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## **The Role Of Knowledge Moderating A Farmer's Intention To Adopt Black Soldier Fly Farming: As Seen In The Evidence In The Luzon Region Of The Philippines**

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### **ABSTRACT**

Insect farming has been widely studied as a viable alternative to increase food security, particularly in low-income nations, and as a more sustainable source of animal feed. Insect-based feedstuffs are a good alternative to fishmeal, soymeal, and other feedstuffs since they are comparable in protein and nutrients, need less space to produce, have a minimal environmental impact, and are already a natural component of the diet of poultry, fish, and pigs. Despite all these benefits, there are still obstacles to be addressed to capture the attention of policy-makers and other institutions to support and promote the use of insects in our agricultural chain. The adoption of insect farming among farmers is one of these key obstacles. Even though using insects as an alternate source of animal feed might benefit rural communities in many ways, misperceptions and a lack of acceptability may make it difficult for farmers to accept, integrate, and promote this technology. The factors that impact farmers' intentions to adopt these methods, however, are not very well understood. The major objective of this study was to analyze the level of acceptance of insect farming, specifically Black Soldier Fly farming technology in the Calabarzon region of the Philippines. The conceptual framework used was a modified framework based on Theory of Planned Behavior (TPB), a prominent model used to predict the acceptance of new technologies or innovations. The novelty brought forth in this study was the incorporation of knowledge as the moderating variable.

**Keywords:** Black Soldier Fly, Insect-Based Animal Feed, Theory of Planned Behavior, Sustainability.

## INTRODUCTION

One of the most pressing issues of this century is how to meet the world's food demand in a sustainable manner. Food production will have to increase by at least 70% in order to meet global demand for food due to population growth, urbanization, and economic growth in many countries, as well as shifts in people's diets towards higher consumption of animal foods, fruits and vegetables, and increased efforts to alleviate hunger and malnutrition in low-income countries (FAO, 2013; HLPE, 2016). For the manufacturing of feedstuffs, this increased demand for animal products will necessitate vast quantities of scarce resources (van Huis et al., 2013).

Feedstuffs such as meat meal, fishmeal, and soymeal account for about 60% to 70% of the overall costs of animal production systems (van Huis et al., 2013). In order to ensure food security especially for those in developing nations, it is critical to identify alternate sources of protein for animal feed with low environmental consequences and low economic costs in this context of increasing demand for food and decreasing supply of agricultural land, water, and other natural resources.

### 1.1 INSECT FARMING AND APPLICATIONS

One of these choices is insect farming. Insects are high in protein, and their manufacturing has a low environmental impact (van Huis et al., 2013). The black soldier fly (BSF) *Hermetia illucens*, are among the insect species that are mass farmed because they can feed on a variety of substrates, including organic waste streams (Chia et al., 2018). The capacity of these insects to transform organic waste into high-quality nutrition has opened up new economic opportunities quickly. Insect-based protein has been used in pig (Biasato et al., 2019), poultry (Onsongo et al., 2018), and fish (Mancini et al., 2018) feeds as an alternative to fishmeal or soybean meal. As a sustainable alternative to fishmeal, soy meal, and other feeds, insects have been proposed because they are comparable in nutrients, require less space to produce, have a low environmental impact, and are a natural part of the diet of fish, poultry and pigs in nature (Rumpold & Schlüter, 2013). Insects are also a natural part of the diet of fish, poultry, and pigs in nature. They may be raised on a variety of organic materials with minimal or no economic value, converting waste biomass into a high-value-added protein-rich substance with a low initial investment. They are an excellent tool for bioconversion that can be utilized to address waste disposal difficulties in rural regions (Gahukar, 2016). In addition, after the insects have been grown, the excrement or frass can be used as an organic fertilizer, completing the nutrient cycle. (Sheppard et al., 2002; Newton et al., 2005; Rumpold & Schlüter, 2013).

### 1.2 HERMETIA ILLUCENS OR THE BLACK SOLDIER FLY

**Figure 1.** *Hermetia illucens* or The Black Soldier Fly.



**Source:** *cotinis Diptera collection via Flickr.*

The Black Soldier Fly (BSF) can be found in tropical and subtropical climates around the world (Sheppard, et al., 2002). BSF Larvae (BSFL) can grow on a variety of waste streams, including organic (fruits, vegetables and produce) waste, human excrement, and animal excrement. As a result, BSFL are optimal in valorising organic waste while still producing good nutritional quality of BSFL biomass which makes them useful as livestock feed (Chia et al., 2019; Sprangers et al., 2017; Nana et al., 2018). Their harvest time is much faster than that of traditional protein sources. BSF are not classified as pests nor are they classified as a disease vector (Verner et al., 2021; Halloran et al., 2018). Adult BSF are neither harmful nor attracted to human environments (Bosch et al., 2019).

### **1.1.1 Research on BSF Larvae Used As Animal Feed**

Broiler chickens and quails showed adequate taste, scent, and nutritional composition when BSF larval meal replaced soybean and fishmeal in proportions of 10–56%, confirming that BSF larval meal is appropriate for inclusion in poultry diets (Onsongo et al., 2018). BSF larval meal has also been successfully used as a fish feed in Africa in nursing Nile tilapia fingerlings with varying degrees of fishmeal replacement by BSF meal produced identical growth and feed conversion results (Devic et al., 2018). Piglets fed meals containing 5–10 percent BSF larval feed grew well with minor changes in blood profiles (Biasato et al., 2019). Also, at higher levels of inclusion, performance comparable to that of conventional feed has been seen (Chia et al., 2019). BSF larval meal is an appropriate component of animal diet, according to study (Van Huis et al., 2013; Biasato et al., 2019; Onsongo et al., 2018).

### **1.1.2 Use of BSF Larvae As A Waste Management Solution**

BSF larvae can be raised on organic garbage that would otherwise end up in landfills, polluting the environment. BSF larvae, for example, can reduce 30 metric tons of food waste. While creating 930 kg of dry biomass, 10 metric tons of garbage were saved (a 66 percent waste reduction) (Salomone et al., 2017). BSF larvae were found to reduce waste by 51–80 percent on pig, poultry, and household trash (Nana et al., 2019). Private enterprises in Africa are currently converting slum garbage into organic fertilizer and fly larvae (Dicke et al., 2018). These programs aid in the sanitization of the environment for low-income areas. Finally, the use of fly larvae as feed ingredients produces high-quality feed ingredients while also contributing to a circular economy.

## **1.3 PROBLEM IDENTIFICATION, RESEARCH GAP AND NOVELTY**

This research aims to fill a gap in the literature by looking into the factors that influence farmers' decisions to use insect farming as a source of animal feed. Policymakers, cooperatives, farmer associations, and others may see these techniques as a fantastic way to boost their region's rural development and be enticed to implement and promote insect farming systems. In order to avoid risks to human and animal health, which are highly dependent on how insects are raised and processed, such technical assistance should focus on the development and application of appropriate and cost-effective handling, processing, and storage practices for insects once they have been harvested (Zhou et al., 2016). As a result, if small-scale insect farming is to be implemented in rural regions, especially in developing nations, it is vital to first examine farmer acceptability of the procedures.

## **1.4 SCOPE OF THE STUDY**

The main goal of this study is to analyze the level of acceptance of insect farming, specifically BSF rearing and farming practices for animal feed among farmers in the Philippines. The conceptual framework used is based on the main constructs of the Theory of Planned Behavior (TPB), one of the most popular models used to predict the acceptance of new technologies or innovations, as well as the analysis of some socio-economic characteristic.

## **LITERATURE REVIEW**

### **2.1 THE THEORY OF PLANNED BEHAVIOR (TPB)**

Icek Ajzen established the theory of planned behavior (TPB) in 1991 as a derivative of Ajzen and Fishbein's theory of reasoned action (1980). The purpose of the individual to conduct a specific activity is a key aspect in the TPB. According to Ajzen (2005), the immediate determinant of behavior is the intention to act. The TPB assumes that the stronger a person's desire to engage in a behavior, the more likely they are to do so (Ajzen, 1991). In the TPB, purpose is generated from three conceptually distinct constructs: attitude, subjective norm, and perceived behavioral control, all of which can be tested directly or inferred from people's beliefs (indirect measures).

#### **2.1.1 Attitude Towards Behavior (ATB)**

The degree to which a person has a favorable or unfavorable opinion of the conduct is referred to as attitude (Ajzen, 1991). Individuals generate attitudes based on their perceptions of what may or may not be true about a given subject, which perceptions may or may not be based on facts, knowledge, or even an emotional reaction to the subject, and which perceptions are occasionally backed by beliefs and values (Willock et al., 1999).

#### **2.1.2 Subjective Norm (SN)**

Subjective norm is a social component that refers to the perceived social pressure to perform or refrain from performing an action.

#### **2.1.3 Perceived Behavioral Control (PBC)**

The ease or difficulty with which an individual perceives doing an action is referred to as perceived behavioral control (Ajzen, 1991).

#### **2.1.4 Behavioral Intention**

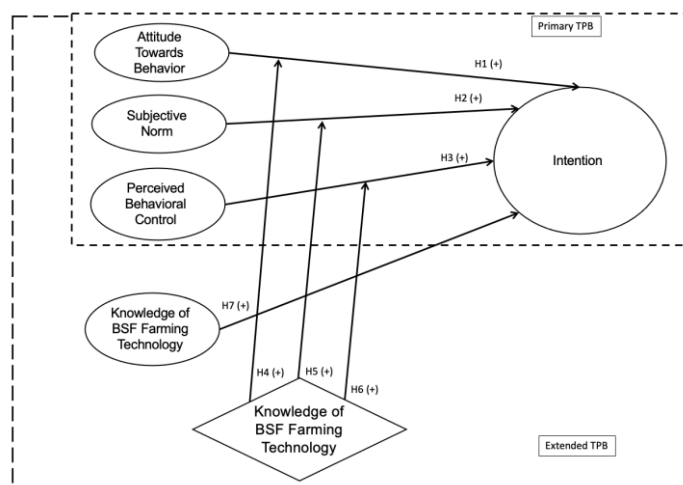
The stronger an individual's intention to undertake the behavior is, the more positive these three components are (Ajzen, 1991). As a result, the relative impact of attitude, subjective norm, and perceived behavioral control in predicting intention is likely to differ across activities and situations (Ajzen, 1991). In this study, intention was defined as farmers' intention to adopt insect farming to produce insect-based animal feed.

#### **2.1.5 Knowledge as The Moderating Variable**

In social science and business studies around the world, the moderating variable is becoming more prominent. It demonstrates model complexity and maturity, providing a clearer picture of the study's criteria variable (Chen, 2021; Maumoh & Yindi, 2021). As a result, the researcher will attempt to use knowledge as a moderator for the study, as knowledge is one of the cognitive factors in decision making (Rivis et al., 2006). According to Chen 2021), the moderating variable could be used to strengthen weak or inconsistent aspects of the literature regarding the relationship between the predictors, in this case attitude toward behavior, subjective norm, and

perceived behavioral control, and the criterion variable, in this case intention to adopt the black soldier fly farming behavior.

**Figure 2. Theoretical framework**



Source: Data processed by the author (2022)

Knowledge can be defined as awareness, consciousness, or familiarity gained via experience or learning; it can also be defined as facts, feelings, or experiences known by a person or a group of people. Knowledge, in this context, refers to the expertise and abilities obtained by a person or a group of individuals as a result of a theoretical or practical understanding of a subject (Shmueli et al., 2016).

Based on the literature review, the following is hypothesized:

H1: A higher Farmers' Attitude will influence a higher intention to adopt BSF farming technology.

H2: A higher Farmers' Subjective Norm will influence a higher intention to adopt BSF farming technology.

H3: A higher Farmers' Perceived Behavioral Control will influence a higher intention to adopt BSF farming technology.

H4: A higher Farmers' Knowledge of BSF Farming Technology will impact a higher influence between high attitude toward the intention to adopt that technology.

H5: A higher Farmers' Knowledge of BSF Farming Technology will impact a higher influence between high subjective norm toward the intention to adopt that technology.

H6: A higher Farmers' Knowledge of BSF Farming Technology will impact a higher influence between high perceived behavioral control toward high intention to adopt that technology.

H7: A higher Farmers' Knowledge of BSF Farming Technology will influence a higher intention to adopt BSF farming technology.

## METHODOLOGY

### 3.1 RESEARCH METHOD

The method of analysis and data collection is utilized to determine the study's overall reliability and validity (Saunders et al., 2007). To supplement the findings, the researcher is collecting information from individuals living in the Rizal province of the Calabarzon Region utilizing primary and secondary data. Primary data is information obtained directly through

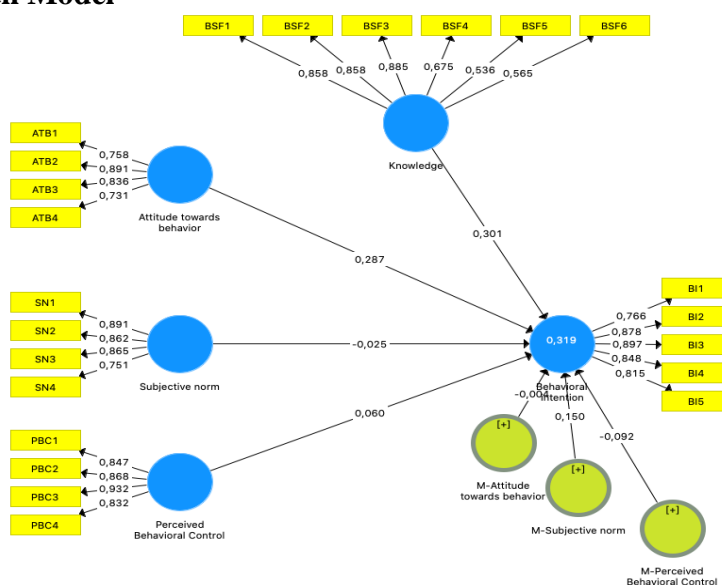
questionnaires filled out by respondents in a Google form in order to obtain individual viewpoints. Secondary data, on the other hand, is a source of research data obtained through an active search and collection of information from journals, books, reports, and other data gathered by earlier researchers.

### 3.2 DATA COLLECTION

To be efficient within an acceptable time frame, data will be collected utilizing a questionnaire approach provided to respondents through an online form in this study. A questionnaire is a group of written questions with a formula (Sekaran & Bougie, 2013). Google Forms will construct an online questionnaire and send it to selected respondents via WhatsApp, Facebook Messenger, and Viber. The questionnaire would be distributed to the respondents of the population sample, which was confined to individuals experienced in raising poultry residing in the Luzon Region (Mapa, 2020). Closed-ended questions are employed in the questionnaire; the Likert scale is often used to gauge a person's intention, attitudes, views, or perceptions concerning social phenomena in the form of interval scales. A Likert scale inquiry is one in which the response is given on a five-point scale. The researcher employs a scale of 1-5 in this study, with each meaningful scale being "1" Strongly Disagree, "2" Disagree, "3" Neutral, "4" Agree, and "5" Strongly Agree. Reliability and validity of the questionnaire and complete data analysis was performed using Partial Least Square - Structural Equation Modeling or PLS-SEM.

## FINDINGS, ANALYSIS AND DISCUSSION

Figure 3. Research Model



Source: PLS-SEM result, 2022

## 4.1 RESULTS

### 4.1.1 Accepted Hypotheses

According to these findings, H1 & H7 are accepted. So, a higher Farmers' Attitude and Knowledge of BSF Farming Technology will influence a higher intention to adopt BSF farming technology.

### 4.1.2 Rejected Hypotheses

According to these findings, H2, H3, H4, H5, & H6 are rejected. So, a higher Farmers' Subjective Norm and Perceived Behavioral Control will not influence a higher intention to adopt BSF farming technology. Additionally, there is no moderating effect of knowledge on



the relationship between independent variables and the intention to adopt BSF farming technology.

## CONCLUSION

While attitude towards behavior and knowledge revealed a positive and significant relationship towards a farmer's intention to adopt BSF farming technology, the other independent variables, subjective norm and perceived behavioral control did not reveal any significant influence in behavioral intention. Finally, knowledge as the moderating variable also showed to significant effect on the relationship between the independent variables and the dependent variable in this study.

In terms of practical contributions, this was the first research of its kind to provide data on the intention to adopt new agricultural technology, notably BSF farming technology. Because BSF farming technology is a very new and innovative body of agricultural knowledge, any addition to this highly beneficial practice is noteworthy. There has been no previous research that used TPB theory to investigate the moderating influence of knowledge on a farmer's intention to adopt BSF farming technology.

First, this study will contribute to the agricultural industry, particularly in the spheres of circular economies, alternative sources of protein for animal feed, waste management, and profitable small-scale farming applications. As explained in the background of the problem in Chapter 1, the market is in demand for alternative sources of animal protein. With Earth's growing population, the demand of innovative, cost-saving and problem-solving farming methods are at an all-time high. As most research regarding BSF farming technology has been focused on scientific applications, the results of this study will also contribute to the agribusiness sector.

Second, as this study revealed that attitude towards behavior has positive and significant effect on a farmer's intention to adopt BSF farming technology, it can be applied to businesses in the BSF farming technology industry. By targeting perception and individual beliefs, companies can influence the consumers' intention to adopt BSF farming technology. This may be translated to sales by providing products or services that encourage adoption of this technology. Third, this study revealed that knowledge, as an independent variable, had a direct and positive influence towards the intention to adopt BSF farming technology. This can also be applied to businesses who provide products or services contributing to the growth of a consumer's familiarity and expertise on the subject of BSF Farming technology. Examples of these are educational materials such as books, e-books, videos, etc. and services such as workshops, consultation services, subscription services, etc.

Whether it be on the business strategy side, product management or service creation, the possibilities for business applications using the results of this study are some of the many practical contributions.

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