

**MAKERERE**



**UNIVERSITY**

**KNOWLEDGE, ATTITUDES AND PRACTICES OF POULTRY  
FARMERS IN WAKISO DISTRICT TOWARDS BLACK  
SOLDIER FLY LARVAE FARMING**

**BY**

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**A RESEARCH DISSERTATION TO BE SUBMITTED TO DIRECTORATE OF  
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MASTER OF SCIENCE IN LIVESTOCK DEVELOPMENT  
AND MANAGEMENT (LIVESTOCK SECTOR  
PLANNING AND MANAGEMENT)**

**NOVEMBER, 2025**

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## **DEDICATION**

I dedicate this report to my Husband, and my Children for all the love, support and encouragement throughout this course. May God bless you abundantly.

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I give thanks and glory to the Almighty God for the life, good health and protection throughout this journey.

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## TABLE OF CONTENTS

<b>DECLARATION AND APPROVAL .....</b>	<b>i</b>
<b>DEDICATION .....</b>	<b>ii</b>
<b>ACKNOWLEDGEMENT.....</b>	<b>iii</b>
<b>TABLE OF CONTENTS .....</b>	<b>iv</b>
<b>LIST OF TABLES.....</b>	<b>vii</b>
<b>LIST OF FIGURES.....</b>	<b>viii</b>
<b>LIST OF APPENDICES .....</b>	<b>ix</b>
<b>ABSTRACT .....</b>	<b>x</b>
<b>CHAPTER ONE .....</b>	<b>1</b>
<b>INTRODUCTION .....</b>	<b>1</b>
1.1 Background.....	1
1.2 Problem statement .....	2
1.3.1 General objective .....	3
1.3.2 Specific objectives .....	3
1.4 Research questions .....	3
1.5 Justification.....	3
1.6 Conceptual framework .....	4
<b>CHAPTER TWO.....</b>	<b>6</b>
<b>LITERATURE REVIEW .....</b>	<b>6</b>
2.1 The need for an alternative protein source .....	6

2.2 Black soldier fly rearing .....	6
2.3 Knowledge, attitudes and practices of farmers towards Black soldier fly farming .....	7
2.4 Constraints of commercial rearing of Black soldier flies .....	8
2.5 Limitations to adoption of black soldier farming .....	9
<b>CHAPTER THREE.....</b>	<b>10</b>
<b>MATERIALS AND METHODS.....</b>	<b>10</b>
3.1 Research design and approach.....	10
3.2 Description of the geographical area .....	10
3.3 Target population.....	11
3.4 Sampling strategies.....	11
3.4.1 Inclusion criteria .....	11
3.4.2 Exclusion criteria.....	11
3.5 Sample Size .....	11
3.6 Sampling procedure.....	12
3.7 Data variables .....	12
3.8 Data collection.....	12
3.8.1 Tools.....	13
3.8.2 Pre-testing .....	13
3.8.3 Data quality control .....	13
3.9 Data management and analysis .....	13
3.9.1 Data management .....	13

3.9.2 Data analysis.....	13
3.9.2.1 To assess the knowledge, attitude, and practices towards BSF farming .....	14
3.9.2.2 To identify the constraints faced by poultry farmers in rearing of black soldier fly in Wakiso District .....	16
3.9.2.3 To identify factors limiting the adaptation of black soldier fly farming .....	16
3.10 Ethical considerations .....	16
3.11 Dissemination of the research findings .....	16
<b>CHAPTER FOUR .....</b>	<b>17</b>
<b>RESULTS .....</b>	<b>17</b>
4.1 Demographic characteristics.....	17
4.2 Knowledge, attitude and practices of poultry farmers towards BSFL farming in Wakiso District.....	18
4.4 Factors limiting the adaptation of black soldier fly farming among poultry farmers in Wakiso District.....	25
<b>CHAPTER FIVE .....</b>	<b>27</b>
<b>DISCUSSION .....</b>	<b>27</b>
<b>CHAPTER SIX .....</b>	<b>30</b>
<b>CONCLUSION AND RECOMMENDATIONS.....</b>	<b>30</b>
6.1 Conclusions .....	30
6.2 Recommendations.....	30
<b>REFERENCES .....</b>	<b>31</b>

## LIST OF TABLES

Table 1: Frequency table of Gender by education level.....	18
Table 2: Frequency table of Gender by knowledge index .....	18
Table 3: Logistic regression analysis of knowledge (yes/no) and the demographic characteristics of farmers .....	20
Table 4: Logistic regression analysis of attitude and the demographic characteristics of farmers of BSFL farming in Wakiso District .....	22
Table 5: Relationship between Gender and Attitude towards BSFL .....	23
Table 6: Spearman rank-order correlation analysis between knowledge attitude and practices.....	24

## LIST OF FIGURES

Figure 1: Conceptual framework as modified from Daley 1998 .....	5
Figure 2: Map of Uganda showing the location of Wakiso district .....	10
Figure 3: Number of respondents per Subcounty.....	17
Figure 4: Proportion of poultry farmers who were knowledgeable about BSFL farming in Wakiso District .....	19
Figure 5: Attitude of poultry farmers on BSFL farming in Wakiso District.....	21
Figure 6: Frequency of selected BSFL related practices of poultry farmers in Wakiso District.....	23
Figure 7: The frequency of constraints faced by poultry farmers involved in BSL Farming in Wakiso District.....	25
Figure 8: Total number of respondents per limitation regarding BSFL farming among poultry farmers in Wakiso District.....	26

## **LIST OF APPENDICES**

Appendix II: Questionnaire.....	38
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## ABSTRACT

In Uganda, the poultry sector is facing mounting challenges due to the high costs and limited availability of conventional protein ingredients such as fishmeal. Black soldier fly (BSF) larvae (*Hermetia illucens*), with their high crude protein content, have been identified as a viable alternative protein source for poultry feed. This study sought to assess the knowledge, attitudes, and practices (KAP) of poultry farmers towards BSF larvae farming, constraints and factors limiting BSF farming in Wakiso District. Using a cross-sectional survey design, data was collected from 80 poultry farmers using a pre-tested semi-structured questionnaire. Data were analyzed for descriptive statistics, Spearman rank correlation to assess relationships among KAP variables and demographic/institutional factors. Results revealed that 58.8% of the respondents demonstrated a high level of knowledge about BSF farming, including aspects about BSF appearance, feeding behavior, and the nutritional benefits of larvae in poultry diets. Higher education levels and larger farm sizes were significantly associated with greater knowledge. 47.5% of respondents exhibited a positive attitude toward BSF farming. Male farmers and those with lower education levels showed more favorable attitudes. 51% of the farmers reported frequently applying good BSF farming techniques, including waste management through larvae rearing and the use of BSFL in poultry feed. Despite high knowledge levels, correlations between knowledge, attitudes, and practices were found to be weak or insignificant. This suggests that knowledge alone is insufficient to change behavior without addressing broader contextual and structural challenges. Farmers faced challenges, including a lack of a stable market for BSF products, insufficient feed, negative public perceptions of insect farming, a shortage of start-up capital, inadequate rearing materials, and poor storage facilities. Others included lack of institutional support, limited access to credit, and absence of government policy. Policy frameworks, access to affordable credit, market development, and practical training programs will be essential to scaling BSF as a sustainable protein source in Uganda's poultry industry. The study recommends that government agencies prioritize awareness campaigns, capacity building, and the creation of an enabling environment for BSF farming.

# CHAPTER ONE

## INTRODUCTION

### 1.1 Background

The Global demand for protein to be consumed by humans and animals as food and feed outstrips supply and this gap keeps increasing (Gasco *et al.*, 2020) The rising demand is reported to be driven by increasing human population estimated to reach 9.7 billion people by 2050 (Rossi *et al.*, 2016). Productivity and profitability of livestock enterprises like poultry and piggery is reported to be declining due to the high costs of the protein ingredient in feed formulations (Ogunnusi *et al.*, 2023). Existing alternatives such as soymeal and fish that are currently utilized for animal feed formulations directly compete with human nutritional needs (Nogales *et al.*, 2018). In a bid to address the above livestock production challenges, black soldier fly farming has been promoted as an alternative protein source for animal feeds.

The black soldier fly, scientifically known as *Hermetia illucens*, has been advocated as a cheap alternative protein ingredient in livestock feed formulations such as poultry (Alvarez *et al.*, 2015). The larvae of black soldier fly are reported to contain between 33% to 63% crude protein (Makkar *et al.*, 2014; Sudha *et al.*, 2022). Figures that are comparable to fish meal and soybean meal (Gasco *et al.*, 2020; Jia *et al.*, 2022; Kaiser *et al.*, 2022). Some scientific studies have also reported that poultry generally prefer the larvae of black soldier fly (Kurek *et al.*, 2022) and have shown increased growth rates and performance (Munthali *et al.*, 2023). Based on the above studies, it is evident that black soldier fly larvae have a role in poultry nutrition (Munthali *et al.*, 2023; Ouko *et al.*, 2022). Generally, there is limited information on farmers' knowledge and practices towards feeding black soldier fly to their poultry, an aspect assessed in this study.

Besides being a protein ingredient and the role of black soldier fly larvae in diets of poultry. It's an enterprise that has advantages in environmental waste management (Beesigamukama *et al.*, 2021). Studies have reported that black soldier fly larvae can consume poultry waste and generate high-value protein and Fras (organic fertilizer) (Beesigamukama *et al.*, 2021; Sangiorgio *et al.*, 2022; Thrastardottir *et al.*, 2021). This is particularly important for Wakiso district livestock farms, which currently struggle

with poultry waste management. It is, however, not understood if the poultry farmers in Wakiso district understand these benefits.

In Uganda, black soldier fly farming is an industry in its infancy (Tanga *et al.*, 2021). A few farms have emerged and are currently producing black soldier fly larvae; it is reported that there are up to 1,000 startup farms in East Africa (Tanga *et al.*, 2021). As a new enterprise, there is limited information available on the constraints and drivers of adoption for early adopters. As such, there is a need to assess the constraints and factors influencing the adoption of black soldier fly farming in Wakiso District.

Based on the above situational analysis on the role of black soldier fly larvae in poultry nutrition and farming, this study seeks to assess the knowledge, attitudes, and practices of poultry farmers in Wakiso District towards black soldier fly larvae farming. As well as the constraints and limitations to the adoption of black soldier fly farming.

## **1.2 Problem statement**

The profitability and productivity of poultry enterprises have been reported to be highly hindered by the high cost of protein ingredients in feed formulations, yet feeding accounts for 70% of the production costs in a poultry enterprise (Ogunnusi *et al.*, 2023). Fish and soybeans, which are the current dominant protein sources in the formulation of commercial poultry feed, directly compete with human nutritional needs. Moreover, fish sources are reported to be increasing in number while also becoming depleted in the lakes (van Riel *et al.*, 2023). As a result, livestock farmers, especially poultry, have struggled to run and maintain profitable and productive enterprises due to the scarcity and high feed costs. In an effort to address the aforementioned production challenges, farmers have been exploring alternatives, including edible insects. Among these insects, black soldier fly farming has been identified as a key candidate due to its high protein and amino acid profiles (Makkar *et al.*, 2014).

In Uganda, the practices of growing black soldier fly larvae have been adopted as an alternative source of protein in animal feeds. A few black soldier fly farms have emerged, but adoption remains low. For increased production of black soldier fly larvae, a market for the end products must be established, which can be driven by end users such as poultry farmers. And for poultry farmers to utilize the black soldier fly, they need to know how to use it and practice. Existing studies have focused on

nutritional properties and composition assessment of black soldier fly larvae (Bukuluki *et al.*, 2020). Previous studies on BSF larvae farming in Uganda have focused on nutritional profiles of larvae farming (Gasco *et al.*, 2020). However, there are limited studies assessing the knowledge, attitudes, and practices of black soldier fly larvae farming among poultry farmers. Therefore, this study was designed to fill this knowledge gap by assessing the knowledge, attitudes, and practices towards black soldier fly larvae farming among poultry farmers in Wakiso District and further identifying the constraints and factors limiting the adoption of black soldier fly farming.

### 1.3 Objectives

#### 1.3.1 General objective

The aim of this study was to assess the knowledge, attitudes and practices of BSF for increased farmers' access to alternative cheap protein.

#### 1.3.2 Specific objectives

- i. To assess the knowledge, attitudes and practices of poultry farmers towards BSF farming in Wakiso District.
- ii. To identify the constraints faced by poultry farmers in the commercial rearing of BSF in Wakiso District.
- iii. To identify factors limiting the adoption of black soldier fly farming among Wakiso district poultry farmers.

### 1.4 Research questions

1. What are the poultry farmers' knowledge, attitudes and practices towards BSF farming among poultry farmers in Wakiso District?
2. What are the constraints faced by poultry farmers in the commercial rearing of BSF in Wakiso District?
3. What are the factors limiting the adoption of black soldier farming among Wakiso District poultry farmers?

### 1.5 Justification

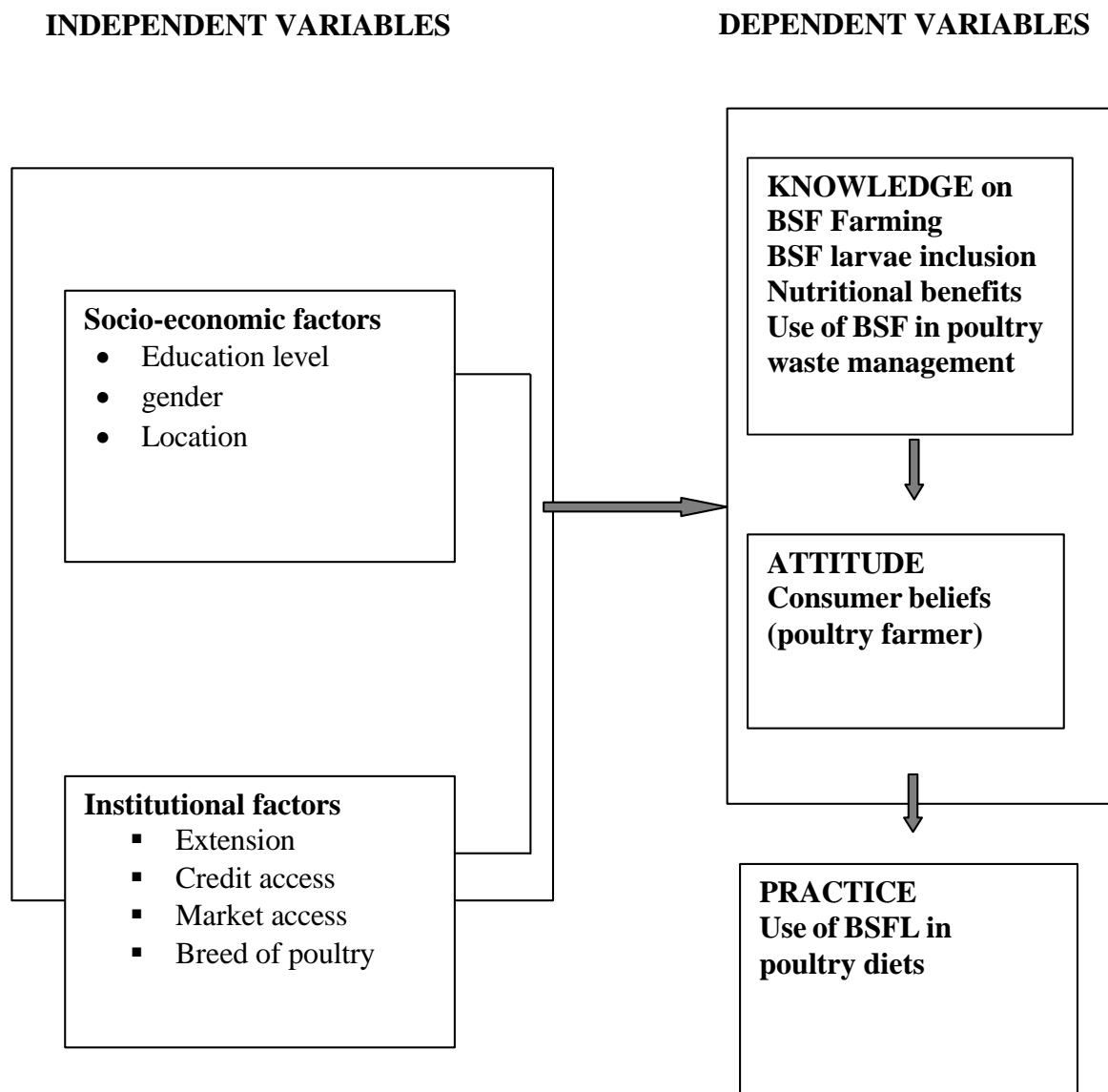
This study will help to establish the loopholes in the knowledge, attitude and practices of BSF farming among poultry farmers in Wakiso District so as to generate knowledge

and to improve on the existing information. No such data has been documented about the loopholes in the knowledge, attitude and practices of BSF farming among poultry farmers in Wakiso District.

## **1.6 Conceptual framework**

The knowledge, attitude and practices study by Daley, (1998) and empirical research on the acceptance of innovation in agriculture served as the foundation for this study's framework, which is depicted in Figure 1. The conceptual framework described how farmers' socio-economic and institutional factors have a direct impact on the knowledge, attitudes, and practices of black soldier fly among poultry farmers in Wakiso District. Therefore, the current conceptual framework was built on the premise that socio-economic and institutional factors influence poultry farmers' knowledge, attitudes, and practices. The dependent variables will be knowledge, attitudes, and practices towards black soldier fly farming, whereas the independent variables will include socio-economic and institutional factors. Farmers' knowledge and Attitude will be the intervening variables for black soldier fly farming practices employed by farmers in Wakiso District. Figure 1 indicates the expected relationship between the independent and dependent variables.

**Conceptual framework for knowledge, attitudes and practices of poultry farmers in Wakiso District towards black soldier fly larvae farming**



*Figure 1: Conceptual framework as modified from Daley 1998*

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 The need for an alternative protein source

Livestock, including poultry, employ over 1.3 billion people globally. The poultry sub-sector alone supports the livelihoods of nearly 600 million farmers, with 33% of these coming from sub-Saharan Africa. Currently, Uganda's total poultry population is estimated to be approximately 47.6 million chickens, and production has increased from 1,536,000 in 2008 to 5,852,000 in 2017 (Wamala, 2021; Warsame & Turyasingura, 2022). All these depend on locally available conventional feed resources, such as cereal crop residues and fish (Duguma & Janssens, 2021). The protein component accounts for a value that is approximately between 60 and 70% of production costs (Ravindran, 2013). It is estimated that fishmeal is the most widely consumed protein ingredient in poultry feed, and it is approximated that over 14% of the global fish catch is used as fishmeal for animal feed production (Gokulakrishnan *et al.*, 2023).

Dried silver cyprinid argentea (commonly known as mukene) is used as a protein source in poultry feeds (Otieno, 2022). With the current annual increase (3.2%) in the human population of the country, the demand for argentea is expected to rise, and its catches are anticipated to decrease due to overfishing, which may negatively affect both the poultry sector and the entire animal industry (Wyatt *et al.*). Unfortunately, soybean, which is a cheaper and readily available substitute for fishmeal, has a lower nutritional content (in terms of protein digestibility and amino acid patterns) compared to the latter. Consequently, the increasing cost of feed has a significant impact on small-scale poultry farmers. There is a need to adopt locally available alternatives to reduce the production cost for poultry farmers, enabling them to achieve profits from their enterprise. Rearing black soldier flies can solve this problem, and it has added benefits (Peres & Lim, 2023).

#### 2.2 Black soldier fly rearing

Black soldier fly larvae meal (BSFLM) is an animal-grade alternative to fish meal due to its high protein and lipid contents, and the interest in using it is growing (Roy *et al.*,

2024). It is also high in essential amino acids, fatty acids, and minerals such as copper, iron, and zinc (Sudha *et al.*, 2022).

Additionally, it is said to have better results when it comes to improvement in egg production, quality, and taste as well as carcass characteristics of broiler chickens as compared to fish (Abasubong *et al.*, 2025). This relatively new farming technology if fully adopted has a huge potential to make the livestock sector more economically beneficial. Since female BSF produces 350 to 700 eggs within its short lifespan of five to eight days, and yet it is not affected by seasonality, they can easily solve the problem of the ever-fluctuating prices of the currently available protein sources which is blamed on scarcity as a reason of seasons (Sudha *et al.*, 2022). Uganda is still at infant stages of exploring BSF larvae as an alternative protein source for poultry feed (Musinguzi *et al.*, 2024). It was found out that to replace 45% of the existing protein sources, Uganda must produce about 1.5 million tons of BSF (Abro *et al.*, 2022) however, lack of awareness is a barrier for uptake of the technology and the country is far from realizing this (Veldkamp & van Niekerk, 2018).

### **2.3 Knowledge, attitudes and practices of farmers towards Black soldier fly farming**

The global awareness among farmers of insects as a potential protein source in animal feed is currently high. Farmers are now producing insects not only as food for themselves but also as feed for animals and for waste management because they are excellent bio degraders (Sebatta *et al.*, 2018; Sogari *et al.*, 2019). Insect farmers are aware that even if they occur naturally in the environment, for optimal benefits, they should be kept in captivity, and each rearing step must be controlled (van Huis, 2022; Varelas, 2019). In a study by Mlcek *et al.* (2014), *farmers expressed their awareness of the benefits of insect farming and using them as feed for animals*, such as their small space requirement, limited investment costs, and the simplicity of the technology compared to fish farming. Other farmers highlighted the rapid returns on investment and the fact that the technology does not require in-depth training (Boppré & Vane-Wright, 2019).

In general, farmers have a positive attitude towards growing and feeding their animals with insects, particularly black soldier flies and their larvae. This is because, naturally, birds eat insects, so it is not seen as abnormal by most people (Takov *et al.*, 2021).

There is, however, a percentage of people who look at growing and feeding their birds with insects and, in particular, “maggots” as disgusting. This negative perception can be taken away by continued sensitization and training (Rowe, 2020, p. 6).

In fact, a study has found that attitude towards insect farming is directly related to the level of education. In this study by Boppré and Vane-Wright (2019), farmers with a higher level of formal education were more likely to adopt insect farming techniques than those with less formal education, as they are more likely to attend various training seminars, comprehend, and apply the information given to them.

In a study done in several Asian countries, BSF were used for food waste treatment and oil production before being converted into feed for animals (Ouko *et al.*, 2022). In this case, the insect larvae are pressed, dried, and packaged in bags, so the birds do not necessarily eat live larvae (Kim *et al.*, 2021). In some parts of Africa, the insect larvae are fed to the birds in their raw form, with no treatment, pressing or roasting (Mutungi *et al.*, 2019). In a study done in Ghana, the larvae are grown under cow dung or pig droppings. They are then harvested in the morning and fed to the birds before any other feed is given to the poultry (Akter *et al.*, 2025). Other farmers grow the larvae in paddocks and release their poultry into each ready paddock to eat the larvae directly from the litter or garbage piles where they are grown (Pieterse *et al.*, 2019).

#### **2.4 Constraints of commercial rearing of Black soldier flies**

One of the major challenges of commercial BSF rearing is that the enterprise lacks a well-developed value chain and does not generate notable value additions (Chetty, 2022). This could be one of the reasons why the growth to industrial scale production to be able to compete with the currently available protein sources is still hard. This makes dependence on BSFL as a source of protein not sustainable, as farmers are only able to produce a few kilograms of feed. If the product is to be put on the market, this low production scale might cause a rise in the price of the feed. As a result, BSF may not be able to substitute fishmeal (Tiwasing & Pate, 2024).

In addition to the above, the lack of credit facilities, inadequate capital, high market levy, insufficient supply of maggots, and inadequate preservation methods impede maggot production, processing, and marketing (Auzins *et al.*, 2024).

Currently, many farmers in parts of Africa and Asia who have adopted the technology feed their animals or birds with BSFL directly, without processing. However, this means that the producer does not optimize the financial benefits of the technology. To do so, they need to further process it and make it available for sale as packaged animal feed, just as fish is currently done.

This, on the other hand, requires substantial amounts of electricity and money, which many willing farmers in these areas currently lack (Adamtsey *et al.*, 2024; Nyirenda, 2023b; Okello, 2022; Mutai, 2024). These, among many others, are the constraints that are facing the adoption of this new technology.

## **2.5 Limitations to adoption of black soldier farming**

One of the major hindrances to the adoption of the BSFL technology is the fear of the new Innovation (Adamtsey *et al.*, 2024). This can be overcome by numerous sensitization sessions to teach farmers how to move beyond their perceived fears (Abro *et al.*, 2022b). In a study conducted in Nigeria, the lack of knowledge on where to obtain parent stock was one of the hindrances to the adoption of the technology. Others included irregular larva production, perceived economic viability and environmental friendliness (Okello, 2022). Farmers with extensive experience using other sources of protein are also very difficult to convince to adopt this new technology.

## CHAPTER THREE

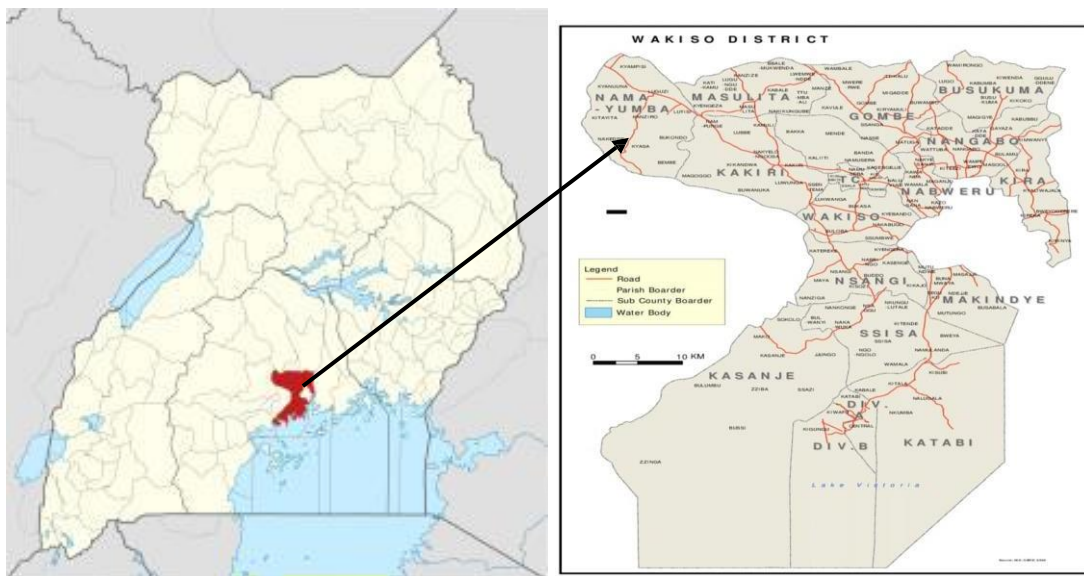
### MATERIALS AND METHODS

#### 3.1 Research design and approach

The study employed a cross-sectional design with a quantitative research approach, using a pre-tested semi-structured questionnaire for data collection. A cross-sectional survey research design allows for the collection of data from a cross-section of respondents at one point in time (Xuewei *et al.*, 2022).

#### 3.2 Description of the geographical area

The study was conducted in Wakiso (Wakiso District). Wakiso district is located at 0.0630° N, 32.4467° E in central Uganda. The district was purposively chosen because it pioneered black soldier fly production in central Uganda, and its residents are predominantly poultry farmers (Abro *et al.*, 2022a; Darias & Mirera, 2023). Wakiso District covers a total land area of 2,704 Km<sup>2</sup> and is made up of 17 sub-counties, 135 parishes, and 2,107 villages (Nyirenda, 2023). The 2024 census revealed that a total of 5.8 million households engage in agriculture (Wakiso District Local Government, 2020). More than two-thirds (69%) of households derive their livelihoods from subsistence farming as the main source of earning. In terms of employment, 52% of the population are subsistence farmers (UBOS, 2024).



**Figure 2: Map of Uganda showing the location of Wakiso district**

### 3.3 Target population

The study targeted all the poultry farmers in Wakiso.

### 3.4 Sampling strategies

#### 3.4.1 Inclusion criteria

All poultry farmers who live in Wakiso district and use BSFL

#### 3.4.2 Exclusion criteria

All poultry farmers who live in Wakiso district and use BSFL whose farms are not in the same district were excluded.

### 3.5 Sample Size

The total number of participants involved in the study was determined according to a formula provided by Yamane (1967). See equation (I)

$$n = \frac{N}{[1 + N(e^2)]} \dots \dots \dots (I)$$

Where;

n: Sample size

N: Population size =80

e: Level of precision. = 0.01

$$n = \frac{N}{1 + N(e^2)}$$

$$n = \frac{80}{1 + 80(0.01^2)}$$

$$n = \frac{80}{1 + 0.008}$$

n=79.37 approximately 80 farmers

### **3.6 Sampling procedure**

In this study, a two-stage sampling technique was employed. The first stage was purposive selection of the district due to its status of black soldier fly farming. This was followed by purposive selection of 5 out of the 17 sub counties in the district which were also intensively involved in black soldier fly farming. These include Busukuma, Kasanje, Kira, Makindye, and Sissa. Given the limited number, the Snowball technique was employed to identify poultry farmers involved in black soldier farming in Wakiso, where one farmer told us about the other to raise the 80 number of respondents in the selected sub-counties.

### **3.7 Data variables**

#### **Measurement of Quantitative Variables**

*Dependent variables:* The dependent variables for this study are knowledge, attitude, and practices.

*Independent variables:* The independent variables included variables pertaining to the interviewee's individual characteristics and institutional characteristics. These include education level and gender. They also include institutional factors such as extension services, credit access, market access, breed of poultry, and size of poultry farm.

### **3.8 Data collection**

Data was collected using a semi-structured questionnaire administered to sampled farmers who were growing BSF between March and April 2020. Data was collected by research assistants who received prior training on the data collection tool. The questionnaire comprised questions on the characteristics of poultry farmers (age, education level, land size, marital status, access to credit, market, and extension services), their knowledge, practices, and attitudes towards black soldier farming.

About attitudes and practices, a five-point Likert scale was used to solicit responses from the farmers, with a scale ranging from (1) strongly disagree, (2) disagree, (3) neutral, (4) agree and (5) strongly agree on black soldier farming. On the other hand, data on knowledge was collected in a binary response where a “**yes**” indicates that the farmer is knowledgeable and a “**no**” indicates that the farmer is not knowledgeable.

### **3.8.1 Tools**

Used a semi-structured questionnaire (appendix 2), which is a quantitative research method.

### **3.8.2 Pre-testing**

The tools were pretested to ensure validity and reliability. The pre-test was done for purposes of clarity, validation, suitability and logical flow of the variables and revised accordingly, before being used in the field. The tool was pre-tested outside the study area.

### **3.8.3 Data quality control**

Research assistants underwent a week of training in quantitative data collection methods, which included familiarisation with the BSF growing story, its benefits, and relevant terminologies. Standard operating procedures were developed to guide the extraction of data from interviewees. The research assistants were trained in practical interviewing, note-taking during the interview process and audio recording of the participant responses where necessary.

## **3.9 Data management and analysis**

### **3.9.1 Data management**

Filled-in data forms were checked for completeness and quality. The data was stored in a password-protected Microsoft Access (2010) database. This data was cleaned where necessary, and attempts were made to complete any missing data by returning to the source of the data.

### **3.9.2 Data analysis**

Collected data was entered into Microsoft Excel 2019 before analysis. After entry, the data was cleaned for possible errors. Descriptive analysis was then performed in STATA v. 14. The following sub-sections present details of the analysis by objective.

### 3.9.2.1 To assess the knowledge, attitude, and practices towards BSF farming

#### *Construction of latent variable knowledge, attitude, and practices*

Poultry farmers' knowledge, attitude, and practices towards black soldier fly farming were measured using a total of 60 observations, including 20 observations for knowledge, 20 observations for attitude, and 20 observations for practices, based on two rounds of the Delphi method application (expert opinion), as detailed below.

#### *Assessment of farmers' knowledge towards BSFL in Wakiso district*

Farmers' knowledge on black soldier fly farming was measured by administering questions with binary responses of "yes/no". The binary scores for each question were added together to give a knowledge score ranging from 0 to 10. The answer "yes" was coded as 1, while the answer "no" was coded as 0. A total score of 0–20, with an overall score of greater than indicates more favorable knowledge on black soldier fly farming. On the other hand, a knowledge index was created from the raw knowledge scores of each poultry farmer using the formula given by Savithe *et al.*, (1999) and Nyi *et al.*, (2022).

$$\text{Index of knowledge (IK)} = \frac{\text{Number of correct responses}}{\text{Total number of knowledge observations}}$$

A binary score was subsequently derived from the normalized IK scores, where scores equal to or greater than the mean were assigned "knowledge" and those less than the mean were assigned "no knowledge".

Cronbach's Alpha analysis was done to determine the reliability and internal consistency of questions regarding farmers' knowledge of BSL-based meal as a feed diet for poultry.

### ***Assessment of farmers' attitudes towards BSFL in Wakiso district***

Farmers' attitudes toward black soldier fly farming were measured using a 5-point Likert scale, following the procedures outlined by Likert (1932). This type of interview results in a single score that represents the degree to which a person is favorable or unfavorable with respect to the question asked (Bernard, 1994). Each respondent was asked to indicate their extent of agreement or disagreement with each statement along a 5-point scale: strongly agree, agree, undecided, disagree, and strongly disagree. Weights assigned to these responses were 5, 4, 3, 2, and 1, respectively. The score 3 was treated as the mid-point. The attitude ratings were summed to obtain an overall attitude score, ranging from 20 to 100 points. The attitude index was then created using the following Nyi *et al.*, (2022), taking the total of the respondents' actual scores.

Index of attitude

$$= \frac{\text{Sum of scores} - \text{Minimum possible scores}}{\text{Difference between minimum and maximum possible scores}}$$

A binary score was subsequently derived from the normalized scores, where scores equal to or greater than the mean were assigned "high attitude" and those less than the mean were assigned the "low attitude".

### ***Assessment of farmers' practices towards BSFL in Wakiso district***

The questionnaire contained 20 items to assess the practices of black soldier fly farming. A five-point Likert scale was used to solicit responses from the poultry farmers, with a scale ranging from (1) never, (2) rarely, (3) occasionally, and (4) frequently on practices of black soldier fly farming. The practice index was then created using the following Nyi *et al.*, (2022), taking the total of the respondents' actual scores.

Index of Practices (IP)

$$= \frac{\text{Sum of scores} - \text{Minimum possible scores}}{\text{Difference between minimum and maximum possible scores}}$$

### **3.9.2.2 To identify the constraints faced by poultry farmers in rearing of black soldier fly in Wakiso District**

Identification of the constraints faced by poultry farmers in rearing black soldier flies in Wakiso District was achieved by the use of a three-point scale reflecting a continuum of constraint severity (2 = “severe”, 1 = “mild” and 0 = “not a constraint”). The weighted mean was computed for each item and used to rank it in order of severity for the respective variable.

### **3.9.2.3 To identify factors limiting the adaptation of black soldier fly farming**

Identification of factors limiting the adaptation of black soldier fly farming among poultry farmers in Wakiso District was achieved by illustrative interview quotes, a questionnaire survey which followed the analytic hierarchy process (AHP).

## **3.10 Ethical considerations**

Ethical approval was sought from the Committee of Higher Degrees, Research and Ethics, School of Veterinary Medicine, Makerere University, Kampala. Data was used anonymously and was treated strictly confidentially throughout the study.

The quantitative data was obtained from interviews. There was direct contact with any study participants and therefore informed consent was obtained.

Completed data forms were stored in a locked filing cabinet. Once captured, all identifiers were deleted to ensure that the final dataset is anonymous.

## **3.11 Dissemination of the research findings**

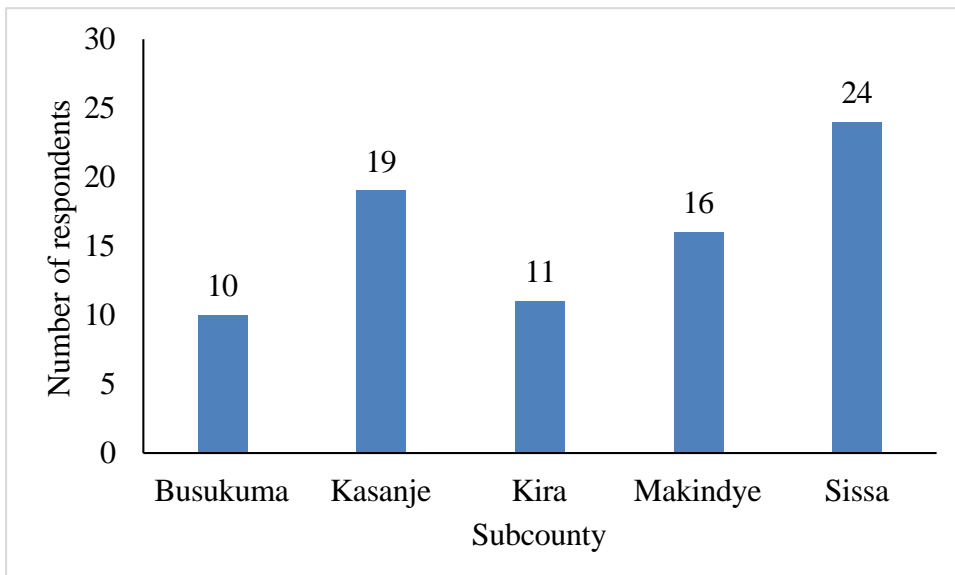
A written report would be submitted to districts through their district veterinary officers and to MAAIF. Additionally, the findings will be disseminated through academic papers and conference presentations.

## CHAPTER FOUR

### RESULTS

#### 4.1 Demographic characteristics

Most of the farmers were female (n = 50, 62.5%) and the rest (n=30, 37.5%) were male. Most of the respondents were from Ssisa Subcounty (n=24, 30%) and Kasanje (n=19, 23.75%), followed by Makindye (n=16, 20%), Kira (n=11, 13.75%) and those from Busukuma (n=10, 12.5%) were the least. Almost half (n = 35, 43.75%) of the farmers were the household heads, while 56.25% (n = 45) were spouses of the household heads. Thirty-one respondents (11.25%) had lost their spouses, thirty-nine were married (12.5%), and 31 (38.75%) were single. The majority of the respondents (n = 72, 90%) were full-time farmers, 3.75% (n = 3) of the respondents were salaried employees, 1.25% (n =1) was a businessman, and 5% (n = 4) were casual labourers on the farm. All the farms visited kept fewer than 1000 birds. Of the farmers interviewed, 71.25% (n = 57) were commercial farmers and 28.75% (n =23) were subsistence farmers. Majority of the respondents had attained primary school education, and these were mainly female. Most males had professional training school education as their highest level of education (figure 3 and Table 1).



*Figure 3: Number of respondents per Subcounty*

**Table 1: Frequency table of Gender by education level**

<i>Education level</i>	<i>Female</i>		<i>Male</i>		<i>Total</i>
	Frequency	%	Frequency	%	
No formal education	10	12.5	10	12.5	20
Primary school education	25	31.25	6	7.5	31
Professional training school education	9	11.25	14	17.5	23
Secondary school education	6	7.5	0	0	6
Total	50	62.5	30	37.5	80

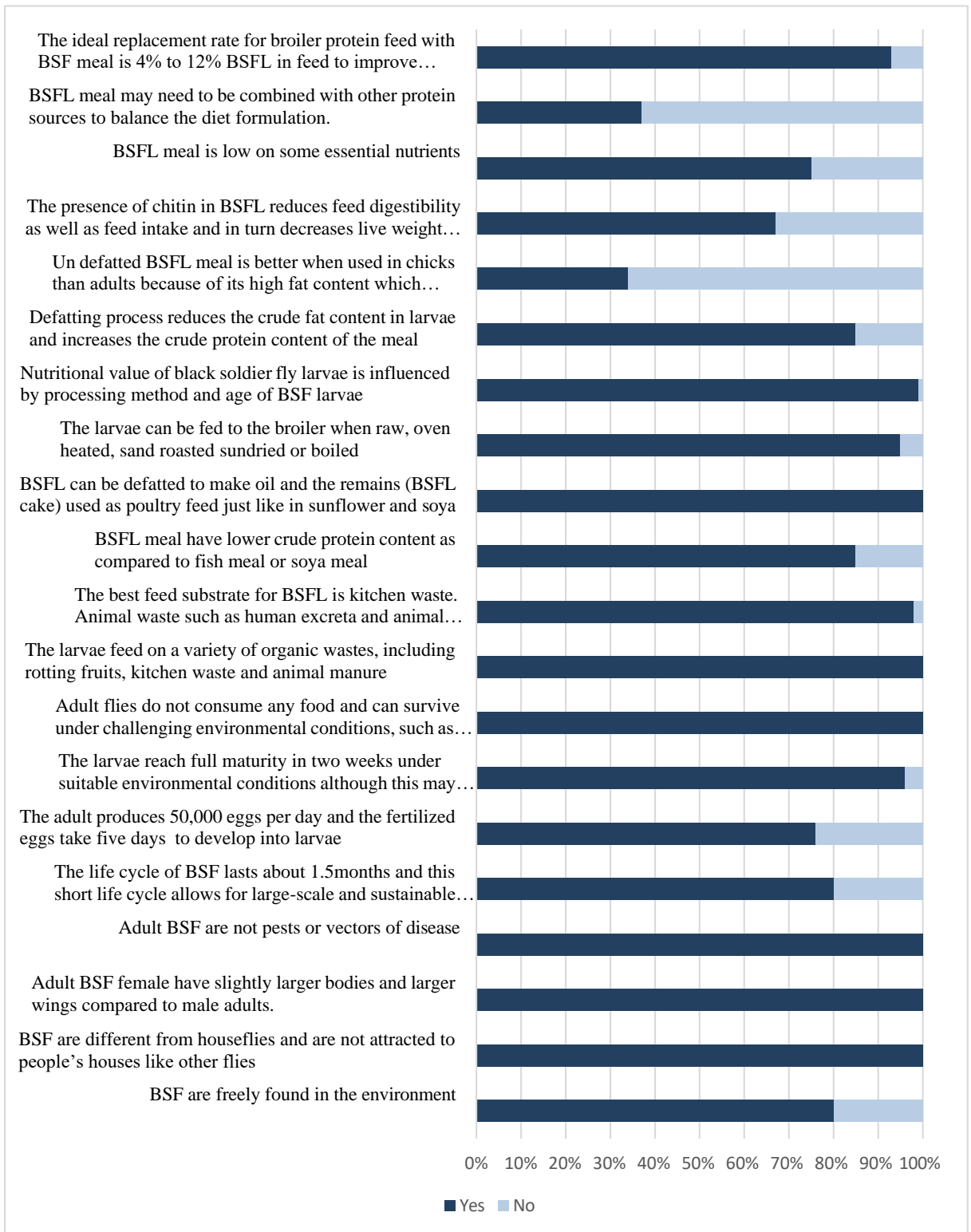
#### **4.2 Knowledge, attitude and practices of poultry farmers towards BSFL farming in Wakiso District**

##### ***a. Assessment of farmers' knowledge towards black soldier fly larvae farming in Wakiso District***

A total of 58.8% of the farmers had a knowledge index equal to or greater than the mean (0.88), and the majority of these were female (Table 2). These were considered knowledgeable, while the rest were considered to lack knowledge as they had a knowledge index less than the mean.

**Table 2: Frequency table of Gender by knowledge index**

<i>Gender</i>	<i>Knowledge index</i>								<b>Total</b>
	<b>0.6</b>	<b>0.65</b>	<b>0.75</b>	<b>0.8</b>	<b>0.85</b>	<b>0.9</b>	<b>0.95</b>	<b>1</b>	
Female	0	0	0	2	7	0	27	14	50
Male	3	4	12	1	4	1	5	0	30
Total	3	4	12	3	11	1	32	14	80
Percentage	<b>3.75</b>	<b>5</b>	<b>15</b>	<b>3.75</b>	<b>13.75</b>	<b>1.25</b>	<b>40</b>	<b>17.5</b>	<b>100</b>



**Figure 4: Proportion of poultry farmers who were knowledgeable about BSFL farming in Wakiso District**

**Table 3: Logistic regression analysis of knowledge (yes/no) and the demographic characteristics of farmers**

<i>Knowledge (yes or no)</i>	<i>Odds Ratio</i>	<i>Std. Err.</i>	<i>z</i>	<i>P&gt;z</i>	<i>[95% Interval]</i>	<i>Confidence</i>
Gender	0.675	0.608	-0.44	0.663	0.1154989	3.948487
Education level	12.919	10.2	3.24	<b>0.001*</b>	2.748546	60.72185
Occupation	0.62	0.98	-0.30	0.763	0.0277596	13.83474
Type of farm	0.001	0.002	-3.66	<b>0.000*</b>	0.0000281	.0417547
Farm size	5.2	3.767	2.28	<b>0.023*</b>	1.25698	21.50963

\* = significant

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**Wald chi2(5) = 21.09**

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Prob > chi2 = 0.0008

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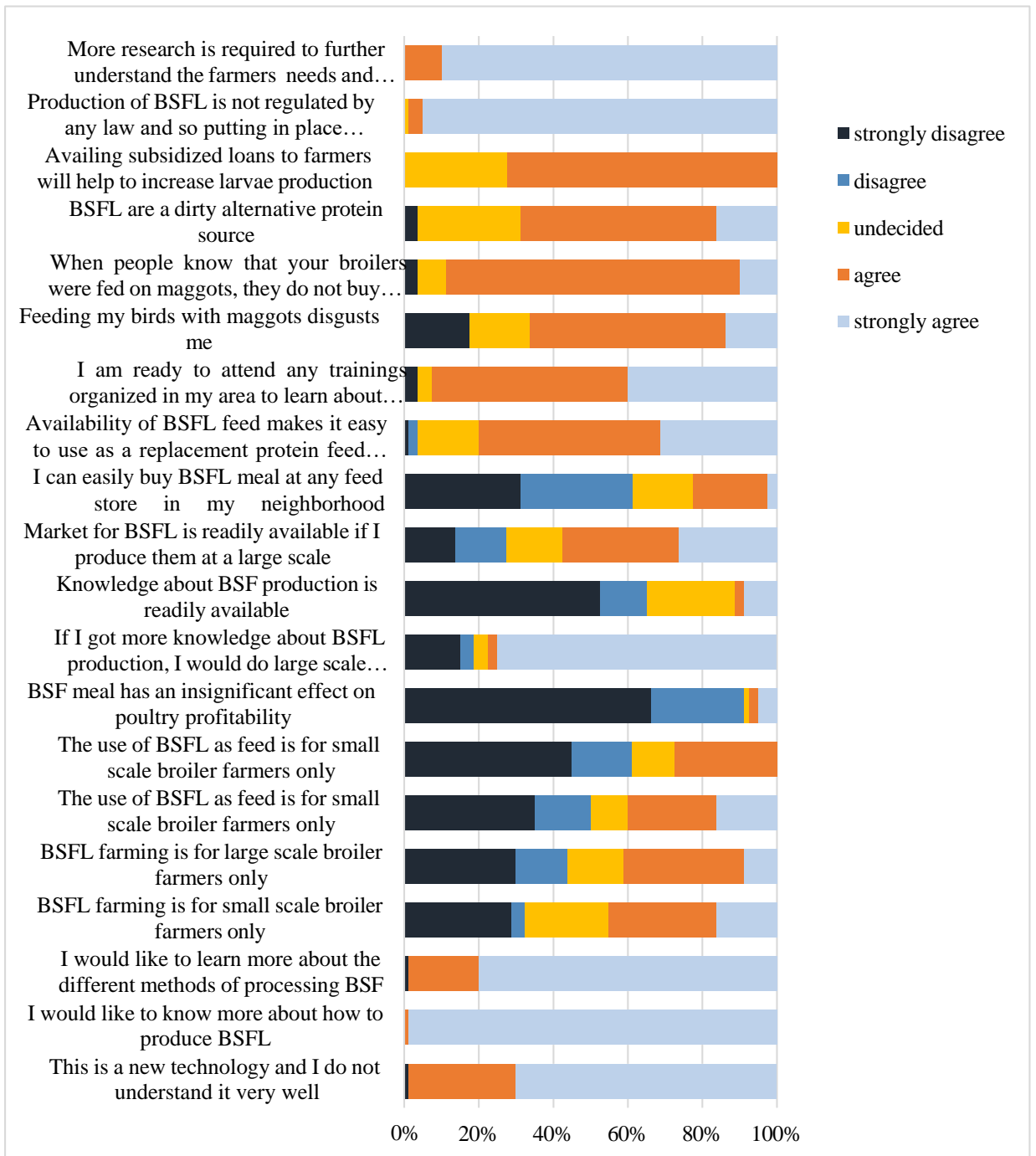
Log likelihood = -24.560191

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Table 3 shows that the odds ratio for education level (12.919) suggests that farmers with a higher education level were significantly more likely to have knowledge about BSFL. This result is statistically significant ( $p = 0.001$ ). Although the confidence interval was relatively wide, indicating some variability. The odds ratio for the type of farm (0.001) suggests a strongly negative association with knowledge, implying that subsistence farmers were significantly less likely to be knowledgeable about BSFL than commercial farmers. a lower likelihood of having the knowledge. This result is highly statistically significant ( $p = 0.000$ ). The very narrow confidence interval supports the precision of this estimate. The odds ratio for farm size is 5.2, indicating that larger farm size significantly increases the likelihood of having the knowledge in question. This result is statistically significant ( $p = 0.023$ ). The confidence interval is somewhat wide, indicating some variability but still a significant effect.

***b. Assessment of farmers' attitudes towards BSF farming in Wakiso District***

Figure 5 shows that 47.5% of the respondents had a positive attitude as they had an attitude index equal to or greater than the mean (0.65).



**Figure 5: Attitude of poultry farmers on BSFL farming in Wakiso District**

**Table 4: Logistic regression analysis of attitude and the demographic characteristics of farmers of BSFL farming in Wakiso District**

<i>Attitude</i>	<i>Odds Ratio</i>	<i>Std. Err.</i>	<i>z</i>	<i>P&gt;z</i>	<i>[95% Confidence Interval]</i>	
Gender	0.202	0.1596	-2.02	<b>0.043*</b>	0.0428649	0.950608
Education	0.377	0.141	-2.60	<b>0.009*</b>	0.180744	0.7864206
Occupation	2.467	1.445	1.54	0.123	0.7826517	7.773572
Type of farm	0.934	0.936	-0.07	0.945	0.1309032	6.659455
Farm size	2.864	1.207	2.50	<b>0.013*</b>	1.253909	6.540825

\* = significant

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**Wald chi2 (5) = 16.53**

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Prob > chi2 = 0.0055

Log likelihood = -42.664066

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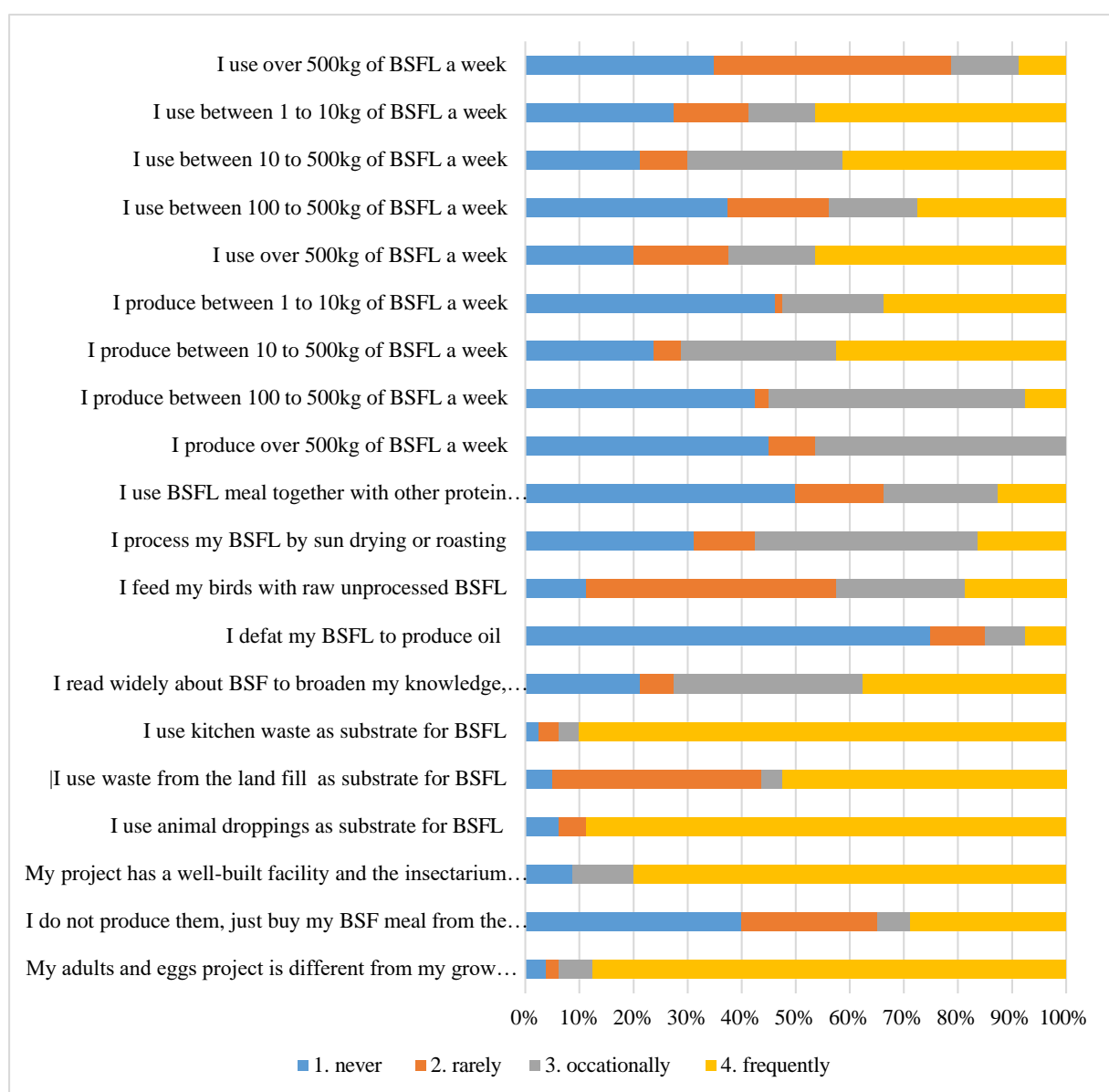
Table 4 shows that the odds ratio for gender (0.202) suggests that male farmers were significantly less likely to have a positive attitude towards BSFL farming compared to female farmers. This result is statistically significant ( $p = 0.043$ ). The confidence interval does not include 1, reinforcing the significance of the predictor. The odds ratio for education is 0.377, suggesting that higher education is associated with a reduced likelihood of having a positive attitude towards BSFL farming. This result is statistically significant ( $p = 0.009$ ). The confidence interval indicates that this effect is reliable. Farmers with large farm size (odds ratio 2.863843), were significantly more likely to have a positive attitude towards BSFL farming. This result is statistically significant ( $p = 0.013$ ). The confidence interval suggests this effect is reliable. This means that gender and education are significant predictors of a positive attitude, both of which are associated with a lower likelihood of having a positive attitude. Farm size is also a significant predictor, associated with a higher likelihood of having a positive attitude. The Wald chi-squared statistic and its associated p-value (16.53 and 0.0055, respectively) suggest that the model as a whole is statistically significant.

**Table 5: Relationship between Gender and Attitude towards BSFL**

<i>Attitude</i>	<i>Female</i>	<i>Male</i>	<i>Total</i>
<i>Low attitude</i>	22	20	42
<i>High attitude</i>	28	10	38
<i>Total</i>	50	30	80

**c. Assessment of farmers’ practices towards BSFL farming in Wakiso District**

Figure 6 shows that 51% of the respondents frequently applied good practices of black soldier fly farming.



**Figure 6: Frequency of selected BSFL related practices of poultry farmers in Wakiso District**

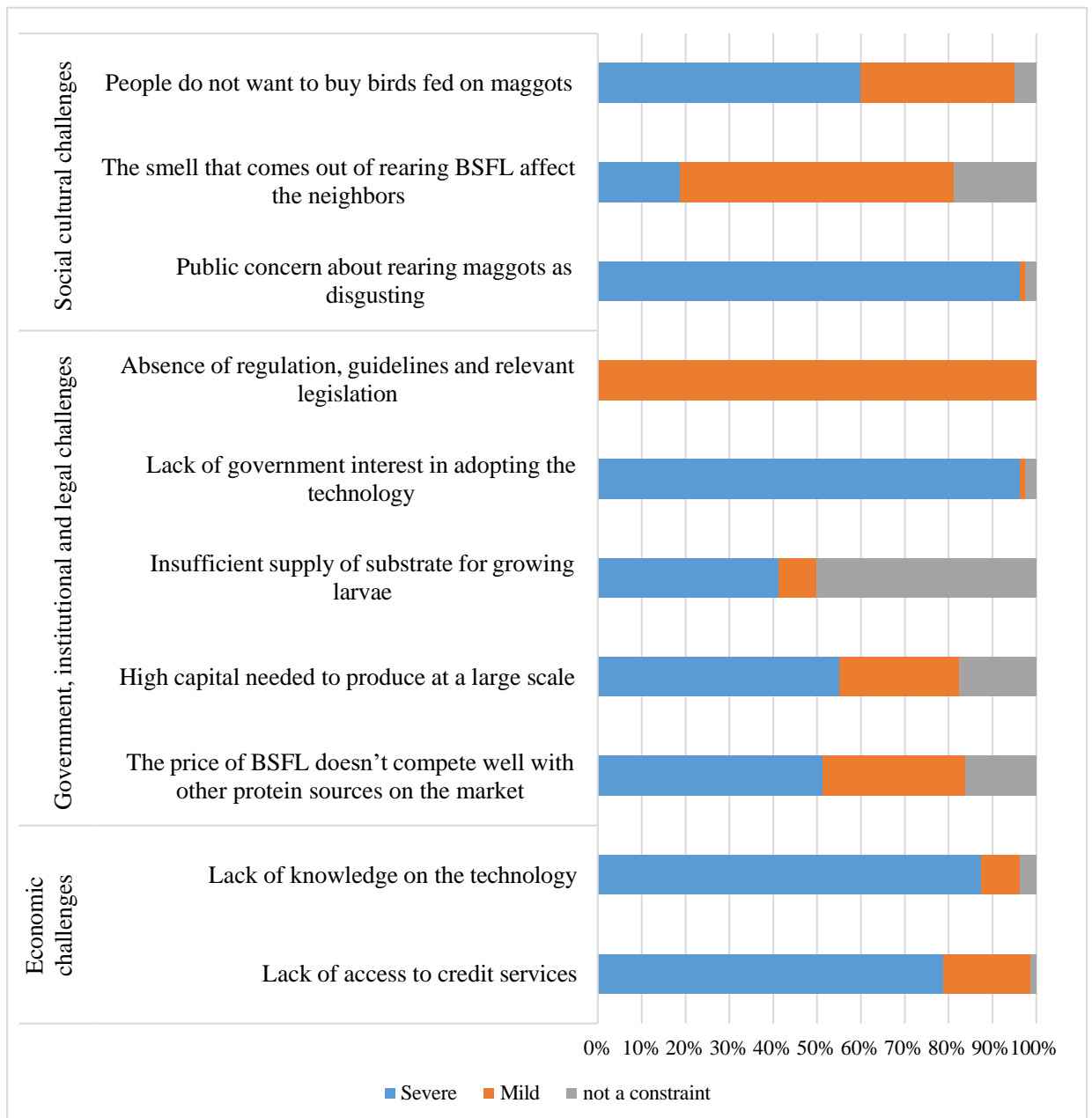
*d. Correlation between Knowledge, Attitude, and Practices*

**Table 6: Spearman rank-order correlation analysis between knowledge attitude and practices**

	<i>Knowledge</i>	<i>Attitude</i>	<i>Practices</i>
<i>Knowledge</i>	1.0000		
<i>Attitude</i>	-0.0165	1.0000	
<i>Practices</i>	-0.0943	0.1070	1.0000

The results of a Spearman rank-order correlation analysis between knowledge, attitude, and practices revealed that there is a very weak inverse relationship between knowledge and attitude (Correlation coefficient (rho): -0.0165) (Table 6). The correlation is close to zero, suggesting that changes in knowledge level did not significantly influence attitude towards BSFL farming. In addition, the Correlation coefficient (rho): -0.0943 suggested a weak inverse relationship between knowledge and practices. Again, the correlation is close to zero, indicating a very weak inverse relationship between these variables. Regarding the relationship between attitude and practices, the correlation coefficient (rho): 0.1070 suggests a weak direct relationship between attitude and practices. The correlation is slightly positive, suggesting a slightly good attitude towards BSFL farming associated with better farming practices.

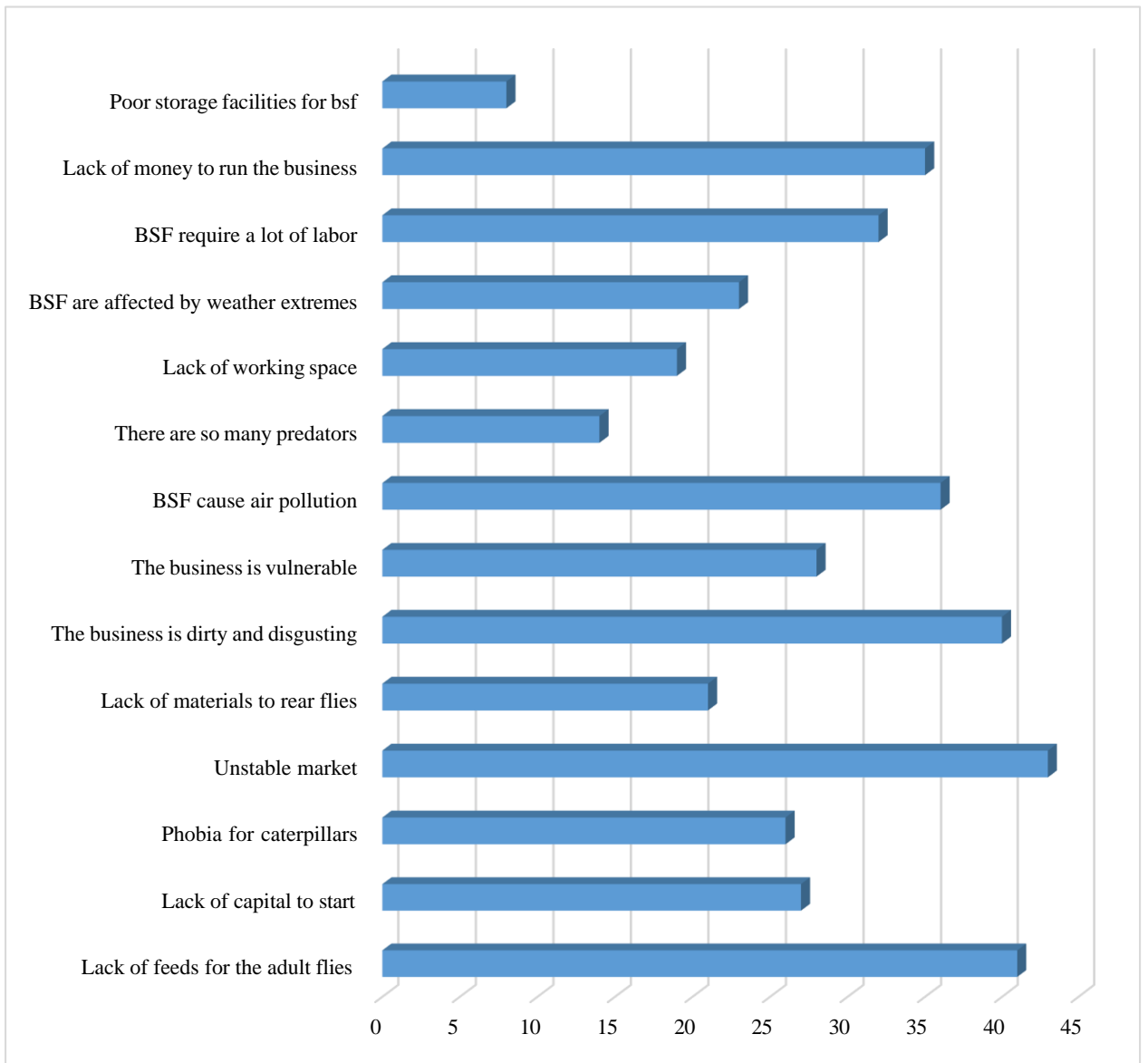
In summary, there is almost no correlation between **knowledge and attitude** (-0.0165). This suggests that changes in knowledge are not directly related to changes in attitude. Regarding **Knowledge and Practices**, there is a weak negative correlation (-0.0943). This suggests that as knowledge increases, practices do not decrease significantly. For **attitude and practices**, there is a weak positive correlation ( $r = 0.1070$ ). This suggests a slight tendency for positive attitudes to be associated with better practices, but the relationship is very weak. Overall, the Spearman rank-order correlations indicate that there are no strong relationships between the variables "knowledge," "attitude," and "practices".



**Figure 7: The frequency of constraints faced by poultry farmers involved in BSL Farming in Wakiso District**

#### **4.4 Factors limiting the adaptation of black soldier fly farming among poultry farmers in Wakiso District**

The unstable market for larvae, Lack of feed for the adult flies, and the perception that the business is dirty, and disgusting were the most mentioned limitations, as shown in Figure 8.



***Figure 8: Total number of respondents per limitation regarding BSFL farming among poultry farmers in Wakiso District***

## CHAPTER FIVE

### DISCUSSION

The majority of the poultry farmers were knowledgeable about BSF and BSFL. This is in line with the study by UBOS (2024), which found the same. Most of these knowledgeable respondents were female, and this result was not surprising because most of the respondents in this study were female. Results showed that demographic characteristics such as education level and the size of the farm were significant positive predictors of having knowledge about BSFL. The type of farm, whether commercial or subsistence, was a significant negative predictor of farmers' knowledge. This result too was not surprising because it is obvious that the higher one's level of education, the more knowledge they attain, as described in a study by Dossey *et al.* (2016). If they further get more BSFL /BSF training, they get even better.

The surprising bit was that most respondents had a primary school education as their highest level of education, yet the majority of the respondents were knowledgeable (Table 1). Primary school education is considered a low level of education. These results could be interpreted as contradictory to the result of the logistic regression in Table 4. However, it could be interpreted that most of the basic knowledge required for BSFL farming by poultry farmers is attained at the primary school level, and the more education one attains, the more they become. Basic knowledge for BSFL farming may not require higher education but rather practical training and experience. Regarding farm size, it is presumed that the bigger one's farm, the more knowledge they seek to acquire regarding their source of protein nutrition, which in this case is BSFL. For the result of the type of farm, whether commercial or subsistence, being a significant negative predictor of having knowledge is not surprising, as all the farmers interviewed were subsistence farmers, and this could have hindered their quest for knowledge on BSFL. Slightly less than half of the farmers have a positive attitude towards BSF/BSFL farming. This is in line with the result in the study by Kilpatrick and Rosenblatt (1998) but contradictory to the results obtained by Tacon (2020), which suggested that farmers generally have a positive attitude towards BSFL farming.

The results of the logistic regression analysis assessing the relationship between attitude and the demographic characteristics of farmers indicated that gender and education

were significant predictors of a positive attitude, both of which were associated with a lower likelihood of having a positive attitude. Therefore, both someone's gender and their level of education can predict their attitude, and in this case, both are associated with a lower likelihood of having a positive attitude. To further explain this result, being female was associated with a significantly lower likelihood of having a positive attitude. This result was not surprising, given the known fear women have of arthropods in general. Contrary to what was previously explained for knowledge, the results further suggested that higher education is associated with a lower likelihood of having a positive attitude. This could be associated with the fact that people with a higher education level have other sources of income and can therefore afford alternative protein sources other than BSFL. This lowers their attitude towards the subject. On the other hand, farm size was a significant predictor, associated with a higher likelihood of having a positive attitude. To explain this result further, it was noted that individuals with larger farms tend to have a higher likelihood of having a positive attitude compared to those with smaller farms. It is a self-explanatory result, as such farmers always look for all alternatives to cut the cost of production, and so their attitude to BSL is high.

The majority of the respondents frequently applied good practices of black soldier fly farming, as shown in graph 4. This result could be associated with the higher level of knowledge seen in graph 2. However, in general, the Spearman rank-order correlation analysis between knowledge, attitude and practices revealed that there was almost no correlation between knowledge and attitude. This could also explain the contradiction in the relationship between knowledge, which is a positive relationship, and education, in comparison to the relationship between attitude and education, which is a negative relationship. This result suggested that changes in knowledge are not associated with changes in attitude. However, regarding knowledge and practices, there is a very weak negative correlation between knowledge and practices. To further explain this, the weak negative correlation (-0.0943) between knowledge and practices suggests that while farmers may gain knowledge but, external constraints (such as lack of resources or market access) may hinder practical application. This result contradicts a study by Higa *et al.* (2021). On a slightly brighter note, the results revealed a very weak positive correlation between attitude and practices. This means, when attitude improves, practices improve slightly, but this change is so small that it is not very significant or noticeable. Overall, the Spearman rank-order correlation analysis showed an extremely

weak correlation between knowledge and attitude, suggesting that an increase in knowledge does not necessarily translate into a more positive attitude towards BSFL farming. Unstable market for larvae, lack of feeds for the adult flies, the perception that the business is dirty, and public concern about rearing maggots as disgusting were the most mentioned constraints and limitations of the adoption of black soldier fly farming among peri-urban poultry farmers. This finding aligns with the results reported by Dossey *et al.* (2016). While lack of government interest in adopting the technology, lack of access to credit services and lack of knowledge on the technology were also mentioned as constraints of BSFL farming. These results are in exact agreement with those reported in (Tacon, 2020).

## **CHAPTER SIX**

### **CONCLUSION AND RECOMMENDATIONS**

#### **6.1 Conclusions**

Poultry farmers in Wakiso District generally have good knowledge of BSF and BSFL. Their attitudes towards BSF farming are generally slightly below average but they frequently apply good practices of black soldier fly farming. The main limitation to BSFL farming is an unstable market for larvae, a lack of feed for the adult flies, the perception that the business is dirty, and public concern about rearing maggots as disgusting. There is a lack of government interest in adopting the technology, a lack of access to credit services, and a lack of knowledge on the technology constraints. These results should be considered as relevant by the animal production department of the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) as they could serve as a reference to enacting policies and strategies aimed at improving poultry production in the country through reduced cost of production.

#### **6.2 Recommendations**

- Awareness and sensitization about BSF farming should be intensified by the government through MAAIF, as this is the first step towards the adoption of the technology and improved perceptions about the technology.
- There is a need for improved access to credit services and stability of the market for the BSF larvae.
- There is a need to address other constraints and limitations faced by farmers after adopting BSF technology.

## REFERENCES

- Abasubong, K. P., Amin, A. B., Uwem, G. U., & Desouky, H. E. (2025). A review of fish waste and byproducts in poultry production: effects on growth, egg quality, carcass traits, and broader knowledge beyond physiological response. *Animal Advances*, 2(1). <https://doi.org/10.48130/animadv-0025-0027>
- Abro, Z., Macharia, I., Mulungu, K., Subramanian, S., Tanga, C. M., & Kassie, M. (2022). The potential economic benefits of insect-based feed in Uganda [Original Research]. *Frontiers in Insect Science, Volume 2 - 2022*. <https://doi.org/10.3389/finsc.2022.968042>
- Adamtey, N., Badu, E., Ayimba, N., Kimathi, F., & Gebrezgabher, S. (2024). Black soldier fly farming for feed and biofertilizer: a practical guide. <https://doi.org/https://hdl.handle.net/10568/141837>
- Akter, N., Dao, T. H., Crowley, T. M., & Moss, A. F. (2025). Optimization of Split Feeding Strategy for Laying Hens Through a Response Surface Model. *Animals*, 15(5).
- Alvarez, E., Guillou, N., Martineau, C., Bueken, B., Van de Voorde, B., Le Guillouzer, C., Fabry, P., Nouar, F., Taulelle, F., de Vos, D., Chang, J.-S., Cho, K. H., Ramsahye, N., Devic, T., Daturi, M., Maurin, G., & Serre, C. (2015). The Structure of the Aluminum Fumarate Metal–Organic Framework A520. *Angewandte Chemie International Edition*, 54(12), 3664-3668. <https://doi.org/https://doi.org/10.1002/anie.201410459>
- Auzins, A., Leimane, I., Reissaar, R., Brobakk, J., Sakelaite, I., Grivins, M., & Zihare, L. (2024). Assessing the socio-economic benefits and costs of insect meal as a fishmeal substitute in livestock and aquaculture. *Animals*, 14(10), 1461. <https://doi.org/http://dx.doi.org/10.22004/ag.econ.338590>
- Beesigamukama, D., Mochoge, B., Korir, N. K., K.M. Fiaboe, K., Nakimbugwe, D., Khamis, F. M., Subramanian, S., Wangu, M. M., Dubois, T., Ekesi, S., & Tanga, C. M. (2021). Low-cost technology for recycling agro-industrial waste into nutrient-rich organic fertilizer using black soldier fly. *Waste Management*, 119, 183-194. <https://doi.org/https://doi.org/10.1016/j.wasman.2020.09.043>

- Boppré, M., & Vane-Wright, R. I. (2019). Welfare Dilemmas Created by Keeping Insects in Captivity. In C. Carere & J. Mather (Eds.), *The Welfare of Invertebrate Animals* (pp. 23-67). Springer International Publishing. [https://doi.org/10.1007/978-3-030-13947-6\\_3](https://doi.org/10.1007/978-3-030-13947-6_3)
- Bukuluki, P., Mwenyango, H., Katongole, S. P., Sidhva, D., & Palattiyil, G. (2020). The socio-economic and psychosocial impact of Covid-19 pandemic on urban refugees in Uganda. *Social Sciences & Humanities Open*, 2(1), 100045. <https://doi.org/https://doi.org/10.1016/j.ssaho.2020.100045>
- Chetty, K. (2022). *Examining practices and traditions of waste re-use as an alternative feedstock in the poultry industry in KwaZulu-Natal, South Africa*
- Daley, D. M. (1998). Attribution theory and the glass ceiling: Career development among federal employees. *International Journal of Organization Theory & Behavior*, 1(1), 93-116. <https://doi.org/10.1108/IJOTB-01-01-1998-B005>
- Darias, M. J., & Mirera, D. O. (2023). Towards a more sustainable aquatic food system: Interdisciplinary research on sustainable marine aquaculture in Africa. Book of Abstracts. Towards a more sustainable aquatic food system: Interdisciplinary research on sustainable marine aquaculture in Africa,
- Dossey, A. T., Tatum, J. T., & McGill, W. L. (2016). Chapter 5 - Modern Insect-Based Food Industry: Current Status, Insect Processing Technology, and Recommendations Moving Forward. In A. T. Dossey, J. A. Morales-Ramos, & M. G. Rojas (Eds.), *Insects as Sustainable Food Ingredients* (pp. 113-152). Academic Press. <https://doi.org/https://doi.org/10.1016/B978-0-12-802856-8.00005-3>
- Duguma, B., & Janssens, G. P. J. (2021). Assessment of Livestock Feed Resources and Coping Strategies with Dry Season Feed Scarcity in Mixed Crop–Livestock Farming Systems around the Gilgel Gibe Catchment, Southwest Ethiopia. *Sustainability*, 13(19), 10713. <https://www.mdpi.com/2071-1050/13/19/10713>
- Gasco, L., Gabriele, A., Paolo, B., Antonella, D. Z., Paolo, D. P., Anna, D. A., Riccardo, F., Rosaria, M., Giuliana, P., Giovanni, P., Luciano, P., Aldo, P., Achille, S.,

- Genciana, T., Francesca, T., & Roncarati, A. (2020). Insect and fish by-products as sustainable alternatives to conventional animal proteins in animal nutrition. *Italian Journal of Animal Science*, *19*(1), 360-372.  
<https://doi.org/10.1080/1828051X.2020.1743209>
- Gokulakrishnan, M., Kumar, R., Ferosekhan, S., Siddaiah, G. M., Nanda, S., Pillai, B. R., & Swain, S. K. (2023). Bio-utilization of brewery waste (Brewer's spent yeast) in global aquafeed production and its efficiency in replacing fishmeal: From a sustainability viewpoint. *Aquaculture*, *565*, 739161.  
<https://doi.org/https://doi.org/10.1016/j.aquaculture.2022.739161>
- Higa, J. E., Ruby, M. B., & Rozin, P. (2021). Americans' acceptance of black soldier fly larvae as food for themselves, their dogs, and farmed animals. *Food Quality and Preference*, *90*, 104119.  
<https://doi.org/https://doi.org/10.1016/j.foodqual.2020.104119>
- Kenya, U., & Africa, E. (2021). Market systems assessment.
- Kilpatrick, S., & Rosenblatt, T. (1998). Information vs training: Issues in farmer learning. *The Journal of Agricultural Education and Extension*, *5*(1), 39-51.  
<https://doi.org/10.1080/13892249885300151>
- Kim, C.-H., Ryu, J., Lee, J., Ko, K., Lee, J.-y., Park, K. Y., & Chung, H. (2021). Use of Black Soldier Fly Larvae for Food Waste Treatment and Energy Production in Asian Countries: A Review. *Processes*, *9*(1), 161.  
<https://www.mdpi.com/2227-9717/9/1/161>
- Kurek, M. A., Onopiuk, A., Pogorzelska-Nowicka, E., Szpicer, A., Zalewska, M., & Póltorak, A. (2022). Novel Protein Sources for Applications in Meat-Alternative Products—Insight and Challenges. *Foods*, *11*(7).
- Munthali, M. G., Chilora, L., Goliath, M., Burke, W. J., Benbow, E., Kang'ombe, J., & Safalaoh, A. (2023). The economic cost-benefit analysis of black soldier fly as an alternative animal and fish feed ingredient in Malawi.  
<https://doi.org/http://dx.doi.org/10.22004/ag.econ.338590>

- Musinguzi, S. P., Kato, D., & Azabo, R. (2024). Potential of Black Soldier Fly (*Hermetia illucens*) Larvae as Replacement for Fish Meal as the Standard Animal Protein Source for Broiler Chicken Feed in Uganda.
- Mutai, L. K. (2024). *Utilisation of biomass waste as feed for edible insects and how it can be used to close the food economy cycle and contribute to food security in Sub Sahara Africa* <https://opus4.kobv.de/opus4-rhein-waal/frontdoor/index/index/docId/1959>
- Mutungi, C., Irungu, F. G., Nduko, J., Mutua, F., Affognon, H., Nakimbugwe, D., Ekesi, S., & Fiaboe, K. K. M. (2019). Postharvest processes of edible insects in Africa: A review of processing methods, and the implications for nutrition, safety and new products development. *Critical Reviews in Food Science and Nutrition*, 59(2), 276-298. <https://doi.org/10.1080/10408398.2017.1365330>
- Nogales Mérida, S., Velazco Vargas, J. L., Martínez-Llorens, S., & Tomas-Vidal, A. (2018). Nutritional value of four pest animals to be used in feeding monogastric organisms. *Archivos de zootecnia*, 67(258), 278-282.
- Nyirenda, E. J. (2023). Production and utilization of black soldier fly (*Hermetia illucens*) larvae as a component of high-quality feed in Malawi <http://www.fish-for-life.org/documents/MSc%20Thesis-Esther%20J.%20Nyirenda-%202023-Final.pdf>
- Ogunnusi, O. J., Toyé, C. O., & Akinwemoye, A. A. (2023). Feed management as a paradigm for profitable poultry enterprise. *Animal Research International*, 20(1), 4684–4693. <https://www.ajol.info/index.php/ari/article/view/246910>
- Okello, A. O. (2022). *Farmers' Perceptions and Preferences for Commercial Insect-based Feed in Kiambu County, Kenya* [University of Nairobi]. <https://erepository.uonbi.ac.ke/handle/11295/161548>
- Otieno, M. A. (2022). *Nutritional content of formulated feeds and in-situ based feeds of aquaculture fish in the Winam gulf of lake Victoria, Kenya* [University of Eldoret].

- Ouko, K. O., Mukhebi, A. W., Obiero, K. O., Opondo, F. A., Ngo'ng'a, C. A., & Ongor, D. O. (2022). Stakeholders' perspectives on the use of black soldier fly larvae as an alternative sustainable feed ingredient in aquaculture, Kenya. *African Journal of Agricultural and Resource Economics*, 17(1), 64-79.  
<https://doi.org/http://dx.doi.org/10.22004/ag.econ.333958>
- Peres, H., & Lim, C. (2023). Utilization of soybean products in diets of nonsalmonid marine finfish. In *Alternative protein sources in aquaculture diets* (pp. 281-312). CRC Press.  
<https://www.taylorfrancis.com/chapters/edit/10.1201/9781003421214-11/utilization-soybean-products-diets-nonsalmonid-marine-fish-helena-peres-chhorn-lim>
- Pieterse, E., Erasmus, S. W., Uushona, T., & Hoffman, L. C. (2019). Black soldier fly (Tenebrio molitor) pre-pupae meal as a dietary protein source for broiler production ensures a tasty chicken with standard meat quality for every pot. *Journal of the Science of Food and Agriculture*, 99(2), 893-903.  
<https://doi.org/https://doi.org/10.1002/jsfa.9261>
- Rossi, S., Tubiello, F. N., Prosperi, P., Salvatore, M., Jacobs, H., Biancalani, R., House, J. I., & Boschetti, L. (2016). FAOSTAT estimates of greenhouse gas emissions from biomass and peat fires. *Climatic Change*, 135, 699-711.
- Rowe, A. (2020). Insects farmed for food and feed—global scale, practices, and policy.  
<https://doi.org/https://doi.org/10.31219/osf.io/nh6k3>
- Roy, J. K., Ahmed, J. U., Mannaf, M., Jannat, A., & Islam, M. M. (2024). Assessing the economic viability and factors affecting farmer adoption of black soldier fly larvae as broiler feed in Bangladesh: a comparative analysis. *Discover Agriculture*, 2(1), 71. <https://doi.org/10.1007/s44279-024-00064-9>
- Sudha, C., Ahilan, B., Felix, N., Uma, A., Chidambaram, P., & Prabu, E. (2022). Replacement of fish oil with black soldier fly larvae oil and vegetable oils: Effects of growth, whole-body fatty acid profile, digestive enzyme activity, haemato-biochemical responses and muscle growth-related gene expression of

- juvenile striped catfish, *Pangasianodon hypophthalmus*. *Aquaculture Research*, 53(8), 3097-3111. <https://doi.org/https://doi.org/10.1111/are.15823>
- Tacon, A. G. (2020). Trends in global aquaculture and aquafeed production: 2000–2017. *Reviews in Fisheries Science & Aquaculture*, 28(1), 43-56.
- Takov, D. I., Zubrik, M., & Contarini, M. (2021). Insects as a food source–potential and perspectives. *Polish Journal of Entomology*, 90(2), 48-62. <https://doi.org/DOI: 10.5604/01.3001.0014.8764>
- Tanga, C. M., Egonyu, J. P., Beesigamukama, D., Niassy, S., Emily, K., Magara, H. J. O., Omuse, E. R., Subramanian, S., & Ekesi, S. (2021). Edible insect farming as an emerging and profitable enterprise in East Africa. *Current Opinion in Insect Science*, 48, 64-71. <https://doi.org/https://doi.org/10.1016/j.cois.2021.09.007>
- Tiwasing, P., & Pate, L. (2024). Exploring edible insects as feed in the UK: current challenges and future prospects. *Journal of Insects as Food and Feed*, 11(1), 139-155. <https://doi.org/https://doi.org/10.1163/23524588-00001264>
- UBOS. (2024). *National Population and Housing Census*.
- van Riel, A.-J., Nederlof, M. A. J., Chary, K., Wiegertjes, G. F., & de Boer, I. J. M. (2023). Feed-food competition in global aquaculture: Current trends and prospects. *Reviews in Aquaculture*, 15(3), 1142-1158. <https://doi.org/https://doi.org/10.1111/raq.12804>
- Veldkamp, T., & van Niekerk, T. (2018). Behaviour and growth performance of young turkeys fed live black soldier fly larvae. *Journal of Insects as Food and Feed*, 4(Supplement 1), S38-S38. <https://www.wageningenacademic.com/doi/pdf/10.3920/JIFF2018.S1#page>
- Wakiso District Local Government. (2020). *District Profile*. Retrieved 2 from
- Warsame, A. A. A., & Turyasingura, B. (2022). The Status of Non-Ruminant Farm Animal Production in Uganda with Focus on Somalia: A Review. *Animal and*

*Veterinary Sciences*, 10(1), 8-14.

<http://www.sciencepublishinggroup.com/j/avs>

Wyatt, D., Kaosaard, M., Rerkasem, B., Pendleton, R., Nakajud, A., Buranamas, B.,  
Ingersoll, J., Pfanner, D., & Ingersoll, J. *Livestock and Fisheries*.

## Appendix I: Questionnaire

My name is Nambi Evelyn Stella, I am a masters of livestock development and management (livestock sector planning and management) student of Makerere University. I am doing a survey knowledge, attitudes and practices of poultry farmers in Wakiso District towards black soldier fly larvae farming. Your farm has been randomly selected for the interview. We request that you answer to questions as accurately and honestly as possible so that our findings and future activities are then based on addressing the challenge of high prices of protein feed ingredients in animal feed. Your contribution will be highly appreciated.

### Part 1: Interview Background

#### 1.1 Survey details

Date of Interview	...../...../.....
Name of Enumerator	
Questionnaire Number	
subcounty	
Village	

#### 1.2 Social and Demographic Status of Respondents

##### 1.2.1 Gender of household head

	Gender ( <i>see code</i> )
Male	
Female	

*Gender: 1=Male 0=Female*

##### 1.2.2 Age of household head years old

##### 1.2.3 Relation of respondent to household head

	Tick appropriate
1. Self	
2. Spouse	

3. Son/daughter	
4. Other (specify).....	

**1.2.4 Marital status of household head**

	Tick appropriate
1. Single	
2. Married	
3. Separated or Divorced	
4. Widow/widower	

**1.2.5 Education characteristics of household head**

	Tick appropriate
1. No formal education	
2. Primary school education	
3. Professional training school education	
4. Secondary school education	
5. Higher education/university/college	

**1.2.6 Main occupation of household head**

	Tick appropriate
1.Farming (crop +livestock)	
2.Salaried employment	
3.Business	
4.Casual laborer on-farm	
5.Casual laborer off-farm	

**1.2.7 Type of farming**

	Tick appropriate
1.Commercial farmer	
2. Subsistence farmer	

### 1.2.8 Farm size

	Tick appropriate
1. Over 10,000 birds	
2. 1000 – 9999 birds	
3 below 1000 birds (specify)	

### Part 2: Farmers Knowledge Attitudes and Practices

#### a. Farmer's knowledge (1. Yes, 0. No)

	STATEMENT	SCORE (1. Yes, 0. No)
1.	BSF are freely found in the environment	
2.	BSF are different from houseflies and are not attracted to people's houses like other flies	
3.	Adult BSF female have slightly larger bodies and larger wings compared to male adults.	
4.	Adult BSF are not pests or vectors of disease	
5.	The life cycle of BSF lasts about 1.5 months and this short life cycle allows for large-scale and sustainable production	
6.	The adult produces 50,000 eggs per day and the fertilized eggs take five days to develop into larvae	
7.	The larvae reach full maturity in two weeks under suitable environmental conditions although this may take even several months in the unfavorable environment	
8.	Adult flies do not consume any food and can survive under challenging environmental conditions, such as droughts, areas with no food shortages and low oxygen levels	
9.	The larvae feed on a variety of organic wastes, including rotting fruits, kitchen waste and animal manure	
10.	The best feed substrate for BSFL is kitchen waste. Animal waste such as human excreta and animal droppings are not the best option.	

11.	BSFL meal have lower crude protein content as compared to fish meal or soya meal	
12.	BSFL can be defatted to make oil and the remains (BSFL cake) used as poultry feed just like in sunflower and soya	
13.	The larvae can be fed to the poultry when raw, oven heated, sand roasted sundried or boiled	
14.	Nutritional value of black soldier fly larvae is influenced by processing method and age of BSF larvae	
15.	Defatting process reduces the crude fat content in larvae and increases the crude protein content of the meal	
16.	Un defatted BSFL meal is better when used in chicks than adults because of its high fat content which ensures optimal weight gain	
17.	The presence of chitin in BSFL reduces feed digestibility as well as feed intake and in turn decreases live weight and daily gain in poultry	
18.	BSFL meal is low on some essential nutrients	
19.	BSFL meal may need to be combined with other protein sources to balance the diet formulation.	
20.	The ideal replacement rate for poultry protein feed with BSF meal is 4% to 12% BSFL in feed to improve poultry performance.	

**b. Farmers attitude (5. strongly agree, 4. agree, 3. undecided, 2. disagree 1. Strongly disagree)**

		SCORE (tick)				
1.	This is a new technology and I do not understand it very well	5	4	3	2	1
2.	I would like to know more about how to produce BSFL	5	4	3	2	1
3.	I would like to learn more about the different methods of processing BSF	5	4	3	2	1
4.	BSFL farming is for small scale poultry farmers	5	4	3	2	1

	only					
5.	BSFL farming is for large scale poultry farmers only	5	4	3	2	1
6.	The use of BSFL as feed is for small scale poultry farmers only	5	4	3	2	1
7.	The use of BSFL as feed is for small scale poultry farmers only	5	4	3	2	1
8.	BSF meal has an insignificant effect on poultry profitability	5	4	3	2	1
9.	If I got more knowledge about BSFL production, I would do large scale production	5	4	3	2	1
10.	Knowledge about BSF production is readily available	5	4	3	2	1
11.	Market for BSFL is readily available if I produce them at a large scale	5	4	3	2	1
12.	I can easily buy BSFL meal at any feed store in my neighborhood	5	4	3	2	1
13.	Availability of BSFL feed makes it easy to use as a replacement protein feed source	5	4	3	2	1
14.	I am ready to attend any trainings organized in my area to learn about BSFL production and use	5	4	3	2	1
15.	Feeding my birds with maggots disgusts me	5	4	3	2	1
16.	When people know that your poultry were fed on maggots, they do not buy them easily	5	4	3	2	1
17.	BSFL are a dirty alternative protein source	5	4	3	2	1
18.	Availing subsidized loans to farmers will help to increase larvae production	5	4	3	2	1
19.	Production of BSFL is not regulated by any law and so putting in place regulation to guide it production will be of great importance	5	4	3	2	1
20.	More research is required to further understand the farmers needs and challenges	5	4	3	2	1

**c. Farmers practices (4. Frequently, 3. Occasionally, 2 rarely, 1 never)**

		SCORE (tick)			
1.	My adults and eggs project is different from my grow out larvae project and I earn from them differently	4	3	2	1
2.	I do not produce them, just buy my BSF meal from the nearest suppliers	4	3	2	1
3.	My project has a well-built facility and the insectarium is different from the larvarium	4	3	2	1
4.	I use animal droppings as substrate for BSFL	4	3	2	1
5.	I use waste from the land fill as substrate for BSFL	4	3	2	1
6.	I use kitchen waste as substrate for BSFL	4	3	2	1
7.	I read widely about BSF to broaden my knowledge, attend as many seminars as I can about BSF whenever I am called	4	3	2	1
8.	I defat my BSFL to produce oil	4	3	2	1
9.	I feed my birds with raw unprocessed BSFL	4	3	2	1
10.	I process my BSFL by sun drying or roasting	4	3	2	1
11.	I use BSFL meal together with other protein ingredients such as fish when mixing my poultry feed	4	3	2	1
12.	I produce over 500kg of BSFL a week	4	3	2	1
13.	I produce between 100 to 500kg of BSFL a week	4	3	2	1
14.	I produce between 10 to 500kg of BSFL a week	4	3	2	1
15.	I produce between 1 to 10kg of BSFL a week	4	3	2	1
16.	I use over 500kg of BSFL a week	4	3	2	1
17.	I use between 100 to 500kg of BSFL a week	4	3	2	1
18.	I use between 10 to 500kg of BSFL a week	4	3	2	1
19.	I use between 1 to 10kg of BSFL a week	4	3	2	1
20.	I use over 500kg of BSFL a week	4	3	2	1

