FACTORS AFFECTING FARMERS' ATTITUDE TOWARDS PESTICIDES USE, MEDIATION EFFECT OF PERCEIVED USEFULNESS ON USAGE BEHAVIOR

Amanpreet Kaur, Guru Nanak Dev University, Amritsar
Vikas Kumar, Indian Institute of Management Amritsar
Prabhjot Kaur, Guru Nanak Dev University, Amritsar
Kulwinder Kaur, Indian Institute of Management Jammu

ABSTRACT

The present study identifies the impact of various factors on farmers' attitude and usage behaviour towards pesticides. After a thorough examination of previous studies, the constructs namely environmental concern, attitude, government initiatives, innovativeness, pesticide knowledge, perceived usefulness, training, and usage behaviour were identified. The research comprises primary data collected from 287 farmers (pesticides users) residing in the rural areas of India using purposive sampling. Partial least square structural equation modelling (PLS-SEM) by Smart PLS 3.3.5 software was used to analyze the data. The results show that all the constructs except 'environmental concern' are strong determinants of farmers' pesticide usage. The authors also demonstrated that perceived usefulness and attitude partially affect farmers' pesticides usage behaviour. Henceforth, the study has implications for the government, policymakers, environmentalists, public health advisors, and pesticide manufacturers.

Keywords: Farmers' Attitude, Usage Behavior, Pesticides, Government Initiatives, Perceived Usefulness, Structural Equation Modeling.

INTRODUCTION

There has been a hundredfold increase in pesticide use in India since the green revolution during the 1960s. The intensification of agriculture to secure food for the world population has led to the adoption of chemical pesticides for crop protection. The Punjab Malwa belt in India accounted for 75 percent of total pesticide use and reported 107 cancer cases per one lakh population. Despite such grievous conditions, the state continues to use the same (Kaur et al., 2021). However, it is asserted that pesticide use can be reduced by 42 percent without affecting the crop yield. However, farmers are further induced to use pesticides due to their availability at cheap rates and popularity among peers. In 2020-21, India produced 255,090 metric tons of pesticides and consumed 62,193 metric tons (DPPQS, 2021; Maksymiv, 2015), which signifies India's extensive use of pesticides. India's agricultural states have used enormous pesticides to achieve higher yields (Mohapatra & Shilpa, 2010). Such injudicious use of pesticides has proved harmful to humans and the whole ecosystem, having adverse effects on non-target organisms, the environment (land, air, water bodies, drinking water, and food), and human health (Blair et al., 2015).

In the last decade, vast literature has developed on the ill effect of pesticides on human health and the environment. Consequently, the relevance of factors guiding farmers' behavior towards pesticide use has also risen (Bakker et al., 2021; Catherine et al., 2019). Past studies

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substantiated that pesticides have grown much importance after the green revolution. However, several questions are being raised concerning their sustainability (Ali et al., 2020), like farmers feel they have limited capacity to reduce the application of pesticides in farming, and peers firmly determined their pesticide use intentions (Bakker et al., 2021). In a study conducted in Greece, only 12.5 percent of farmers expressed their intention to reduce pesticide use (Damalas, 2021). A study gauging the knowledge level of farmers found that just one-third of farmers obtained information regarding pesticides from government extension agents, whereas the majority preferred private agents (Mubushar et al., 2019; Babarinsa et al., 2018). Knowledge about pesticide hazards was the most important factor resulting in pesticide use reduction; while selecting pesticides, the performance and effectiveness of the pesticide were given prime importance by farmers (Abadi, 2018; Lechenet et al., 2017; Akter et al., 2018).

On the other hand, technically trained farmers considered environmental criteria while choosing pesticides (Chèze et al., 2020; Sharifzadeh et al., 2018; Chantre & Cardona, 2014). The training was the most critical intervention for elevated safety behavior in reducing farmers' exposure to pesticides (Damalas & Spyridon, 2017). Although most of the farmers in Uganda and Costa Rica are well aware of the detrimental effects of pesticides, only a handful of them used personal protective measures during the application of pesticides (Staudacher et al., 2020). Various studies have been conducted on usage behavior and products/services like mobile technology, information systems, smartphone, hotel, and social media (Fernández et al., 2020; Kumar et al., 2020; Hu et al., 2017; Renny & Hotniar, 2013; Davis, 1989), whereas there is a dearth of literature concerning farmers' usage behavior regarding pesticides in the Indian context. Therefore, the present research aims:

1. To identify the factors that influence farmers' attitudes and behavior to use pesticides, and
2. To examine the impact of identified factors on farmers' attitudes and pesticide usage behavior.

The research is comprised of five sections. Section 1 is devoted to introducing the problem and the specification of the research objectives. Section 2 put forward the literature review and hypothesis formulation. The third section deals with the description of the methodology. The following sections present the data analysis and results of the assessment of the measurement model and hypothesis testing. Finally, the conclusion, policy implications, and the study's limitations are presented in the fifth section (Fornell & Larcker, 1981).

LITERATURE REVIEW

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines are used for systematic literature review in this manuscript. The PRISMA group developed these guidelines in 2009 by the PRISMA group to help separate the analogous approach often adopted, resulting in biased and opinionated research with a systematic and statistical approach. Initially, article selection criteria were established and found 373 published articles. After reviewing the abstract step, 274 articles were not relevant to our scope of the study. In the screening step, 51 articles were not meeting the inclusion criteria.

The next followed in PRISMA is eligibility, and after the study remaining 48 articles, 26 articles are lacking in the identification of criteria. In conclusion, 22 articles are included in this study for further analysis. The systematic literature review using PRISMA used in this study is shown in fig. 1. Past studies regarding pesticides have focused on knowledge and perception of farmers regarding pesticides, different approaches to pesticide problems, and new technologies like IPM and effects of pesticides (Mohapatra & Shilpa, 2010). These studies guided us towards

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a deeper investigation of the factors influencing farmers' behavior towards pesticide use following the planned behavior theory. Attitude is the primary key to understanding human behavior and intentions as it helps in predicting the broad pattern of behaviors (Ajzen, 2006). Seventy-six studies about the behavior of farmers regarding pesticides have been reviewed in the present research (Ajzen, 1985) (Figure 1).

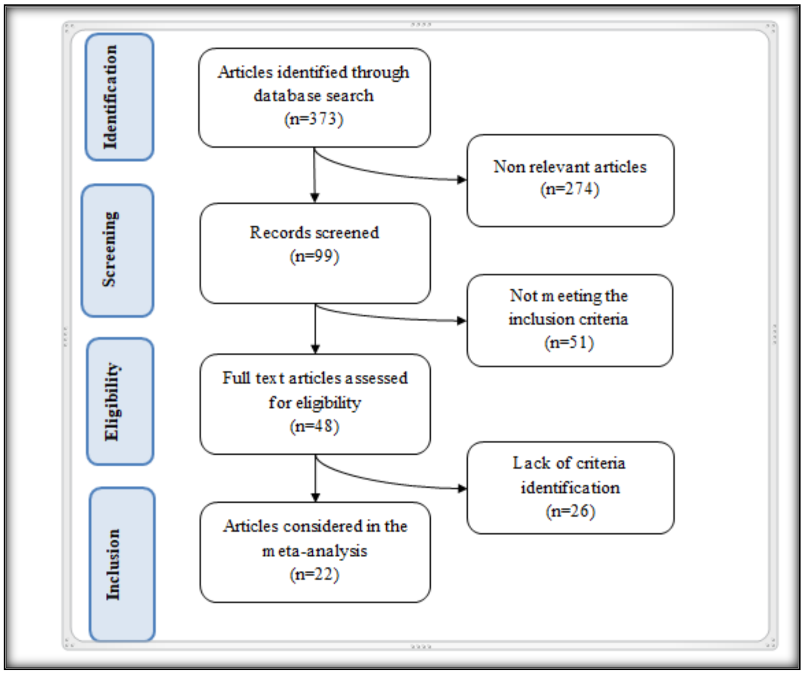

FIGURE 1
SYSTEMATIC LITERATURE REVIEW USING PRISMA

Environmental Concern

When a person considers environmental concerns of human activities, it leads to the willingness to reduce the negative environmental impacts (Rroy & Nayak, 2022; Hundal & Kumar, 2015). Environmental considerations induce farmers to reduce pesticide use (Bakker et al., 2021; Kaur et al., 2021; Stallman et al., 2015; Ahnström et al., 2013). In a study of Bangladesh, the crop and vegetable growers knew that reducing pesticides would improve the environment while simultaneously reducing crop yield (Ali et al., 2020). Environmentally motivated farmers are more conscious of the use of pesticides comparative to others; they use natural remedies for controlling pests (Sharifzadeh et al., 2018). It changes their attitude and usage behavior (Ahnström et al., 2013; Stallman et al., 2015). The opinions of farmers regarding the impact of pesticides on the environment are inspected by whether they agree or disagree that pesticides adversely affect the surrounding environment, soil, and health. Hence;

H_1: *Environmental concerns significantly influence farmers' attitudes to use pesticides.*

H_2: *Environmental concerns significantly influence farmers' pesticides usage behavior.*

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Government Initiatives

The government can approve or disapprove pesticide policies according to legal rules by influencing the number and scope of pesticides (Abadi, 2018). For regulating the use of pesticides, the government can promote new technologies (like Integrated Pest Management) (Van et al., 2013). The government issues insecticide licenses to retailers, test pesticides samples, and oversees government pesticide agencies. Some studies found mistrust between the government and the farmers (Ali et al., 2020; Akter et al., 2018). The government initiatives are composed of the farmers' perceptions regarding the role of the government concerning control of prices, maintenance of quality standards, instructions about the dose to be applied, and supervision of the dealers or retailers. Thus;

H_3: *Government initiatives positively influence farmers' attitudes to use pesticides.*

H_4: *Government initiatives positively influence farmers' pesticides usage behavior.*

Pesticide knowledge

Farmers cannot make good cropping decisions without adequate knowledge about pesticide classification, period of re-entry, and mixing of pesticides (Damalas & Spyridon, 2017; Yassin et al., 2002). Many farmers are unaware of using pesticides and handling their ill effects. Some farmers also use pesticides on non-targeted crops due to a lack of knowledge (Ali et al., 2020; Oesterlund et al., 2014; Williamson et al., 2008). In a study conducted by Rahman & Zabed (2003), the farmers with more technical knowledge applied more pesticides than others. In another study, contrasting results showed that farmers with better knowledge about exposure risk and adverse health effects of pesticides used fewer pesticides (Mubushar et al., 2019; Sharifzadeh et al., 2018; Praneetvatakul et al., 2016). The pesticide knowledge construct consists of the knowledge level of the farmers about the standard dose to be sprayed, the time gap between the two doses, and their use in crop rotation. Therefore;

H_5: *Pesticide knowledge positively influences farmers' attitudes to use pesticides.*

H_6: *Pesticide knowledge positively influences farmers' pesticides usage behavior.*

Training

Farmer's attitude and usage behavior regarding pesticides get influenced by whether or not farmers receive training. After receiving training, a farmer knows better about pesticides, the way to use, the amount to use, the right way to dispose of the pesticide containers, and their potential health and environmental hazards, which brings about a significant change in their perception of pesticides (Syan et al., 2019; Stallman et al., 2015; Wilson & Tisdell, 2001). Training is necessary to reduce farmers' exposure to pesticides, enhance knowledge (Mubushar et al., 2019), and control pesticide hazards (Damalas & Spyridon, 2017). Trained farmers are more likely to consider environmental criteria while selecting and using pesticides (Sharifzadeh et al., 2018). Farmers who have received specific training are likely to reduce pesticide usage after becoming aware of the harmful effects of pesticides (Staudacher et al., 2020), whereas in some cases, training enhances the usage of pesticides. Whether farmers have or have not

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received training regarding the time of pesticide application, its quantity and frequency of application constituted the training construct. Henceforth;

H_7: *Training positively influences farmers' attitudes to use pesticides.*

H_8: *Training positively influences farmers' pesticides usage behavior.*

Perceived Usefulness

Perceived usefulness is the subjective perception that the user believes that the performance can be improved using specific techniques (Davis, 1989). It directly impacts intention to use (Syan et al., 2019; Renny & Hotniar, 2013) and is identified as determining factor of attitude and usage behavior. It is a function of the self-regulating orientation of a person, concerning the degree to which a consumer believes that the product has enhanced his efficiency (Sledgianowski & Songpol, 2009). It has a strong association with user satisfaction, which builds his attitude towards using pesticides. Effectiveness and performance were of the highest importance while using pesticides (Sharifzadeh et al., 2018; Damalas & Spyridon, 2017). So far as the construct 'perceived usefulness' is concerned, it pertains to farmers' perception regarding pesticides reducing the cost of pest management, increasing agricultural income, needing less training and additional equipment. Hence;

H_9: *Perceived usefulness positively influences farmers' attitudes to use pesticides.*

H_{10}: *Perceived usefulness positively influences farmers' pesticides usage behavior.*

Innovativeness

Farming is highly competitive dependent on several natural factors, making it a precarious venture. Innovation helps farmers prosper by using superior technologies and products (Walder et al., 2019; Lioutas & Charatsari, 2018). The relatively well-off farmers with more land, income, and education tend to innovate. New and supposedly superior pesticides are introduced to check evolving varieties of pests. The notions of farmers regarding new pesticides and their additional values influence their attitude and usage behavior (Abadi, 2018; Lioutas & Charatsari, 2018);

H_{11}: *Innovativeness significantly influences farmers' attitudes to use pesticides.*

H_{12}: *Innovativeness significantly influences farmers' pesticides usage behavior.*

Attitude

Attitude is defined as 'a leaned predisposition of human being' and a "*mental or neural state of readiness,"* which influence, guide, or predict a person's actual behavior. Whether positive or negative, farmers' attitude regarding pesticide is closely related to the behavioral intention of usage (Bakker et al., 2021; Kumar et al., 2020; Staats et al., 2011; Allport, 1935). Farmers' unfavorable attitude towards pesticides is formed by their past effects on health, which motivates them to use alternative crop protection methods (Wang & Wang, 2021; Catherine et

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al., 2019). In contrast, the favorable attitude created by the benefit of pesticide use positively affects usage behavior (Bakker et al., 2021; Staudacher et al., 2020; Kapoor & Kumar, 2019). The perception of farmers about the cost of pesticides, use by peer farmers, easy availability of pesticides, and applying types of equipment constituted the attitude construct. The hypothesis of the association between attitude and usage behavior is given as follows:

H_{13}: *Attitude positively influences farmers' pesticides usage behavior.*

Usage Behavior

Human behavior is the action or reaction of an individual to external or internal stimuli (Staudacher et al., 2020; Kim et al., 2010). Knowledge of the pesticides and their potential hazards elevates the safety behavior in farmers (Damalas & Spyridon, 2017), while in some cases, even after knowing about the health risks, the farmers expressed low personal protection behavior (Staudacher et al., 2020). Farmer's inappropriate behavior, like the unsafe disposal of waste packets of pesticides, makes the ecological conditions worse (Damalas et al., 2006). Usage behavior is influenced by the quality of pesticides, effectiveness, and recommendations (Öztaş et al., 2018).

Proposed Conceptual Framework

For the present study, six independent variables, namely environmental concern, government initiatives, innovativeness, pesticide knowledge, perceived usefulness and farmers' attitude construct taken as endogenous variables. Thirteen hypotheses depict the relationship between the constructs, as shown in Figure 2.

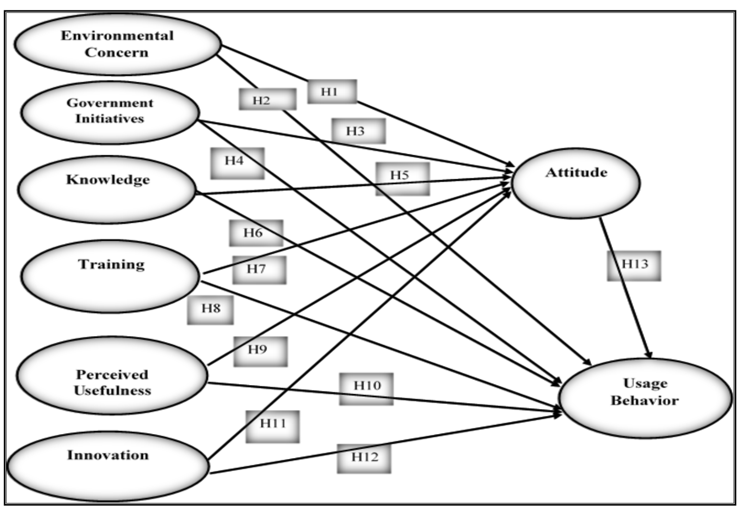

FIGURE 2
CONCEPTUAL MODEL

Methods

The present research comprises primary data collected from 287 farmers (pesticide users) residing in the rural areas of the northern region of India using random sampling from June 2021

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to October 2021. Direct interviews with farmers were conducted at their villages, farms, and pesticide shops. The authors have developed these statements after an in-depth analysis of various studies on the behavior of farmers regarding the use of pesticides (Bakker et al., 2021; Ali et al., 2020; Damalas & Spyridon, 2017; Mubushar et al., 2019; Sharifzadeh et al., 2018). Before conducting the final survey, a pilot study was conducted on 65 respondents to check the reliability of the research questionnaire. As recommended by the respondents, due modifications were incorporated in the questionnaire after conducting the pilot study. A Likert scale was used to categorize the responses where "*one*' referred to a strong disagreement and "*seven'* referred to strong agreement. Partial Least Square-Structural Equation Modelling (PLS-SEM) using SmartPLS 3.3.5 software is used to analyze the data (Ringle et al., 2015) owing to the small sample size, i.e., 287 and the appropriateness for this technique for the theories in the developing stage (Hair et al., 2017; Rigdon et al., 2017).

DATA ANALYSIS

Demographics

Results describe that all 287 respondents are male. Most of them (94.8 percent) are married and have a higher secondary level educational qualification (43.2%). Many respondents have income levels less than 4 lakh (36.2%). The most significant proportion of farmers (30.3%) acquires 2 to 4 hectares, and only 11.5% have land above 10 hectares (Table 1).

Table 1
DEMOGRAPHICS

Particulars	n	%	Particulars	n	%
Age (Years)			Annual Income		
18-32	24	8.4	Less than 4,00,000	104	36.2
33-42	60	20.9	400001-600000	104	36.2
43-52	82	28.6	600001-800000	58	20.2
53 and above	121	42.2	8,00,001-10,00,000	18	6.3
Marital Status			Above 10,00,001	3	1
Married	272	94.8	Land Acquired		
Single	15	5.2	Below 1 hectare (Marginal)	30	10.5
Qualification			1-2 hectare (Small)	55	19.5
Illiterate	46	16	2-4 hectare (Semi-medium)	87	30.3
Higher Secondary	124	43.2	4-10 hectare (Medium)	82	28.6
Graduation	83	28.9	Above 10 hectares (Large)	33	11.5
Post-Graduation	28	9.8	Gender		

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& above					
Others	6	2.1	Male	287	100

Common Method Bias

A two-stage process is followed in SEM to analyze the data. In the first stage, the validity and reliability of the measurement model are assessed, and in the second stage, structural model assessment is followed. To cope with Common Method Bias (CMB), preventive measures like clarifying questions, describing complex concepts, avoiding double-barreled questions, and maintaining the complete anonymity of the respondents (Rodríguez & Antoni, 2020). Second, data have been checked for CMB by Harman's single factor test, which explained 29.67 percent variance (less than 50%), confirming no CMB in the data (Podsakoff et al., 2003; Bagozzi & Youjae, 1998). Third, the scale was checked for multicollinearity among indicators using Variance Inflated Factor (VIF), whose value should be less than 3.3 (Sarstedt et al., 2017). As per the results, all VIF values are in the accepted range (1.077 to 1.739) less than 3.3, assuring the absence of multicollinearity among variables (Table 2).

Measurement Model

Construct validity refers to how measured items reflect latent constructs in the theoretical framework (O'Leary-Kelly & Vokurka, 1998). The validity of the measurement model is determined through factor loadings and "*Average Variance Extracted*" (AVE). The item loadings should be greater than 0.5 (Kumar et al., 2020a; 2020b; Hair et al., 2017; Kumar & Hundal, 2019; Farrell, 2010). In the present study, all the values range from 0.611 to 0.951. According to Bagozzi &Youjae, (1998), the AVE is the second method for attesting convergent validity should have a value greater than 0.5. All the item loading values are above 0.5, thus confirming this parameter (Table 2). The reliability or internal consistency of the model is confirmed with Composite Reliability and Cronbach's Alpha. The value of Cronbach's Alpha and standard Composite Reliability is higher than the accepted values of 0.7 and 0.6, respectively (Kumar et al., 2019a; 2019b; Hair et al., 2017; Nunnally, 1978). Thus, all the parameters have confirmed the validity and reliability of the measurement model.

Table 2
VALIDITY AND RELIABILITY

Constructs and Statements	**Loadings**	**VIF**	**α**
Environmental Concern (Ali et al., 2020; Sharifzadeh et al., 2018) CR=0.928, AVE=0.812		1.739	0.884
Pesticides have harmful effects on the environment.	0.933		
The pesticides have harmful effects on the soil.	0.886		
Pesticides have harmful effects on health.	0.883		
Attitude (Bakker et al., 2021; Staudacher et al., 2020; Wang & Wang, 2021) CR=0.946, AVE=0.816		1.371	0.925
The cost of pesticides is reasonable.	0.888		

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The majority of the peers are using pesticides.	0.915		
The pesticides are readily available in the market.	0.883		
Equipment of pesticide use is readily available.	0.926		
Government Initiatives (Abadi, 2018; Akter et al., 2018; Ali et al., 2020) CR=0.894, AVE=0.679		1.57 6	0.84 3
The government controls the price mechanism of pesticides.	0.846		
The government ensures the quality of pesticides.	0.81		
The government ensures the amount of pesticides to be used on crops.	0.85		
The government supervises the dealers.	0.789		
Innovativeness (Walder et al., 2019; Abadi, 2018; Lioutas & Charatsari, 2018) CR=0.936, AVE=0.829		1.25 5	0.89 7
Newly introduced pesticides attract me.	0.916		
Usually, newly introduced pesticides provide additional value.	0.863		
Usually, newly introduced pesticides are more effective.	0.951		
Knowledge (Ali et al., 2020; Damalas & Spyridon, 2017; Mubushar et al., 2019) CR=0.877, AVE=0.704		1.17 7	0.78 8
I know about the time gap for pesticides usage.	0.897		
I know about the standard amount of spray.	0.815		
I know about pesticide usage during crop rotation.	0.802		
Perceived usefulness (Syan et al., 2019; Sharifzadeh et al., 2018) CR=0.934, AVE=0.825		1.55 3	0.89 3
Pesticide usage reduces the cost of pest management.	0.93		
Pesticide usage enhances my income.	0.928		
Pesticide usage requires less additional equipment.	0.865		
Training (Mubushar et al., 2019; Damalas & Spyridon, 2017; Sharifzadeh et al., 2018) CR=0.872, AVE=0.695		1.07 7	0.78 5
I have received adequate training regarding time for pesticide spray.	0.791		
I have received adequate training regarding the amount of pesticide spray.	0.838		
I have received adequate training regarding the frequency of pesticide spray.	0.869		
Usage behavior (Damalas & Spyridon, 2017; Kim et al., 2010) CR=0.858, AVE=0.606		....	0.77 6
I use high-quality pesticides.	0.83		
I spray the recommended amount of pesticides by the dealers.	0.871		
I will continue my pesticide usage in the future.	0.611		
I also recommend that others to use pesticides.	0.777		

Discriminant validity refers to how constructs empirically differ. Discriminant validity is checked by Fornel-Larcker (1981) criterion, according to which square root of Average Variable Extracted (AVE) of each construct should be greater than correlation values with other constructs. All of the constructs fulfill this criterion, thus proving that the model has no issue related to discriminant validity (Table 3 and 4).

Table 3
DISCRIMINANT VALIDITY

	EC	ATT	GI	INN	KNW	PU	TR	UB
EC	0.901							
ATT	0.277	0.903						
GI	0.535	0.368	0.824					
INN	0.284	0.387	0.314	0.911				
KNW	0.183	0.274	0.236	0.129	0.839			
PU	0.549	0.342	0.414	0.275	0.181	0.908		
TR	0.044	0.012	-0.024	-0.066	0.225	-0.035	0.834	
UB	0.306	0.595	0.4	0.306	0.309	0.363	0.141	0.779

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*Note EC=Environmental concern, ATT=Attitude, GI=Government Initiatives, INN: Innovation, PU: Perceived Usefulness, TR=Training, UB=Usage behavior.

Table 4
HYPOTHESIS TESTING

	Hypotheses	β -value	t-value	*p-values*
H_1	Environmental Concern -> Farmers' Attitude	-0.026^{ns}	0.361	0.359
H_2	Environmental Concern -> Usage Behavior	-0.002^{ns}	0.034	0.487
H_3	Government Initiatives -> Farmers' Attitude	0.187	2.713	0.003
H_4	Government Initiatives -> Usage Behavior	0.149	1.953	0.025
H_5	Knowledge -> Farmers' Attitude	0.168	2.913	0.002
H_6	Knowledge -> Usage Behavior	0.094	1.741	0.041
H_7	Training -> Farmers' Attitude	0.004^{ns}	0.056	0.478
H_8	Training -> Usage Behavior	0.125	2.127	0.017
H_9	Perceived Usefulness -> Farmers' Attitude	0.175	2.763	0.003
H_{10}	Perceived Usefulness -> Usage Behavior	0.122	2.01	0.022
H_{11}	Innovativeness -> Farmers' Attitude	0.266	4.133	0
H_{12}	Innovativeness -> Usage Behavior	0.047^{ns}	0.881	0.189
H_{13}	Farmers' Attitude -> Usage Behavior	0.454	8.282	0

Mediation Effect

The present research finds five mediation effects in the model. Likewise, the indirect effects were analyzed and shown in Table 5. The study used the percentile calculations (bias-corrected bootstrap) method to test the mediation effect (Hayes & Scharkow, 2013). The results elucidate the causal effect of farmers' knowledge, perceived usefulness, attitude, innovation influence on pesticide usage behavior. Thereby describing partial mediation effects of perceived usefulness, attitude on dependent variables (usage behavior), and significant values. The values obtained for the mediation effect are: mediation effect 1 (β=0.55, VAF=30.05%, t=2.754), mediation effect 2 (β=0.070, VAF=25.27%, t=3.356), mediation effect 3 (β=0.182, VAF= 53.22%, t=6.051), mediation effect 4 (β=0.219, VAF=56.44%, t=6.059), and mediation effect 5 (β=0.151, VAF=55.27%, t=4.901). Also, it is pertinent to mention that the mediation effects represent partial mediation effect in all cases, indicating the importance of perceived usefulness and attitude towards pesticide usage.

Table 5
MEDIATION EFFECT

	Relationships and their mediation effects	β-value	T-value	VAF
1	a: Knowledge -> Perceived Usefulness	0.183	2.754	30.05%,
	b: Perceived Usefulness -> Attitude	0.303		*Partial
	c: Knowledge -> Attitude	0.209		
	a × b: Indirect effects	0.055		
2	a: Innovation -> Perceived Usefulness	0.277	3.356	25.27%,
	b: Perceived Usefulness -> Attitude	0.255		*Partial
	c: Innovation -> Attitude	0.317		
	a × b: Indirect effects	0.07		
3	a: Perceived Usefulness -> Attitude	0.342	6.051	53.22%
	b: Attitude -> Usage Behavior	0.532		*Partial
	c: Perceived Usefulness -> Usage Behavior	0.185		
	a × b: Indirect effects	0.182		

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4	a: Innovation -> Attitude	0.388	6.059	56.44%
	b: Attitude-> Usage Behavior	0.565		*Partial
	c: Innovation -> Usage Behavior	0.088		
	a × b: Indirect effects	0.219		
5	a: Innovation -> Attitude	0.275	4.901	55.27%
	b: Attitude -> Usage Behavior	0.554		*Partial
	c: Innovation -> Usage Behavior	0.158		
	a × b: Indirect effects	0.152		

Note: VAF = Variation accounted for.

Discussion

The structural model results reveals the insignificant impact of environmental concerns on farmers' attitude (β value =-0.026, t-value=0.361, *p-value*=0.35) thus rejecting H_1. The results conform to Öztaş et al. (2018) finding that the insensitivity of farmers towards the environmental hazards of pesticides and their waste containers in Egypt. The plausible explanation is that the farmers in India know about the dangerous impact of pesticides on human health and the environment, but they use pesticides out of compulsion. If they do not use pesticides, the yield will decrease drastically, which they cannot afford. They are not financially stable and do not have their crop insured. In addition, the impact of pesticides becomes evident in the long run only, and by assessing the short-run gains, the farmers continue using pesticides. The second hypothesis is also rejected (β value =-0.002, t-value=0.034, *p-value*=0.487), but the results are in contrast with earlier studies of Ahnström et al. (2013), Bakker et al. (2021); and (Stallman et al., 2015), which showed that environmental concerns induced farmers to reduce pesticide use.

However, H_3 is accepted (β value=0.187, t-value=2.713, *p-value*=0.003), implying that government initiatives positively influence farmers' attitude, and similar evidence were provided by Ali et al. (2020). Moreover, government initiatives significantly influence farmers' usage behavior regarding pesticides supporting H_4 (β-value=0.149, t-value=1.953, *p-value*=0.025), as farmers buy pesticides from licensed dealers and adopt the advisories issued by the government and refrain from using pesticides banned by the government.

Moreover, the knowledge significantly impacts farmers' attitude towards pesticides usage (β-value=0.168, t-value=2.913, *p-value*=0.002), validating H_5. It is in line with the fact that when a person knows about a product, how it functions, and what features it has, they will be more willing to use it than when he gets unaccustomed to it. Similar to pesticides, the person with more knowledge about pesticides has a positive attitude towards the use of pesticides. Furthermore, H_6 is validated (β value=0.094, t-value=1.741, *p-value*=0.041), signifying that pesticide knowledge significantly influences user behavior, as evidenced by Rahman & Zabed (2003).

Training does not significantly influence farmers' attitude towards pesticides (β-value =0.004, t-value=0.056, *p-value*=0.478); therefore, H_7 was rejected, providing contradictory evidence to Wilson & Tisdell (2001). Farmers believe that they can get enough information about pesticide use from manuals printed on the pesticide containers. Moreover, they prefer information provided by retailers rather than training programs for a week. On the other hand, training (H_8) significantly impacts farmers' usage behavior (β-value=0.125, t-value=2.127, *p-value*=0.017) as farmers get crucial information about pesticide use during training. It is worth noting that training does not impact farmers' attitudes, but it optimizes their usage behavior as it makes farmers aware of the best pesticides, how to use them, protective gear to be worn, and

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other precautions to be taken while using the pesticide also proved that training impacted pesticide use.

Moreover, (H_9) is accepted (β-value=175, t-value=2.763, *p-value*=0.003), proving the perceived usefulness of pesticides about pest control, resultant increase agricultural income, builds positive attitude towards pesticide in farmers. Additionally, perceived usefulness (H10) also has a significant impact on usage behavior (β-value=0.122, t-value=2.01, *p-value*=0.022), similarly proved by Sharifzadeh et al. (2018), signifying that the perceived usefulness of pesticides plays an essential role in the continuation of widespread use of pesticides by farmers.

Likewise, innovativeness (H_{11}) has a significant positive impact on the farmers' attitude towards pesticide use (β-value=0.266, t-value=4.133, *p-value*=0.000). Pests soon become resistant to existing pesticides and resurge. Thus, farmers are attracted to new, improved pesticides, influencing their attitude towards pesticide use. The hypothesis (H_{12}) dealing with the impact of innovativeness on usage behavior (β-value=0.047, t-value=0.881, *p-value*=0.189) is rejected. This result is similar to that of Abadi (2018) study, which infers that it is definite that farmers are attracted to new pesticides, but they do not adopt the new pesticides.

It is inferred that enhanced knowledge makes farmers accustomed to pesticides' features and benefits, leading to a positive attitude towards pesticides, which further affects pesticide usage behavior. Thus, the farmers' attitude significantly influences usage behavior (β-value= 0.454, t-value =8.282, *p-value*=0.000), hence refuting H_{13}, which is well following the theory of planned behavior. Catherine et al. (2019) and Staats et al. (2011) also found that attitude towards pesticides significantly affected the intention to use pesticides.

IMPLICATIONS

Theoretical Implications

The present research added few substantial theoretical contributions. *First*, this research examined how perceived usefulness, training, government initiative, innovativeness, environmental concern, and pesticide knowledge influence farmers' attitudes and behavior. These relationships have not been explored yet in the given context of farmers' attitudes and usage behavior towards pesticides. *Second*, the present research provides a comprehensive picture of various dimensions of the existing literature. Results disclose that the environmental concern does not significantly impact the farmers' attitude and pesticide usage behavior.

Practical implications

Moreover, local non-governmental organizations are in direct contact with many farmer groups, and they must educate farmers more about the hazards of the overuse of pesticides by organizing training camps. They can play an active role in regulating pesticide use by raising the concerns of the farmers in front of the government and the pesticide manufacturing companies. Environmental organizations like Food and Agricultural Organization, United Nations Environment Programme, United Nations Framework Convention on Climate Change, etc., should organize farmer awareness programs in collaboration with national and local governments. Health organizations such as the National Health Organization of India should regularly conduct checkup camps in rural areas and motivate farmers to conserve their environment.

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CONCLUSION

The current study has considered perceived usefulness, farmers' attitude, training, government initiative, innovativeness, environmental concern, pesticide knowledge as possible determinants of usage behavior. There are several other factors, such as subjective norms, moral norms, social media, perceived behavioral control, and the action of retailers, which could also have a significant impact on user behavior. Future studies can consider these variables to determine farmers' behavior regarding pesticides. Forthcoming studies can make inter-country comparisons of determinants of pesticide usage behavior. The comparisons can also be made regarding determinants varying with different farm sizes.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest: The authors declare that they do not have known personal relationships that could have appeared to influence the work reported in this paper.

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