Hence, pesticide retailers who have had prior experience in trading in biopesticides may be sceptical about having to sell only registered lower-risk products when they are not convinced about farmers' demand for such products.

Our results suggest that to encourage many pesticide retailers to participate in a VSS requiring a restriction on the sale of high-risk products, it would be necessary to incentivise the demand for lower-risk pesticide products. For example, enhancing farmers' knowledge about pesticide risks and IPM through awareness campaigns could play a significant role in driving the demand for safer alternatives to synthetic pesticides, as shown in a recent study from East Africa (Tambo *et al.*, 2023). This may in turn induce a reduction in the supply of high-risk products. Furthermore, given the public good benefits of a reduction in pesticide risks, incentive-based policies such as subsidies on biopesticides and payments for IPM adoption, as well as pesticide taxes based on toxicity levels can be used to incentivise the supply and adoption of lower-risk crop protection products (Möhring *et al.*, 2020; Day *et al.*, 2022). This is particularly important in the context of countries like Nepal, where biopesticides currently account for only about 0.1% of total pesticide import (PQPMC, 2022).

4. Conclusion

In this study, we used a choice experiment survey conducted in Nepal to assess pesticide retailers' preferences and willingness to pay for attributes of sustainability standards. Results revealed a high interest in VSSs aimed at reducing pesticide risks. The pesticide retailers showed preference for VSSs that will provide training opportunities, with a greater value attached to face-to-face training compared to e-learning, particularly among those located in the Terai region of Nepal. The retailers expressed a positive preference for standards that can generate income gains but showed a negative attitude towards unannounced visits to shops to conduct annual quality control inspections. They demonstrated a strong willingness to pay to avoid the health and environmental risks associated with pesticides. However, the results suggested that the retailers perceive a competitive disadvantage from selling only lower-risk pesticide products, plausibly because of the low farmer demand for lower-risk products (such as biopesticides), the ease of accessing cheaper high-risk products from neighbouring countries, and the fact that high-risk pesticide products constitute the best-selling products for most pesticide vendors in the country. In fact, the results showed that biopesticide retailers do not perceive utility from the prohibition of certain pesticides under a VSS scheme. We also found suggestive evidence that the pesticide retailers may be willing to accept to sell only registered lower-risk products if combined with the provision of pest diagnostic and advisory services, which can increase their competitiveness and provide financial benefits.

We conclude that pesticide retailers value VSSs as a potential mechanism to minimise the risks of pesticides to human health and the environment. However, the lack of support for restricting the sale of high-risk pesticides suggests the need for other incentive mechanisms, if pesticide risk reduction goals are to be achieved. For instance, training the pesticide retailers on lower-risk plant protection products and reorienting their business models towards the provision of IPM-based services may help reduce the heavy reliance on increased sales of pesticide products, including high-risk products.

A limitation of this study is the hypothetical nature of the choice experiment, as VSS schemes for pesticide retailers are not yet implemented in practice. It is well known that respondents tend to overstate their willingness to pay in hypothetical settings compared to real settings (Mariel *et al.*, 2021). Another limitation is that while there are several possible attributes of VSSs, we included only six of them in the choice experiment so as to reduce respondent cognitive fatigue. For instance, it would be interesting to assess pesticide retailers' attitudes towards specific health and environmental risks of pesticides and their preferred organization to implement the VSS (e.g. government vs. private or local vs international). Thus, further research that examines other VSS attributes in different settings will be important for understanding the external validity of our results and will contribute to improving the design of VSSs for pesticide retailers. Another interesting topic for future research would be to investigate whether the potential income gains from VSS can actually cover the required investment costs as well as any potential loss of income due to pesticide sale restrictions.

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Supplementary material

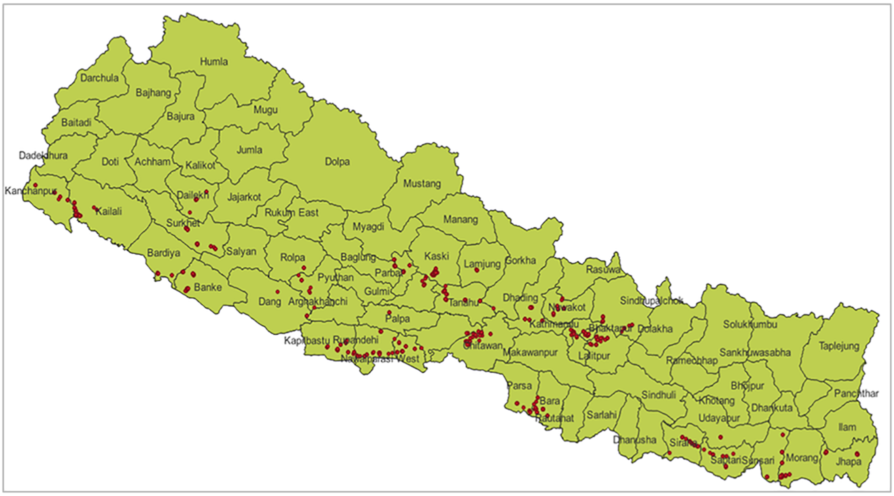


Figure A1. District map of Nepal showing the survey locations. Source: Authors' own work

Choice experiment protocol

We are conducting a study to understand pesticide retailers' preferences for a voluntary sustainability standard (VSS) scheme that is aimed at reducing pesticide risks and protecting human and environmental health. To this end, you will be guided through an experiment in which you will have the opportunity to choose between different hypothetical options of a VSS scheme. The options will differ in terms of the attributes (i.e. requirements and potential benefits) of the VSS scheme. Please note that this is just an experiment and the choices you make here are purely hypothetical. Nonetheless, you are expected to make very truthful choices like you would if you were actually facing these exact choices in reality.

Before starting the experiment, let me explain the VSS attributes in detail. We consider six attributes, namely pesticide-sale model, training model, quality control, expected income, health and environmental risks, and investment costs.

Pesticide-sale model

This attribute refers to the pesticide-related business model you will be required to operate under the VSS scheme. We consider three possibilities:

(1) You will be required to sell any pesticide product so far as it is registered (i.e. no restriction on sale of registered products).

(2) You will be required to sell only registered low-risk products.

(3) You will be required to sell only registered low-risk products, but in addition, you will have the capacity to provide diagnostic and IPM-based advisory services to farmers.

Note that low-risk products can be considered to be those synthetic or biological-based plant protection products which: (1) do not contain substances that are extremely or highly acutely toxic (WHO classes Ia or Ib); (2) do not cause cancer, mutations, fertility and reproduction problems, as reported in national and international databases, such as the Classification and Labelling Inventory of the European Chemical Agency; (3) and are not banned or restricted for health or environmental reasons by national governments or international agreements, such as the Rotterdam Convention, the Stockholm Convention and the Montreal Protocol.

Training model

This attribute relates to the level of training offered as part of the VSS scheme. The training will enhance your skills in crop protection, including pesticide products, pest diagnosis and management, as well as the provision of advisory services. Here, there are three possibilities:

(1) No training provided

(2) Virtual training provided

(3) Face-to-face training provided

Quality control

This attribute is meant to check that you comply with the contractual quality assurance requirements of the VSS scheme. There are two possibilities:

(1) "Scheduled annual inspection + mandatory record keeping" means that your shop and pesticide sale records will be inspected annually on a date agreed with you. In addition, you will be required to maintain pesticide sale records as well as a record of the pest-related advice that you give to your customers.

(2) "Unannounced annual inspection + mandatory record keeping" means that your shop and pesticide sale records will be inspected annually, without prior notice to you. In addition, you will be required to maintain pesticide sale records as well as a record of the pest-related advice that you give to your customers.

Investment costs

(1) This relates to the costs, such as training, certification and inspection costs, that a pesticide retailer would have to incur annually in order to participate in a VSS scheme. The investment costs in the different VSS options include:

(2) 4,000 NPR

(3) 6,000 NPR

(4) 8,000 NPR

(5) 10,000 NPR

Health and environmental risks

This attribute captures the potential risks of pesticides to human health and the environment. This is defined by two levels:

(1) Low risks to humans and the environment

(2) High risks to humans and the environment

High health and environmental risks include acute and chronic health problems from direct exposure to pesticides among retailers and their customers, food contamination, soil and water pollution, as well as poisoning of pollinators, natural enemies and other beneficial organisms. Thus, low risks mean that pesticide retailers and their customers are unlikely to experience these adverse health and environmental effects of pesticides.

Expected income

This attribute relates to the financial benefits that could be derived from crop protection business as part of the VSS scheme. The income gain could be due to a potential increase in product sales (pesticides and PPE) due to enhanced reputation of selling quality and reliable low risk products, and from the provision of quality plant health diagnostic and advisory services to farmers. The income effect is defined by six levels:

(1) Same as your current income from crop protection business

(2) 2% increase over your current income from crop protection business

(3) 4% increase over your current income from crop protection business

(4) 6% increase over your current income from crop protection business

(5) 8% increase over your current income from crop protection business

(6) 10% increase over your current income from crop protection business

I will present to you six choice cards, where each card shows three options (A, B, and C). On each choice card, options A and B always reflect VSSs with variations in attributes, while Option C mostly reflects the situation in the pesticide retail business without a VSS. Thus, the descriptions of "Option A" and "Option B" will change on the six cards because they involve different VSS attributes. Please consider the options carefully and choose the one that you prefer between the three options on each of the cards.

Do you have any question? Is everything clear?

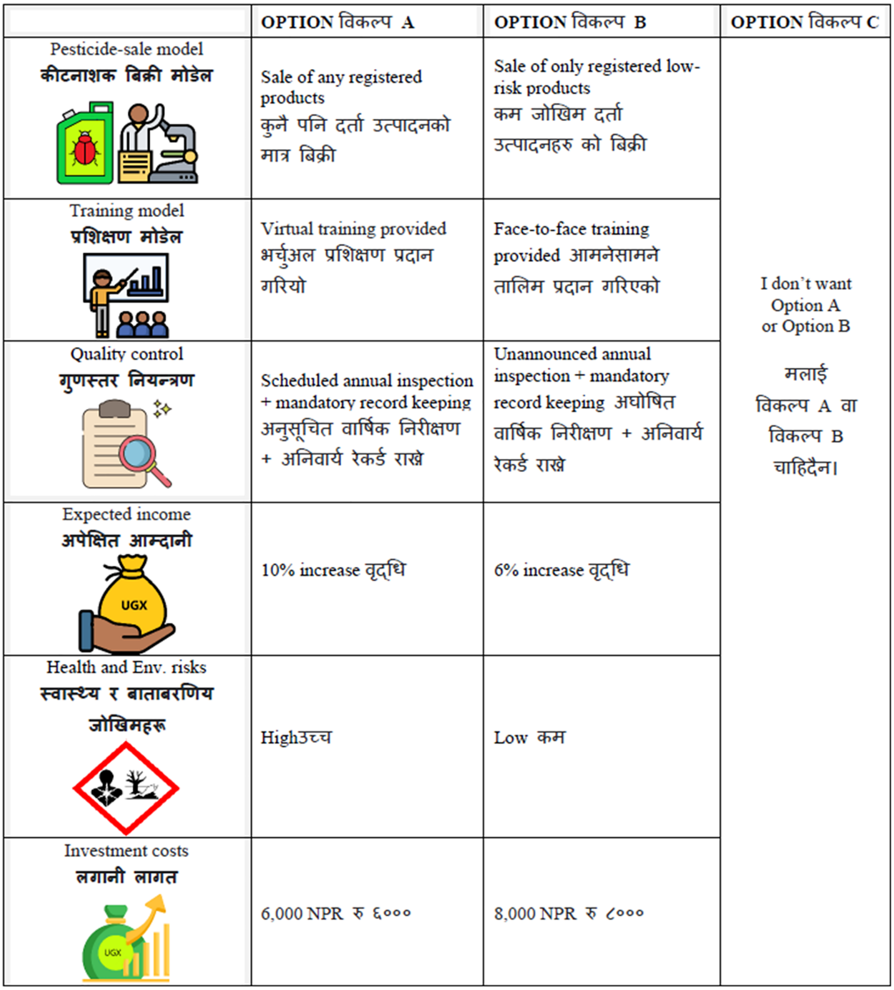
Now, let us take the following as an example.

If you are given the opportunity to choose between options A, B and C, which would you choose?

[*Enumerator: please present the example choice card showing dominant and worse-off options to the respondent. Re-explain the instructions if the respondent needs further clarification*]

You will now be presented with 6 different choice cards, and you will be requested to indicate your most preferred option on each of the choice cards. Please consider each choice card independently from previous cards. That is, for each choice please only consider the three options on the present card and do not feel influenced by possibly better or worse options you saw on a previous card.

[*Enumerator, please select one block of 6 choice cards and present them* ***randomly****, one after the other, to the respondent and record the choices made*]



	OPTION विकल्प A	OPTION विकल्प B	OPTION विकल्प C
Pesticide-sale model **कीटनाशक बिक्री मोडेल**	Sale of any registered products कुनै पनि दर्ता उत्पादनको मात्र बिक्री	Sale of only registered low-risk products कम जोखिम दर्ता उत्पादनहरु को बिक्री	I don't want Option A or Option B मलाई विकल्प A वा विकल्प B चाहिदैन।
Training model **प्रशिक्षण मोडेल**	Virtual training provided भर्चुअल प्रशिक्षण प्रदान गरियो	Face-to-face training provided आमनेसामने तालिम प्रदान गरिएको	
Quality control **गुणस्तर नियन्त्रण**	Scheduled annual inspection + mandatory record keeping अनुसूचित वार्षिक निरीक्षण + अनिवार्य रेकर्ड राख्ने	Unannounced annual inspection + mandatory record keeping अघोषित वार्षिक निरीक्षण + अनिवार्य रेकर्ड राख्ने	
Expected income **अपेक्षित आम्दानी**	10% increase वृद्धि	6% increase वृद्धि	
Health and Env. risks **स्वास्थ्य र बातावरणिय जोखिमहरू**	Highउच्च	Low कम	
Investment costs **लगानी लागत**	6,000 NPR रु ६०००	8,000 NPR रु ८०००	

Figure A2. An example of a choice card. Source: Authors' own work

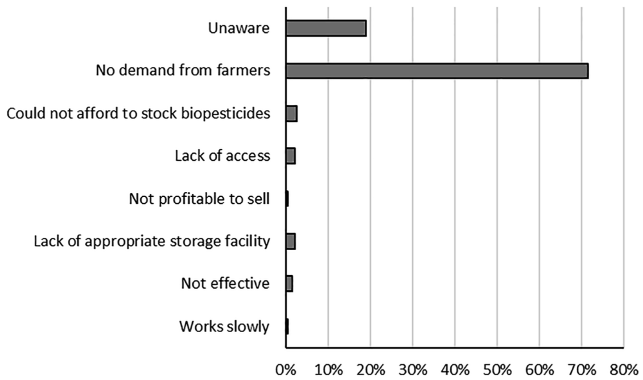


Figure A3. Main reason for not selling biopesticide products (n = 189). Source: Authors' own work

Table A1. Study locations and sample size

Province	Sample districts	Sample size
Koshi	Jhapa, Morang, Sunsari, Udayapur	54
Madhesh	Bara, Parsa, Saptari, Sahlahi, Siraha, Khotang	68
Bagmati	Bhaktapur, Chitwan, Dhading, Kathmandu, Kavrepalanchok, Lalitpur Nuwakot, Rasuwa, Sindhupalchok	131
Gandaki	Baglung, Kaski, Lamjung, Nawalpur, Parbat, Syangja, Tanahu	91
Lumbini	Banke, Bardiya, Dang, Kapilvastu, Parasi, Palpa, Pyuthan, Rolpa, Rupandehi	123
Karnali	Dailekh, Surkhet	36
Sudurpashchim	Kailali, Kanchanpur	35
Total		*538*

Source(s): Authors' own work

Table A2. Examples of high-risk products in shops (*n* = 538)

Product[a]	Percent of shops	WHO toxicity class[b]
Mancozeb	86.25	U
Chlorpyrifos	80.86	II
Carbendazim	58.74	U
Abamectin	46.47	Ib
Paraquat	45.72	II
Aluminium Phosphide[c]	24.35	N
Propiconazole	16.17	II
Glufosinate	15.61	II
Beta-cyfluthrin	4.46	Ib
Flusilazole	1.67	II
Endosulfan	0.56	II
Thiacloprid	0.37	II
Monochrotophos	0.37	Ib
Triazophos	0.37	Ib

Note(s): High-risk products are pesticides that are extremely or highly acutely toxic (WHO classes Ia or Ib), can cause cancer and mutations, can cause fertility and reproduction problems, or are banned internationally or nationally, or restricted for health or environmental reasons, [a]Other high-risk products that were found in not more than one shop (0.19%) include Chlordane, Aldrin, Heptachlor, Toxaphone, Methyl parathion, Phorate and Carbofuran., [b]WHO recommended classification of pesticides: Ia = extremely hazardous; Ib = highly hazardous; II = moderately hazardous; III = lightly hazardous; U = unlikely to present acute hazard; N = not classified., [c]The pesticide products in bold font have been banned in Nepal

Source(s): Authors' own work

Table A3. Model estimates of heterogeneity in preferences

	Ecological region		Sells biopesticides	
	Terai	Hill	Yes	No
Mean parameters				
ASC	−2.56*** (0.33)	−1.66*** (0.38)	−1.88*** (0.29)	−2.86*** (0.46)
Sell only low-risk products (LRPs)[1]	0.18 (0.34)	0.27 (0.38)	0.01 (0.32)	0.77* (0.42)
Sell only LRPs + diagnostic services[1]	0.59 (0.36)	0.27 (0.41)	0.20 (0.33)	1.02** (0.45)
Virtual training[2]	0.28 (0.24)	0.88*** (0.27)	0.52** (0.22)	0.55* (0.30)
Face-to-face training[2]	0.74** (0.29)	0.84*** (0.32)	0.63** (0.27)	1.01*** (0.36)
Unannounced inspection[3]	−0.31*** (0.12)	−0.21* (0.12)	−0.35*** (0.10)	−0.21 (0.13)
Expected income effect	0.02 (0.04)	0.14*** (0.05)	0.06* (0.03)	0.09* (0.05)
Low health and env. risks[4]	1.66*** (0.39)	1.78*** (0.45)	2.11*** (0.37)	1.02** (0.47)
Investment costs (100 NPR)	−0.01 (0.004)	−0.008* (0.005)	−0.005 (0.004)	−0.01* (0.006)
Standard deviations				
Sell only low-risk products (LRPs)	−0.05 (0.29)	−0.11 (0.32)	−0.05 (0.25)	0.04 (0.44)
Sell only LRPs + diagnostic services	1.12*** (0.24)	1.08*** (0.26)	0.95*** (0.24)	1.04*** (0.28)
Virtual training	−0.11 (0.35)	0.69*** (0.24)	0.59*** (0.20)	−0.43* (0.25)
Face-to-face training	0.85*** (0.19)	0.73* (0.38)	0.90*** (0.20)	0.60** (0.30)
Unannounced inspection	0.96*** (0.16)	0.79*** (0.17)	0.94*** (0.14)	0.78*** (0.20)
Expected income effect	0.10*** (0.03)	0.19*** (0.03)	0.14*** (0.03)	0.15*** (0.03)
Low health and environmental risks	1.81*** (0.21)	1.60*** (0.21)	1.96*** (0.19)	1.62*** (0.24)
Log likelihood	−1080.79	−938.85	−1366.27	−699.50
AIC	2193.58	1909.69	2764.53	1431.00
BIC	2298.98	2010.95	2872.46	1529.12
Observations	5274	4140	6,282	3402

Note(s): ***, **, and * denote 1%, 5%, and 10% statistical significance levels, respectively. Numbers in parentheses are standard errors, [1]Reference category is sale of any registered product., [2]Reference category is no training provided., [3]Reference category is unannounced annual inspection., [4]Reference category is high health and environmental risks

Source(s): Authors' own work

Notes

1. Nepal is divided into three ecological regions based on elevation: (1) Terai (lowland region, 17% of the total land area); (2) Hill (midland region, 68% of the total land area); and (3) Mountain (highland region, 15% of the total land area).
2. We also examined other potential sources of preference heterogeneity, for instance, by comparing male vs. female retailers, youth vs. adult retailers, and members vs. non-members of PEAN. We found similar preferences among these groups.
3. Given that our data include only 15 pesticide retailers from the Mountain region, we focused on the Terai and Hill regions where most of the pesticide retailers in the country are concentrated.

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Corresponding author
Justice A. Tambo can be contacted at: j.tambo@cabi.org