The Deviation of Farmer's Willingness and Behaviour to Apply Bio-pesticides

ABSTRACT

Replacing chemical pesticides with biopesticides is essential for maintaining high-quality agricultural products and promoting environmental sustainability.This study takes the willingness and the behaviours of farmers on the application of biopesticides as the research object. The survey was conducted on 127 farmers in junagadh district in Gujarat. The logistic model was used to analyse the influencing factors resulting in the deviation of the behaviours of the farmers from their initial willingness on the application of biopesticides. The results showed that 37 per cent of the farmers surveyed, there's a deviation between their willingness and behaviour regarding the application of bio-pesticides. Among the variables price affordability, peer influences, education level, land size, emergency conditions, bio-pesticide awareness, awareness of hazardous effects from chemical pesticides and quality and safety awareness of agricultural products were significantly affect the deviation of farmers willingness and behaviour to apply bio-pesticides.The primary reason for the deviation of the farmers' behaviours from their willingness is their lack of knowledge about biopesticides and the biopesticides' incomplete market structure. Based on the analysis, it is advised to enhance farmer professionalization, increase awareness of green production methods, and expedite the development of the biopesticides market to further encourage the adoption of biopesticides.

Keywords: biopesticides; willingness; behaviour; deviation.

1. INTRODUCTION

Globally, approximately 6 million tons of pesticides are used each year to manage crop pests and diseases, but less than 30% of these pesticides are used effectively, with up to 70% being misapplied.Pesticide residues spread rapidly through the air, oceans, soil, and organisms due to wind, rain, and other weather conditions[1]. This extensive use of chemical pesticides not only exerts significant pressure on the environment but also negatively impacts the quality and safety of agricultural products due to potential residue contamination [2]. These residues can pose risks to human health by accumulating in the food chain and through bioaccumulation [3]. To address issues related to limited agricultural resources and food safety, biopesticides are increasingly being favoured over traditional chemical pesticides [4]. Biopesticides, derived from natural substances or organisms, offer several benefits: they are versatile, less likely to cause resistance, and are safe for plants, humans, animals, and the environment [5]. Additionally, biopesticides are essential for organic farming and play a vital role in promoting agricultural sustainability [6].

Differences between farmer's willingness to use bio-pesticides and their actual application in agricultural practices have been observed [7].Pray et al. found that although over one-third of agricultural producers in India were inclined to use biopesticides, only 3% of the farmers in their sample had actually utilized them in the past year [8].This phenomenon, where a gap exists between farmers' willingness to use bio-pesticides and their actual behaviours, has been identified by some scholars and is described as a deviation or conflict between intentions and actions. [9]. Such discrepancies can result in misguided decisions by governments and enterprises regarding the production and promotion of bio-pesticides. Consequently, minimizing the gap between farmers' stated willingness and their actual use of bio-pesticides is crucial for effectively advancing their adoption and achieving a sustainable agricultural transformation.

Newman proposed that inconsistencies between willingness and behaviour can manifest in two ways: either as a failure to translate willingness into actions or as a divergence between behaviour and initial willingness due to external factors. He suggested that without addressing these issues, willingness alone may not lead to effective behavioural changes. [10]. Jeffrey R. found that the theory of planned behaviour adds to the individual's subjective willingness the conditions and ability to perform a

specific behaviour [11], and since the ability to perform and subjective willingness are collectively referred to as perceived behavioural control, perceived behavioural control can directly influence individuals' behavioural intentions and applied behaviours [12]. Kumar S.M. et al. also used binary logistic regression in Trichy District in Tamil Nadu [13].

Existing international research on bio-pesticides indicates that the topic has been extensively studied and well-documented. However, there is a lack of research focusing specifically on farmer's behaviours regarding the application of bio-pesticides. Notably, there is a gap in understanding the discrepancy between farmer's willingness to use bio-pesticides and their actual application behaviours, and the factors driving this deviation require further investigation. To address this, this study employs a logistic regression model to empirically examine the factors affecting the deviation between farmers' willingness and their actual use of bio-pesticides.

2. METHODOLOGY

2.1 Data source

The data used in this study were obtained from survey questionnaires and interviews among farmers in Junagadh district of Gujarat. A multi-stage random sampling method was used to select the samples during the actual survey. In the first stage of sampling, the Junagadh district was selected. In the second stage two talukas was selected. At the third stage, four villages from each talukas was selected. From each villages 10 users and 10 non-users farmers was selected. In this way total 160 farmers was selected for the study purpose.

2.1 Statistical method

A binary logistic regression model was employed to examine the factors that contribute to the gap between farmers' initial willingness to use biopesticides and their actual behaviour.For those farmers that don't have bio-pesticide application behaviour, deviation exists and y = 1; if farmers have bio-pesticide application behaviour, there's no deviation and hence y = 0. The logistic regression model is as follows:

$$\boldsymbol{P_i = F(y_i) = \left(\beta_0 + \sum_{j=1}^{n} \beta_j X_{ij}\right) = \frac{exp(\beta_0 + \sum_{j=1}^{n} \beta_j X_{ij})}{1 + exp(\beta_0 + \sum_{j=1}^{n} \beta_j X_{ij})}} \quad \ldots(1)$$

Where,
$\boldsymbol{P_i}$ = probability of deviation between the application intentions and behaviour of i^{th} farmer
$\boldsymbol{F(y_i)}$ = probability distribution function
$\boldsymbol{\beta_0}$ = intercept
$\boldsymbol{\beta_j}$ = regression coefficient of the j^{th} independent variable
$\boldsymbol{n}$ = number of independent variables
$\boldsymbol{X_{ij}}$ = value of the j^{th} variable of the i^{th} farmer.
By taking the logarithm of both sides of Equation (1), the simplified form is obtained as:

$$\boldsymbol{y_i = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \sum_{j=1}^{n} \beta_j X_{ij}} \ldots(2)$$

The samples in this study was those farmers who have the initial willingness to apply bio-pesticides in their agricultural production process. Statistical analysis shows that 127 farmers out of 160 samples have the willingness to apply bio-pesticides, hence this study was conducted empirical analysis based on these 127 samples. For those farmers that don't have bio-pesticide application behaviours, deviation exists and y = 1; if farmers have bio-pesticide application behaviours, there is no deviation and hence y = 0.

3. RESULTS AND DISCUSSION

Based on that, the regression analysis of the sample data was performed using SPSS software and the results are shown in Table 1.The results of the logit regression analysis show the overall percentage of case correctness for the model stands at 84.3 percent. Goodness of fit measures

indicated that the model is acceptable. The likelihood ratio was significant ($p<0.05$), indicating that the amount of variation explained by the model is significantly different from zero. The Cox and Snell R Square value, a commonly used measure for goodness of fit for binary choice model was 0.558, which means 55.8 per cent of the total variation in the dependent variable could be explained by the X variables that were included in the logit model. A Nagelkerka R Square statistical test gave a p- value of 0.726, which indicated that the model fits reasonably well.The results of the logit regression analysis indicated that among the twelve independent variables included in the model, eight were statistically significant in influencing a farmer's behavioural decision to adopt bio-pesticide.

Table 1. Factors affecting deviation between farmers willingness and behaviour application of bio-pesticide n=127

Variable	B	S. E.	Sig.
Age	0.09	0.05	0.190
Education	-1.21*	0.38	**0.012**
Farming income	-0.34	0.28	0.224
Land size	-0.56*	0.17	**0.023**
Bio-pesticide awareness	-2.25*	0.66	**0.045**
Awareness of Hazardous Effect from Chemical Pesticides	-2.06*	0.65	**0.041**
Quality and Safety Awareness of Agricultural Products	-2.20*	0.59	**0.050**
Confidence Level over Bio-pesticides Promotion	-0.31	0.56	0.584
Peer influence	3.44**	0.63	**0.001**
Emergency condition	2.41*	0.64	**0.036**
Bio-pesticide availability	0.60	0.72	0.384
Price affordability	3.96**	0.69	**0.000**
Constant	-2.47	2.86	0.389

**significant 1% and *significant 5%
Likelihood test: 89.534, Cox & Snell R Square: 0.558, Nagelkerke R Square: 0.726

3.1 Analysis of the impacts of individual and family characteristics

The comprehensive regression results show that both education level and land size pass the 5 per cent significance level hence both have a significant negative effect on the deviation of willingness and behaviours of bio-pesticide application. It is confident to conclude that the higher the education level of the farmers and the larger the scales of planting, the less likely there is deviation between their behaviours and willingness. This is because the farmers with better education level have a deeper understanding of bio-pesticides, so it's the easier for them to adopt the application of bio-pesticides. At the same time, for those farmers having larger scales of plantation, agricultural production has become their major work. Since the application of bio-pesticides can effectively ensure the smooth implementation of agricultural production, their behaviours and willingness to apply bio-pesticides are less likely to diverge.

3.2 Analysis of the influences from farmer's awareness

Bio-pesticide awareness has a significant negative effect on the deviation of farmer's willingness and behaviours of bio-pesticide application and it is at 5 per cent significance level. Combined with the

results from descriptive statistics, there is lack of knowledge of bio-pesticides currently for most of the farmers. By taking into consideration their age and low education level, they hardly search for information about bio-pesticides actively. Although farmers claim that they are willing to apply bio-pesticides, they have difficulties in appreciating the advantages of bio-pesticides due to their lack of knowledge and expertise about them and therefore they tend to give up transforming their willingness into concrete behaviours.

The awareness of hazardous effects of chemical pesticides and quality and safety awareness of agricultural products are negatively correlated with the deviation of willingness and behaviours of bio-pesticide application, with both of the factors are statistically significant at 5 per cent level. This is because farmers who are more aware of environmental pollution and the dangers of chemical pesticides tend to be better educated and younger. Those who are more concerned about protecting the rural ecological environment and health are also more likely to adopt biopesticides. So, the likelihood of deviation of their behaviours from willingness on the application of bio-pesticides is lower. On the other hand, quality and safety awareness of agricultural products is part of social responsibility and it is also the farmers own psychological initiative to protect rural ecological environment. Therefore, the stronger the awareness towards agricultural products quality and safety, the less likely the divergence between farmer's willingness and behaviours on bio-pesticides application will take place.

3.3 Analysis of the influences from external factors

Peer influences have a significant positive effect on the deviation of farmer's willingness and behaviours in bio-pesticide application and it is at 1 per cent significance level. This indicates that farmers often depend significantly on their neighbouring peers for guidance on pesticide procurement and application. Such peer influences, which can be seen as social customs or norms, exert pressure on farmers to align their practices with the expectations of others in their community. In the survey, it was found that many farmers were willing to apply bio-pesticides at the first place, however the intention was abandoned as the neighbouring farmers were still using chemical pesticides.

The emergency conditions have a significant positive effect on the divergence between farmer's willingness and behaviours to apply bio-pesticides and it has passed the 5 per cent significance level. Farmers frequently grapple with the choice between using highly toxic but quick-acting chemical pesticides and opting for environmentally friendly biopesticides. Emergency conditions, characterized by temporary anxiety, excitement, and stress during daily agricultural activities, can influence farmer's environmental attitudes by altering their emotions. This emotional shift, in turn, impacts the gap between farmers' willingness to use biopesticides and their actual behaviour.

The price affordability has a significant positive effect on the divergence between farmer's willingness and behaviours of bio-pesticide application and it has passed the 1 per cent significance level. This suggests that the cost of pesticides remains a key consideration for farmers when making purchasing decisions. Since farmers are primarily focused on maximizing profits, the higher price of biopesticides often deters them despite their awareness of environmental protection and willingness to use these products. When the desire to safeguard the environment clashes with the higher cost of biopesticides, most farmers end up choosing the less expensive chemical alternatives.

4. CONCLUSION

This research reveals that while farmer's willingness to adopt bio-pesticides is significantly influenced by individual, awareness-related, and external factors. Higher education levels and larger land sizes correlate with reduced discrepancies between willingness and behaviour, as educated farmers better understand and apply bio-pesticides, and those with larger operations prioritize practices that ensure productivity. Awareness of the risks associated with chemical pesticides and a commitment to environmental safety also reduce deviations, but limited knowledge hampers practical adoption. External factors such as peer influence, emergency conditions, and the higher cost of bio-pesticides further complicate this alignment. Peer pressure often leads farmers to follow community norms, while emergency conditions and high costs can push them toward quick, less environmentally friendly solutions. Addressing these challenges requires enhanced education, improved access to affordable bio-pesticides, and supportive community initiatives to bridge the gap between farmers' willingness and actual application.

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