An Assessment of the Feasibility of Black Soldier Fly Larvae (BSFL) Production in Manicaland Province, Zimbabwe.

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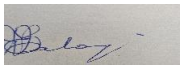
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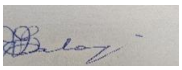
DECLARATION

I hereby declare that the research project entitled **"Assessing the Feasibility of Black Soldier Fly Larvae (BSFL) Production in Manicaland Province, Zimbabwe,"** submitted to Bindura University of Science Education, Department of Agricultural Economics, Education and Extension is a record of an original work done by me under the guidance and supervision of **Dr A Mureva** and this work is submitted in partial fulfilment of the requirements for the award of a Master of Science Degree in Food Security and Sustainable

Agriculture. The results embodied in this thesis have not been submitted to any University or Institute for the award of any degree of diploma.

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DEDICATION

I dedicate this work to my family and loving colleagues at BUSE who motivated me to trudge on.

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I would like to thank the following people for their unwavering support in the production of this report:

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ABSTRACT

The adoption of the Black Soldier Fly Larvae (BSFL) as a potential alternative sustainable and affordable source of protein for livestock feed for rural communities is at an advanced stage in some countries. This study assesses the drivers and limitations to adoption of the BSFL technology as a sustainable protein source for livestock feed for smallholder farmers in Buhera South District, Manicaland Province, Zimbabwe. A mixed methods approach was employed in gathering data. This comprised the use of questionnaires, focus group discussions and key informant interviews. The research focused on farmers who were sensitized on BSFL technology and either adopted or abstained from participating. The findings of this research highlight the potential benefits of BSFL technology adoption as a sustainable protein source for nutritious feed for livestock. BSFL based feed is expected to achieve improved livestock health, ensured nutrition and improved livestock productivity while frass conditions the otherwise infertile soils. However, there are limitations to adoption in terms of awareness, technical expertise, financial support, guide lines and policy framework to support scaling. To this end, expansion of awareness medium, technical trainings, easy access to finance in support of BSFL production endeavors, road map and policy frameworks that support both entrepreneurs and participants are required in Zimbabwe.

Key words
Black soldier fly larvae, sustainable protein source, adoption,

TABLE OF CONTENTS

RELEASE FORM ii

APPROVAL FORM iii

DECLARATION iv

DEDICATION vi

ACKNOWLEDGEMENTS vii

ABSTRACT viii

TABLE OF CONTENTS ix

LIST OF ACRONYMS AND ABBREVIATIONS xi

LIST OF FIGURES xiii

LIST OF APPENDICES xiv

AppendixI household questionnaire for BSFL adopters.....62 xiv

CHAPTER 1: INTRODUCTION 1

1.1 Background to the study 1

1.2 Problem Statement 2

1.3 Main Objective 3

1.3.1 Specific objectives 3

1.4 Justification 4

REFERENCES 5

CHAPTER 2:LITERATURE REVIEW 6

2.0 Introduction- 6

2.1 Economic Feasibility of producing black soldier fly 6

2.2.2 Social Feasibility in BSFL production 8

2.2.3 Technical feasibility 8

2.9 The Conceptual/theoretical framework/s 9

REFERENCES 12

CHAPTER 3: METHODOLOGY 18

3.1 Description of Study Site 18

3.2 Research Design 20

3.3 Data Collection Procedure 20

3.4 Sampling Procedure 21

3.6 Data Analysis Procedure 22

3.7 Ethical Considerations 23
3.8 Conclusion 24
CHAPTER 4:RESULTS AND DISCUSSION 26
4.0 This chapter focusses on the reseach findings, drawing strength from previous works by other scholars. 26
4.2 The technical, economic and social feasibility of producing BSFL in Buhera South district 32
4.2.1Technical Feasibility 32
Knowledge of Waste streams for BSFL used in Buhera South District 35
Knowledge of benefits of BSFL 36
4.2.2 Economic Feasibility 39
4.2.3 Social Feasibility 42
4.3 Key drivers influencing the adoption and utilisation of BSFL production 45
4.4 Limitations influencing the adoption and utilization of BSFL 46
4.5 The context specific strategies that can be adopted to address identified limitations 50
4.6 Conclusion 53
CHAPTER 5: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS 55
5.0 Introduction 55
5.1 Summary of the Study 55
References 59
APPENDICES 63
Appendex 1 -Household Questionnaire for BSF adoption (to be complted by consent) 63
Appendix II Key informant implementing partner- (*to be completed by consent)* 68
Appendix III-Key Informant Agritex(*to be completed by consent*) ..... **Error! Bookmark not defined.**
Appendix IV-Key informant lead farmer-(*to be completed by consent*) 71
Appendix V Consolidated Focus groups-(*to be completed by consent*) 73

LIST OF ACRONYMS AND ABBREVIATIONS

AGRITEX	Agricultural Extension Service
BSE	Bovine Spongiform Encephalopathy
BSFL	Black Soldier Flier Larvae
CLAFA	Crops, Livestock and Fisheries Assessment
EU	European Union
PEU	Perceived Ease of Use
PU	Perceived Usefulness
SADC	Southern African Development Committee
TAF	Technology Acceptance Framework
TAM	Technology Adoption Model
TSE	Transmissible Spongiform Encephalopathy
FAO	Food and Agriculture Organisation
FGDs	Focus Group Discussions
HH	Household Head
LEAD	Linkages for Economic Advancement of the Disadvantaged
NGOs	Non-Governmental Organisations
KIIs	Key Informant Interviews
MNL	Multinomial Logit
MoECTH	Ministry of Environment, Climate, Tourism and Hospitality
MoLAWRD	Ministry of Land, Agriculture, Fisheries Water and Rural Development
MSD	Meteorological Services Department
MVP	Multivariate Probit
NGOs	Non-Governmental Organisations
SDGs	Sustainable Development Goals
SPSS	Statistical Package for Social Sciences
UN	United Nations

LIST OF TABLES

Table 2.1 Nutrient Composition of BSFL……13
Table 2.2 Comparative analysis of BSFL, Fish meal and Soya Beans …….....14
Table 3.1 Data Collection Guide……30
Table 4.1 The logistic Regression Output ……38
Table 4.2. Suggestions on scaling up production and commercialization of BSFL…...63

LIST OF FIGURES

o

Figure 2.1 The Technology Acceptance Model……11

Figure 2.2 The Technology Adoption Curve……11

Figure 3.1The Geographical Location of the Study Area…….....19

Figure 4.1 Age Group of respondents……26

Figure 4.2 Level of Education of participants……28

Figure 4.3 Main occupation of participants……29

Figure 4 4 Extension visits from Agritex…..…….…….33

Figure 4.5 Source of awareness on BSFL……. ….34

Figure 4.6 Waste streams used as substrate ……35

Figure 4.7 Benefits of BSFL technology ……...…… ….37

Figure 4.8 Motivation for adoption of BSFL…….…….39

Figure 4. 9 Farmers' observations on impact of using BSFL as feed……..…41

Figure 4.10 Community perceived benefits of BSF…….…..….42

Figure 4.11 Community willingness to adopt BSFL……...42

Figure 4 12 Perceived Social acceptance of BSFL technology……..……..….43

Figure 4.13 Perceived cultural acceptance of BSFL technology…….……43

Figure 4. 14 Challenges affecting BSFL production…….…….46

Figure 4. 15 Factors affecting BSFL Production…….……48

Figure 4.16 Factors affecting feed formulations…….…….…...49

Figure 4.17 Proposed production process framework for smallholder farmers in Buhera South……52

LIST OF APPENDICES

Appendix I household questionnaire for BSFL adopters…….62
Appendix II KEY informant (implementing Partner) ……66

Appendix III Key informant (Agritex)……68

Appendix IV key informant (lead farmer) …….71

Appendix V Consolidated Focus group discussions……74

CHAPTER 1: INTRODUCTION

1.1 Background to the study

Stock feed is the best source of animal nutrition intake that ensures improved immunity, accelerated growth, good health and productivity (Siddiqui, 2024). Soya meal and Fish meal are the primary protein source ingredients in stock feed production. These two ingredients account for 60 -70% of production expenses (Sanchez -Muros, 2016). Globally, the land available for cultivating soya beans, the conventional vegetable protein source for stock feed production, is limited (FAO, 2024). On the other hand, fish meal production is decreasing because of the over-exploitation of small pelagic forage fish, which are needed to produce fish meal and fish oil. Meanwhile, plankton, on which marine organisms feed, is declining due to ocean flooding, resulting in lower fish production. (Veldkamp et al., 2012). The shortage of these two conventional protein source raw materials has triggered the supply and demand effects on the pricing of the feed. Soaring stock feed prices, from $600USD/t ton in 2005 to $2000USD/t in June 2010, (International Monetory Fund, 2010, as cited in Sanchez -Muros, 2016) have become unaffordable for many livestock farmers, leading to malnourished animals, reduced fertility, lower sales returns and increased livestock mortality (FAO 2022, Siddiqi, 2022). It is also important to note that soya and fish meal production damage the environment. (Sanchez -Muros, 2016). Soya meal production, for instance, leads to deforestation and heavy use of chemicals, which increase greenhouse gas emissions into the atmosphere, thus furthering climate change (Sanchez -Muros, 2016; van Huis, 2013) .

Mixed farming (crop cultivation and animal husbandry) is a key livelihood activity within the SADC region. According to SADC (2022) report for food security pillars, livestock is a significant resource as 60% of the land is suitable for livestock farming, accounting for 64 million cattle, 39 million sheep, 38 million goats, 7 million pigs and 380 million poultry. Of all these, 75% of the livestock are kept under the traditional smallholder farming system. The fragile pastures and the high volumes of livestock mean that the region needs supplementary stock feed to complement pastures, especially during the drier season.

High feed costs have necessitated the search for cheaper, alternative climate-smart protein sources to enable sustainable production of affordable stock feeds. Insects are known to have high protein ratios relative to their body mass. In addition, insect-based feeds have been

proven suitable for livestock diets (Barragan-Fonseca, 2023). These attributes have made insects a strong stock feed protein source option. Despite several insects having proteins suitable for producing stock feeds, the BSFL is currently fingered as one of the best-known insects in this endeavour (FAO, 2022).

BSFL has multiple benefits over many insects in that BSFL thrives well within the tropics and subtropics feeding on cheap organic waste, can be produced all year round, and its larvae has up to 60% protein, making it suitable as a protein source especially for feeds meant for monogastrics like pigs, rabbits, fish and poultry which require protein supplements (FAO, 2024, Kahunde, 2024, Nyakeri, 2019). Monogastrics unlike ruminants lack the digestive system that converts cellulose into protein through microbial fermentation (Adeniji 2007as cited by Sanches-Muros 2016). BSFL feed improves broiler performance and modulates the immune system (Vilela, 2021). And with declining soil fertility leading to demand in fertilizer, BSF technology could just be "what the doctor prescribed"-vermin fertilizer (Diener, 2011, Beesigamukama, 2021). Other insects lack mostly the environment friendliness that BSF commands and are often in competition with livestock on feed e.g. locusts and mopani worms.

(Nyakeri, 2019) notes that BSFL has a dual role- as an efficient converter of a wide range of biodegradable organic waste into animal protein and producing frass or organic fertilizer. This quality has increased interest in BSF technology as a future tool for sustainable waste management, alternative affordable protein sources and organic fertilizer production. As such, BSF is seen as a solution for protein, waste management and circular farming systems, ultimately making the food systems environmentally friendly and more efficient (Kahunde, 2024, Siddiqi, 2022).

So, by adopting BSFL technology, Zimbabwe and Buhera South District would benefit immensely because Buhera South District practises a mixed farming economy. BSFL will address both the soil infertility and livestock poverty death challenges.

This study explores the drivers and limitations to BSFL production and utilization as the protein source in feed formulations by smallholder farmers in Buhera South District**,** Manicaland Province, Zimbabwe.

1.2 Problem Statement

Smallholder farmers in Buhera South District, Zimbabwe, are struggling to improve the productivity and sustainability of their livestock systems due to limited access to affordable

and nutritious feed options in the face of climate change. The underutilization of Black Soldier Fly Larvae (BSFL) as a protein source presents a missed opportunity for enhancing the resilience and sustainability of smallholder livestock farming systems. Attempts have been made to increase the production of soya meal through imports, varietal soya bean improvements, irrigation and the use of chemicals and fertilisers. These measures not only raise production costs that translate to high feed costs, but the use of fertilisers and chemicals also increases greenhouse gas emissions, furthering climate change. There is a need, therefore, to identify the factors that influence the adoption of BSFL. This rich and sustainable protein source is affordable and efficient and has a low carbon footprint (Vilela, 2021, Makkar, 2013). Understanding these factors is crucial to unlocking the potential of BSFL as a sustainable protein source for livestock feed formulations in rural areas of Zimbabwe.

So, this study seeks to identify these enablers and constraints to the production and utilisation of BSFL, especially for poultry feed formulations among smallholder farmers in Buhera South District, Manicaland, Zimbabwe

1.3 Main Objective

To evaluate the drivers and constraints influencing the production and utilisation of BSFL as a sustainable protein source in livestock feed production by smallholder farmers in Buhera South District Manicaland Province, Zimbabwe.

1.3.1 Specific objectives

a) To assess the technical feasibility of BSF larvae production as a sustainable protein source for livestock feed among smallholder farmers in Buhera South District
b) To determine the acceptability and limitations influencing the adoption and utilization of BSFL as a protein source in feed production among smallholder farmers in Buhera South District.
c) To assess the economic feasibility of BSF larvae production as a sustainable protein source for livestock feed among smallholder farmers in Buhera South District

1.4 Justification

The study seeks to identify factors influencing the acceptance and adoption of BSFL as a livestock feed protein source. The findings will inform policy on how to help smallholder farmers adopt the BSFL technology. The findings will also provide insights for lead farmers, extension staff, and NGOs (FAO, WFP, Care International, WHH), who can utilise the project implementation strategies and ensure that project goals are achieved within timeframes. Findings will also inform stock-feed producers (National Foods, Feed Mix), government line ministries and departments (Agritex, Min of Health and Child Welfare, Women Affairs, local government, towns and cities) and policymakers on the viability of incorporating BSF technology in feed formulations and how this can contribute positively to local food systems and garbage management in towns and cities.

1.5 Limitations of the study

The focus of the study was on sensitised people who participated under the initiative of a donor following a needs assessment. As such, the pull effect of donor support may be limited to the area under study and responses to the BSFL project may be different if donor support is absent. In addition, the farmers were operating under a recovery status following the disruption of a food system by a disaster. Hence, the need for quick recovery using improved road runner breeds that require processed feeds could have given farmers an opinion on adopting BSFL-based feed. This can differ in a well-established set-up with an established balanced food system. Given the population's socio-economic and cultural diversity, the sample size is too small to achieve generalisations at the national level. In addition, the research was time and finance-constrained, and deeper assessments were not feasible within time frames. Owing to time constraints, the data collected using questionnaires was not verified for consistency. However, it was triangulated with focus groups, key informants' responses, and statistical data analysis. Future research should focus on various socio-economic and demographic setups to determine the underlying factors of BSFL adoption decision-making considerations.

REFERENCES

FAO. (2024). *FAO Org Africa News> Zimbabwe.* Harare.

Diener, S. Z.-G. (2011). BSF Larva for Organic Waste treatment_ prospects and Constraints-conference paper. *Researchgate*.

FAO. (2022). *Black Soldier Fly Production mnual: A step by Step Guide/ a Zimbabwean Case.* Harare: Sub regional office of southern Africa.

Kahunde, B. W. (2024). BSFL a Sustainable Solution for Protein, Waste Management and Crcular Bio-economy. *Researchgate*, 2 (3) 822-834.

Nyakeri, E. S. (2019). An Optimal Feeding Strategy of BSFL Biomass Productionand Faecal Sludge Reduction. *Reserachgate- Journal of insectsas food and feeds*, 5 (3) 1-14.

SADC. (2022). Food, agriculture and natural resources- Livestock Production.

Sanchez -Muros, M. e. (2016). *Insects as Sustainable Feed Ingredients.* Almeira: Alsevier Inc.

Siddiqi, S. R. (2022). The Blacksoldier FlyLarvae (BSFL)and their affinity for organic waste. *Waste Management*, 1040(3) 1-13.

Veldkamp, T. et al (2017). Insects as feed: A reviewof the economic and environmental implications. *Journal of insects a food and feed*, 3(2) 115-126.

Vilela, J. A. (2021). Blacksoldier inclusion in broiler diets. *Animal Nutrition*, 7(9).

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction-

Black Soldier Fly larvae (BSFL) are being globally considered as a sustainable alternative protein source for stockfeed production in place of soya bean and fish meal protein sources which are experiencing production challenges of late (Makkar, 2013). Sub-Saharan Africa in general and Zimbabwe in particular is trying to adopt BSFL for both livestock feed production and waste management to achieve food security. As an emerging technology, there is need to assess the feasibility, opportunities and constraints to BSFL feed production and adoption with a focus on scalability, cost effectiveness and compliance with regulatory frameworks (Choudhury, 2018).

2.1 Economic Feasibility of producing black soldier fly

Beesigamukama et al. (2021), in their studies on BSFL production in Sub-Saharan Africa, found that BSFL produced using purchased brewery waste, sawdust, biochar and gypsum as substrate presented a high cost on production (81-90%). However, this high capital cost would have been offset if frass had also been brought into the equation. In this case, frass improved net earnings by 5-15 times. Farmers who produced their frass increased profits by 30 -232% compared to those who bought frass (Beesigamukama, 2021). In this case, the frass would be used in maize production as organic fertiliser

BSF production promotes a circular economy revolving. The production of own substrate from farm waste and then utilising BSFL for composting the waste to produce vermin fertiliser, the farmers can cost effectively enrich their soils though the circular production system and BSFL can be produced more economically and sustainably (Beesigamukama, 2021). In addition, it carries a strong message of the methodology. Emphasis is on coming up with a circular food system. Evidence also shows that Sub-Saharan Africa has fragile soils that require fertilizer (Kelly, 2006). Sub Saharan Africa has favourable climatic conditions for BSFL production. BSFL optimal production climatic conditions such as (temperature

being between 25-30 degrees Celsius and relative humidity of 50% to 70%) are characteristic of the tropics (Mutenje, 2020). Hence, sub- Saharan Africa commands a fertile basis for a circular farming economy comprising BSFL, livestock (especially poultry and pigs), fish and crops.

In Malawi, researchers found that BSFL production remained profitable at all scales-smallholder, medium and large-scale farming systems. They also found that even at 10% sensitivity analysis, BSFL returns remained stable (Munthali, 2023).

Modelling the economic viability of BSFL in a fish farming set-up showed that BSFL can be produced locally and provides a viable circular farming economy involving fish (Barragan-Fonseca, 2023). What is of special interest here is that BSFL can be produced profitably at any scale, including small-scale farmers in a rural set-up. Studies in Kenya showed that BSFL production is economically viable if used for feed where household size is large. An increase in labour hours reduced gross margins by 0.34%, while rearing substrate increased gross margins by 1.38% (Matuku, 2021).

Overall, BSFL farming is a viable alternative protein source for animal feeds. It also bears strength in that it can be locally produced at any scale (Raman, 2022, Barragan-Fonseca, 2023, Prihartini, 2022) and can stimulate local economies.

Economic viability in yield shows that BSFL fed on pig manure can produce up to 95-120kg of larvae per cubic metre of waste supplied to the system (Choudhury, 2018).In addition, BSFL has proved to be effective in reducing the concentration of E-coli. This quality makes BSFL-fed livestock have fewer challenges in terms of diseases, e.g. tail biting tendencies among pigs are reduced. In contrast, broilers fed on BSFL have better resistance to diseases.

The market is one major determinant of economic feasibility. It considers competition with conventional feeds that have already established themselves, distance to the market, and the disposable incomes of the community. It is this demand that then influences the volumes that can be produced.

While the economic feasibility of producing BSFL is very encouraging, benefits from BSFL production are realized if the fundamentals are implemented (Diener, 2011, Tomberlin, 2009). The fundamentals comprise the need to: provide production structures, increase awareness among the participants, avail capital for both farmers and entrepreneurs (Munthali, 2023) and incentives to support financial institutions through tax concessions, easy access to finance, and smart subsidies. The government should further provide a road map for BSFL production, including the setting up of a regulatory authority that will ensure national

standards of acceptable feeds in terms of safety and quality, cultivate customer satisfaction (Munthali, 2023)and motivate consumers to transition from the conventional feeds (fish and soya bean-based feeds) (Munthali, 2023) to the insects- based alternative.

2.2.2 Social Feasibility in BSFL production

The social feasibility of producing BSFL refers to the community's response to implementing the BSFL project. It's more of perceptions and attitudes than anything else. Do people accept it or have reservations about how the project will impact people's welfare and cultural values? Deeply cultural communities in Ghana and Nigeria refuse to accept insects as food and feed (Ayieko, 2019). This also applies to older people in Zimbabwe who remain sceptical and offer resistance to insect production. However, youths are more open to innovation (Mutenje, 2020), which implies that ignorance could be the underlying factor. Cultural differences and how some nations view insects in terms of using them for food are critical factors. Consumption of insects is often associated with marginalised communities. This brings in aspects of social stigma and segregation. The European Union (EU) has gone on to outlaw the usage of processed animal proteins (PAPs)in feed for poultry and pigs by enacting the Transmissible Spongiform Encephalopathy (TSE) regulation EC no.999/2001. The TSEs are a group of rare fatal brain diseases that affect animals and humans. The most common are Bovine Spongiform Encephalopathy (BSE) or the mad cow disease that affects cattle, Scrapie that affects sheep and goats, and Creutzfeldt-Jakob Disease that affects humans. These diseases can be transmitted through contaminated feed such as meat, bone meal, or contact with affected animals. This poses a psychological, if not a potential threat to using BSF larvae as a protein source because BSF larvae thrives on such wastes as human waste (Fumière et al., 2009). However, these laws are now being relaxed as knowledge of BSF increases. Other negatives include the foul smell, which typifies damp substrates. BSF larvae bred in such substrates adopt the characteristic aroma.

However, advocates for BSFL utilisation as stock feed consider BSFL as a source of employment, a form of off-farm economic activity, and a stimulant to the economic growth of local economies and local food systems, which translates to social benefits. By and large, awareness and advocacy can unlock these barriers.

2.2.3 Technical feasibility

While the socio-economic feasibility of BSFL production cannot be underscored, cost-effective production of BSFL can only be achieved if people have the technical know-how

(Chineme, 2023). BSFL is a new field requiring much research and information dissemination. Training extension staff (Matuku, 2021, Munthali, 2023) and raising awareness is necessary.

Most commodities become profitable when they attain critical mass. To achieve critical mass in BSFL production, there is a need for farmer organisation into production groups and provision of technical equipment, especially when one chooses to adopt the closed system approach (Prihartini, 2022).

BSFL production has proved technically feasible with many substrates (Diener, 2011, Nguyen, 2015). The following substrates were tried: kitchen waste, pig, dairy, sewage, and concentrated black water (Choudhury, 2018). In all cases, BSFL thrived, albeit with different resultant BSFL quality (Lalander, 2019). Some study findings confirm that the nutrient content of BSFL, notably protein, depended on the substrates used in the treatments. Poultry litter proved to be good in producing healthier Black soldier flies with lower mortality rates, thus ensuring a resilient colony (Choudhury, 2018).

From technical considerations, BSFL production is feasible all year round within the tropics, with optimal temperatures of 25 to 30 degrees Celsius and a humidity of 50 - 70 % (Tomberlin, 2009).

2.9 The Conceptual/theoretical framework/s

Two main theoretical Frameworks will guide this research. These are the technology acceptance framework (TAF) and the technology adoption model (TAM). Technology acceptance is a function of perceptions of the target population towards the new technology. It is important to note that a community's acceptance of a technology depends on their perceived ease of use (PEU) and perceived usefulness (PU) (Davies, 2024). However, a technology maybe accepted as viable or useful but may not be necessarily adopted. Hence technology acceptance is more of emotion and attitude while adoption is to do with behaviour. Adoption entails making use of the technology in a practical way. The adoption of a technology depends on the attitude and subsequent behaviour of the community. With regards to adoption, Worthington (2021), identifies three main groups in any community - the innovators or early adopters, the adopters and the last group is that of laggards or late adopters. Adoption of a technology has a life cycle described by a curve (Fig 8). The first phase is slow and only few people take up the technology. The second phase is that of adopters and is characterised by increased number of adopters and may as well be viewed

within the context of rapid adoption stage, and the last stage is associated with late adopters and few adopters are involved. Finally, the activity fizzles out. The laggards will not adopt any technology until it is tried and tested beyond any reasonable doubt that it is easy to use and that it is useful (Worthington, 2021). Normally by the time laggards adopt it, the innovation would have plateaued and lost its momentum. The laggards tend to lose out on the vigour and opportunities that go with it.

The two models are viewed as the key guiding principles in the assessment of the drivers and limitations to BSFL technology acceptance and adoption by the people of Buhera South District. The models will also be used to design persuasive messaging to encourage adoption (Burgess, 2021).

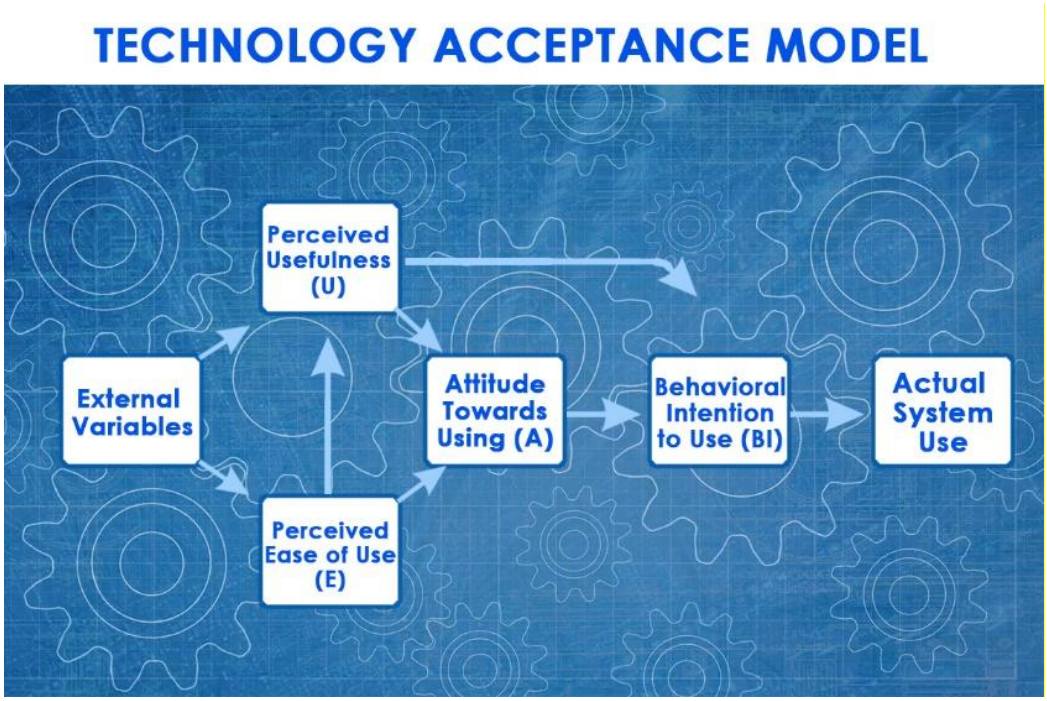


Figure 2.1: The technology Acceptance Framework/ Technology Acceptance Model (TAM)

Source (Davies, 2024)

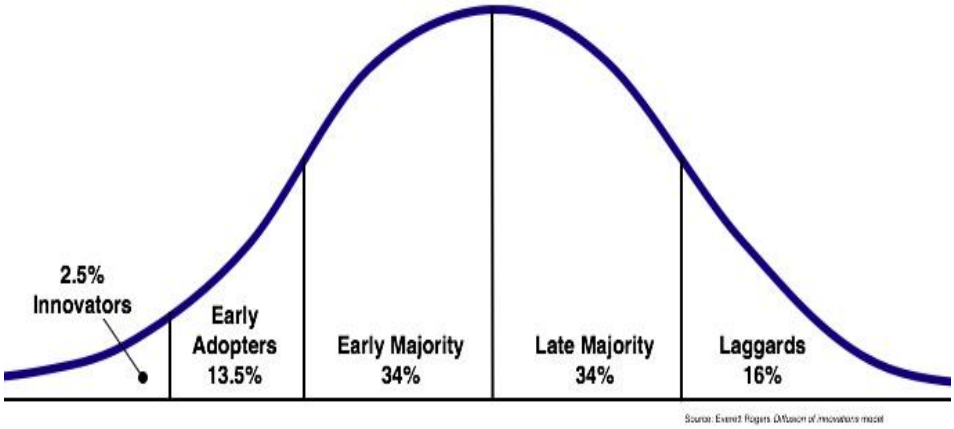


Figure 2.2: Technology Adoption Curve

2.10 Conclusion

The chapter looked at the existing literature and theories on the benefits and constraints of producing BSFL, production feasibility, and factors influencing adoption as well as challenges to its adoption as a technology. The chapter explored the technology adoption curve and technology acceptance model to illustrate how farmers respond to new innovations. This study will further unpack how the farmers make decisions on adoption of new innovations and mitigate challenges with adoption. The frameworks will also inform the study of how the farmers can be mobilised to fast- track adoption.

REFERENCES

FAO. (2024). *FAO Org Africa News> Zimbabwe.* Harare.

Ayieko, e. a. (2019). Insects as food and feed: a review of challenges and prospects in Africa. *Journal of Insect science,* 19 (1)1-7.

Barragan-Fonseca, K. B. (2023). Small Scale Blackoldier Fly- fish farming:a modelwith socio-econpmic benefits. *Animal frontiers,* 13(4)91-101.

Beesigamukama, D. e. (2021). Economic and ecologicalvalue of frassfertiliser from Blac soldier agro-industrialwaste processing. *Journal of Insects as food and feed.,* 89301-10.

Burgess, G. W. (2021). *Application of the The technology Acceptance Model.* Pressbooks.

Chikodzi, D. (2016). Crop Yield sensitivity to climatic variability as tjhe basis for creating climate resilient agriculture. *American Journal of Climate Change,* 5(1)69-76.

Chikodzi, D. (2022,). Unlocking the potential ofcircular Bio-economy: prospects for BSFL production in Zimbabwe. *Zimbabwe Journal of Science and technology,* 17(2) 89-98.

Chineme, A. A. (2023). Open and closed Blacksoldier Fly systems trade offs analysis. *Sustainability,* 15(24)16677.

Choudhury, A. e. (2018). technical feasibilityof Hermetia illucens in Integratedwaste managemntrenovated with sewagewater: an Over view. *Openaccess Libraryjournal,* vol5(4) 1-27.

Davies, F. (2024). *The Technology Acceptance Model30 years of TAM.*

Diener, S. Z.-G. (2011). BSF Larva for Organic Waste treatment_ prospects and Constraints-conference paper. *Researchgate*.

Drury, A. (2025). Feasibility study,what it is, benefits and examples. *Investopeddia*.

Ferrarezi, R. L. (2016). Alternative sources of food for Aquaponicsin the USVirgin islands: A case study with Blacksoldier Fly. *Rresearchgate*.

Giacomo, K. (2023). BSF larvae protei production in Australia. *Animal Frontiers,* Vol13(8) 8-15.

Hopkins, N. L. (2021). Influence of food waste rearing subtrates n BSF larvae composition: A systematic Review. *Insects*, 12(7),608.

Kahunde, B. W. (2024). BSFL a Sustainable Solution for Protein, Waste Management and Crcular Bio-economy. *Researchgate*, 2 (3) 822-834.

Kutama, D. a. (2023). Opportunities and challenges of BSFL farming in rural Zimbabwe. *Journal of Environmental Science and Agriculture*, 11(3)211-222.

Lalander, r. e. (2019). Blacksoldier Flylarvae for organic waste treatment and production and of protein-rich biomass. *Journal of Insect Science*, 19(4) 1-12.

Liu, e. a. (2018). Pathogen reduction in organic waste by black soldier fly larvae. *journal of environmentalScience and health*, part B53, 247-254.

Matuku, K. e. (2021). determinants of profitability of BSFLfarmingenterprisein Kenya. *Journal of insects as food and feed*, 8(6)1-8.

Mertenat, A. D. (2019). Environmental Impacts of insect farming. *Journal of cleaner Production*, 225 p1154-1164.

Mujuru, e. a. (2023). Empowering youths through insect farming- lessons from Mashonaland East. *Zimbabwe Dgriculture journal*, 105(1), 33-40.

Munthali, M. a. (2023). the economic Cost benefit Analysis of BSFL as an alternative animaland fish feed ingredient. *MwaPATA Institute*, 23/01.

Mutenje, e. a. (2020). Adoption of climate smart agriculture technologies in Zimbabwe: insects as food and feed. *International journal of Agricultural Sustainability*, 18(4) 377-390.

Mutungi, C. e. (2022). Insect farming in East Africa: environmental constraints and adaptive practices. *Journal of Insect Agriculture*, 7(1)12-24.

Mwaniki, S. e. (2020). Scaling up BSFL farming in Africa: Lessons from Kenya. *Insects as feed and food*, 5(2)101-115.

Mwanza, e. a. (2021). Exploring the potential of Blacksoldier farming in zambia's rural economy. *Zambian Journal of agricultura sciences*, 10(1),55-67.

Nguyen, e. a. (2015). Ability of a Black soldier fly to recycle food waste. *Environmental Entomology*, 44(3) 406-410.

Nyakeri, E. S. (2019). An Optimal Feeding Strategy of BSFL Biomass Productionand Faecal Sludge Reduction. *Reserachgate- Journal of insectsas food and feeds*, 5 (3) 1-14.

Prihartini, E. e. (2022). Financial analysis of Business feasibility and maggot BSFcultivation development strategy. *Journal of Economics, Financeand management studies*, Vo5(1)15-25.

R. J. (2024). assessing the ecconomic viability and factors affecting farmer adoptionof bsflas broiler fed in Bangladesh: A comparative analysis. *Discover Agriculture*.

Ramachandra, S. B. (2024). Effective utilisation of BSFL(Hermetia Illucens) as a poultry feed. *International Research Conference of Sri Lanka Technology campus,*. Colombo.

Raman, S. e. (2022). opportunities, challenges and solutions for Blacksoldier Flylarvaebased animal feed production. *Journal of Cleaner production*, 373(40)133802.

Rehman, K. H. (2022). BSFHermetia illucens as a potential innovative and environmentally friendly tool for waste management: A review. *Wste Mangement*, 41(1) 81-97.

FAO. (2024). *FAO Org Africa News> Zimbabwe.* Harare.

Ayieko, e. a. (2019). Insects as food and feed: a review of challenges and prospects in Africa. *Journal of Insect science*, 19 (1)1-7.

Barragan-Fonseca, K. B. (2023). Small Scale Blackoldier Fly- fish farming:A modelwith socio-economic benefits. *Animal frontiers*, 13(4)91-101.

Beesigamukama, D. e. (2021). Economic and ecologicalvalue of frassfertiliser from Blac soldier agro-industrialwaste processing. *Journal of Insects as food and feed.*, 89301-10.

Burgess, G. W. (2021). *Application of the The technology Acceptance Model.* Pressbooks.

Chikodzi, D. (2016). Crop Yield sensitivity to climatic variability as the basis for creating climate resilient agriculture. *American Journal of Climate Change*, 5(1)69-76.

Chikodzi, D. (2022,). Unlocking the potential ofcircular Bio-economy: prospects for BSFL production in Zimbabwe. *Zimbabwe Journal of Science and technology*, 17(2) 89-98.

Chineme, A. A. (2023). Open and closed Blacksoldier Fly systems trade offs analysis. *Sustainability*, 15(24)16677.

Choudhury, A. E. (2018). Technical feasibilityof Hermetia illucens in Integratedwaste managemntrenovated with sewagewater: an Over view. *Openaccess Libraryjournal*, vol5(4) 1-27.

Davies, F. (2024). *The Technology Acceptance Model30 years of TAM.*

Diener, S. Z.-G. (2011). BSF Larva for Organic Waste treatment_ prospects and Constraints-conference paper. *Researchgate*.

Dzepe, D. N. (2021). Feeding strategies for small-sczle rearing of BSFL (Hermetia illucens)as organicwaste recycler. *SN AppliedSciences*, 3:252.

Facebook. (2020). Buhera Zimbabwe map.

FAO. (2022). *Black Soldier Fly Production mnual: A step by Step Guide/ a Zimbabwean Case.* Harare: Sub regional office of southern Africa.

Ferrarezi, R. L. (2016). Alternative sources of food for Aquaponicsin the USVirgin islands: A case study with Blacksoldier Fly. *Rresearchgate*.

Giacomo, K. (2023). BSF larvae protei production in Australia. *Animal Frontiers*, Vol13(8) 8-15.

Hopkins, N. L. (2021). Influence of food waste rearing subtrates n BSF larvae composition: A systematic Review. *Insects*, 12(7),608.

Kahunde, B. W. (2024). BSFL a Sustainable Solution for Protein, Waste Management and Crcular Bio-economy. *Researchgate*, 2 (3) 822-834.

Kutama, D. a. (2023). Opportunities and challenges of BSFL farming in rural Zimbabwe. *Journal of Environmental Science and Agriculture*, 11(3)211-222.

Lalander, r. e. (2019). Blacksoldier Flylarvae for organic waste treatment and production and of protein-rich biomass. *Journal of Insect Science*, 19(4) 1-12.

Liu, e. a. (2018). Pathogen reduction in organic waste by black soldier fly larvae. *journal of environmentalScience and health*, part B53, 247-254.

Makkar, H. P. (2013). State- of- the- art on use of inscts as animal feed. *Animal Feed Science andtechnology*, 197, 1-33.

Mapanje, O. S. (2021). The impact of Climate Informationn services on smallholder farmers' livilihood outcomes. *Researchgate*.

Matuku, K. e. (2021). determinants of profitability of BSFLfarmingenterprisein Kenya. *Journal of insects as food and feed*, 8(6)1-8.

Mbunge, E. S. (2024). Leveraging mobile phones to improve malaria heatlhcare service delivery in Buhear communities:Implications for practice and policy. *Behaviour and information Technology*.

Mertenat, A. D. (2019). Environmental Impacts of insect farming. *Journal of cleaner Production*, 225 p1154-1164.

Mujuru, e. a. (2023). Empowering youths through insect farming- lessons from Mashonaland East. *Zimbabwe Dgriculture journal*, 105(1), 33-40.

Mukonoweshuro, T. C. (2023). *Green Protein: Farming BSFlarvaein Zimbabwe.* Harare.

Munthali, M. A. (2023). the economic Cost benefit Analysis of BSFL as an alternative animaland fish feed ingredient. *MwaPATA Institute*, 23/01.

Musau, S. (2024). Cost of production and financial perfomance of selected poultry rearing farmers in Kuambu County, Kenya. *International Journal of general aspects in Finnce Banking and Accounting*, 6(2)14-30.

Mutenje, et. al. (2020). Adoption of climate smart agriculture technologies in Zimbabwe: Insects as food and feed. *International journal of Agricultural Sustainability,* 18(4) 377-390.

Mutungi, C. (2022). Insect farming in East Africa: environmental constraints and adaptive practices. *Journal of Insect Agriculture*, 7(1)12-24.

Mwaniki, S. et al.. (2020). Scaling up BSFL farming in Africa: Lessons from Kenya. *Insects as feed and food*, 5(2)101-115.

Mwanza, et al. (2021). Exploring the potential of Blacksoldier farming in zambia's rural economy. *Zambian Journal of agricultura sciences*, 10(1),55-67.

Newsday . (2024, 8 July). *Livestock Poverty Death grips Zimbabwe.* Harare: Newsday Co.ZW.

Nguyen, et. al. (2015). Ability of a Black soldier fly to recycle food waste. *Environmental Entomology*, 44(3) 406-410.

Nyakeri, E. S. (2019). An Optimal Feeding Strategy of BSFL Biomass Productionand Faecal Sludge Reduction. *Reserachgate- Journal of insectsas food and feeds*, 5 (3) 1-14.

Nyamuhirwa. (2025). Perspectives on adoption of Black Soldier Fly Larvae for animal feed among livestock farmers in Sub Saharan Africa. *Frontiers in Environmental Economis*.

Prihartini, E. et al.. (2022). Financial analysis of Business feasibility and maggot BSFcultivation development strategy. *Journal of Economics, Financeand management studies*, Vo5(1)15-25..

Ramachandra, S. B. (2024). Effective utilisation of BSFL(Hermetia Illucens) as a poultry feed. *International Research Conference of Sri Lanka Technology campus,.* Colombo.

Raman, S. et al.. (2022). Opportunities, challenges and solutions for Blacksoldier Flylarvaebased animal feed production. *Journal of Cleaner production*, 373(40)133802.

Rehman, K. H. (2022). BSFL Hermetia illucerns as a potential innovative and environmentally friendly tool for waste management: A review. *Wste Mangement*, 41(1) 81-97.

Roy, J. (2024). Assessing the economic viability and factors affecting farmer adoptionof BSFL as broiler feed in Bangladesh: A comparative Analysis. *Discover Agriculture*.

SADC. (2022). Food, agriculture and natural resources- Livestock Production.

Sanchez -Muros, M. e. (2016). *Insects as Sustainable Feed Ingredients.* Almeira: Alsevier Inc.

Siddiqi, S. R. (2022). The Blacksoldier FlyLarvae (BSFL)and their affinity for organic waste. *Waste Management*, 1040(3) 1-13.

Siddiqui, H. .. (2024). Future opportunities for products derived from black. *Environment,Develoment and Sustainability*.

Siddiqui, S. G. (2024). Future opportunities for products derived fromBSF treatmentsas animal feedand fertiliser- A Sysstematic Review. *Environment, Development and sustainability*.

Smetana, et al. (2019). Sustainability of insect based food and feed production. *Journal of cleaner production*, 225 1154-1164.

Tanga, et al. (2021). Enhancing food security through insect farmin: the case of BSFL in Uganda. *FAO REPORT*.

Tomberlin, et al. (2009). Development of the Black Soldier Fly in relation to temoerature . *Environmental entomology*, 38(3)530-539.

van Huis, et al.. (2013). *Edible insects: Future prospects for food and feed.*

Veldkamp, T. B. (2015). Insects:Protein -rich feed ingredientin pig and poultry diets. *Animal Frontiers*, 5 (2)45-50.

Veldkamp, T. et al.. (2017). Insects as feed: A reviewof the economic and environmental implications. *Journal of insects a food and feed*, 3(2) 115-126.

Vilela, J. A. (2021). Blacksoldier inclusion in broiler diets. *Animal Nutrition*, 7(9).

Worthington, A. (2021). *Persuasion Theory in action: an Open Reource.* Pressbooks.

CHAPTER 3: METHODOLOGY

3.1 Description of Study Site

The study area is Ward 28 Buhera South District, Manicaland Province, Zimbabwe. The ward lies in Natural Agroecological Region V that is characterized by poor soils and weather challenges such as low rainfall (below 500 mm per annum.), droughts and floods. Fig 3.1 shows the geographical location of the study area.

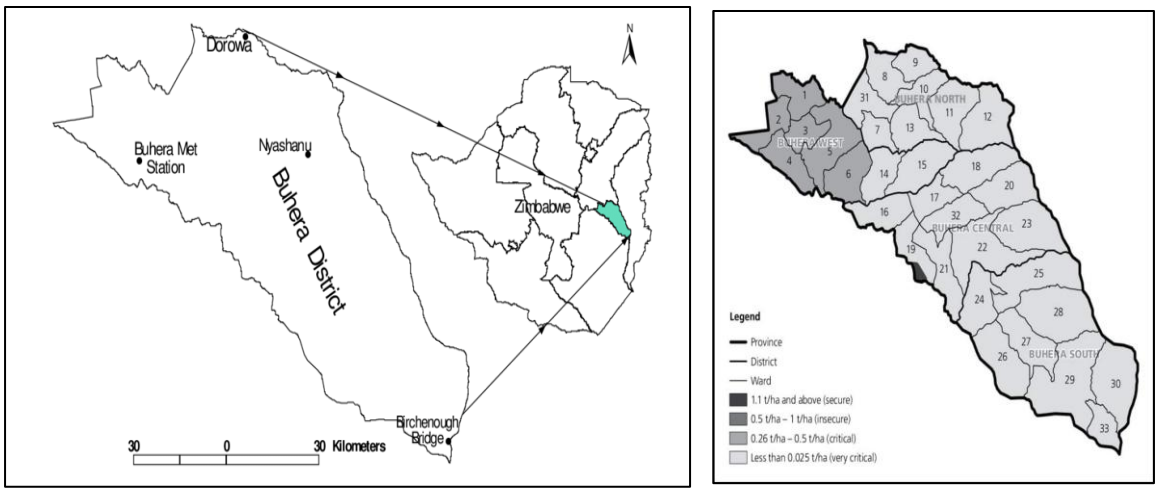


Fig 3.1 The study area.

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Recent Crop, Livestock, and Fisheries Assessments (CLAFA) assessments show that crop production has suffered significantly, with estimates showing a considerable percentage of maize crops classified as "poor" or entirely written off due to insufficient rainfall. This creates challenges for food security in the area. The soils are sandy loams, which are poor in nutrients and require heavy fertilization. Most people rely on agriculture as their main livelihood activity and grow crops for food security. These conditions make Buhera South District a basket case requiring targeted assistance by the government and NGOs. Skills development focuses on improving farmers' knowledge of modern and sustainable agricultural practices that can enhance crop resilience in drought conditions. In 2019, Cyclone Idai-induced floods left some people homeless and without food and livestock (FAO, 2022). The BSFL technology is one of the interventions piloted in the area to leverage livestock recovery after the Cyclone Idai disaster. BSFL was viewed as a panacea to livestock feed shortages and an income generating activity for the cash strapped community.

The community has adopted a mixed farming economy, combining livestock and crop production. This approach enables farmers to diversify their income streams and mitigate climate challenges. Mixed farming is both an insurance against drought and a crop production strategy in the event of crop failure. People will rely on livestock to purchase food, even by barter trade. On the other hand, cattle provide draught power to the land. In the case of small stock like poultry, they provide relish and proteins for households. Hence, both carbohydrates and proteins are guaranteed, at least theoretically, because the decision to slaughter livestock for meat will depend on the individual farmers. The mixed farming economy suits a circular food system anchored on BSFL production (Beesigamukama, 2021), (Barragan-Fonseca, 2023).

The community has developed innovative strategies to cope with these challenges, including using drought-tolerant crops and conservation agriculture practices such as *Pfumvudza*.

Ward 28, Buhera South District in Manicaland Province, Zimbabwe, lies within the rain shadow Save Valley, 40 km to the west of Birchenough Bridge. It comprises three clusters based on population concentrations around service centres or townships- Chimombe, Barura and Mutiusinazita. The main service centres are Chapanduka, Mutiusinazita and Chimombe. Principal crops grown are maize (*Zea mays*), Pearl millet *(Pennisetum glaucum)*, Bambara nuts (*Vigna subterranean*) and groundnuts (*Arachis hypogaea*), while livestock comprise mainly cattle mostly hard Mashona breeds) goats, sheep, poultry (road runners, broilers,

guinea fowls, turkeys) and occasionally pigs. Bambara nuts are a key commercial crop and a must for every household because of their drought-tolerance qualities and suitability for sandy loams. This is followed by millet, which is a staple and drought-tolerant crop. As for livestock, one of the most interesting observations is that almost everyone has a kraal, indicating cattle's importance. Goats are quite dominant and very cheap, mostly priced at 20 US.

3.2 Research Design

The study combines qualitative and quantitative research designs to understand the research topic comprehensively. The focus is on one ward participating in Black Soldier Fly (BSF) production. Both sensitized participants and non-participants were considered for their informed opinions on BSF adoption. This approach enables the study to capture various perspectives and experiences. The research design is flexible and adaptive, allowing the researcher to respond to emerging themes and issues. Using multiple data collection methods, including surveys, interviews, and focus group discussions, key informants enable the researcher to triangulate the data and increase the validity of the findings (Trochim, 2006).

3.3 Data Collection Procedure

Quantitative data is collected using questionnaires, while qualitative data is gathered through focus group discussions (Fowler, 1977). The focus is on establishing knowledge gaps, perceptions, and factors affecting BSF adoption. The data collection tools are pre-tested and refined to ensure that they are valid and reliable (Fowler, 1977). Descriptive statistics was based on summaries anchored on measured frequencies of occurrences (Gravetter, 2014); inferential statistics, and thematic analysis are used to assess the feasibility of BSF production and identify drivers and limitations. Deriving information from pr-existing literature (deductive) and generating themes information from the data being analysed (Inductive) helped in thematic analysis (Braun, 2006). The data analysis procedure is systematic and transparent, ensuring that the findings are valid and reliable. SPSS and Excel will be used to analyse data and present findings on tables and graphically (Tufte, 2001).

The data collection procedure is designed to be efficient and effective, minimizing the burden on participants while maximizing the quality of the data. The use of multiple data collection methods enables the researcher to capture a wide range of perspectives and experiences. Practically, a sample is used to represent a population (Cochran, 1977). The data analysis software is selected based on its ability to handle large datasets and perform complex

analyses. The researcher is trained in the use of the software, ensuring that the data is analysed correctly and efficiently. The model selected was the Logistic Regression Model. Thirteen variables were selected for analysis based on their likelihood to have influence on BSFL adoption. The initial selection of possible variables was based on literature reviews and generated frequencies of occurrence

A total of 101 respondents were interviewed. Two Agritex officers from Ward 28 and three lead farmers, one from each cluster, were interviewed for key informants. One LEAD officer who implemented the project was also questioned as a key informant. For Focus group discussions a total of six focus group discussions were conducted. Each cluster provided two groups, one for males and females apiece. The data collected was summarised in a single report.

3.4 Sampling Procedure

The sample comprised 101 respondents based on an approximated population of 135 sensitised farmers across three clusters with nine lead farmers and 15 members each. The 95% confidence level and 0.05 margin of error with a 50% population proportion were adopted.

The formula used was $n=NZ2p(1-p)/E2(N-1)+Z2p(1-p)$ where

n = sample size, N =population size (in this case 135), **Z**=z score of 1.96 which corresponds with 95% confidence level, **E**= margin of error (5% or 0.05), **P** = population proportion (50% or 0.5)

The study employed a multi-stage purposive sampling approach to select interviewees. The process began with identifying clusters, after which participants were invited to the cluster centre. Nine lead farmers were initially seeded as key participants. A hat-based selection method was used to ensure randomness: seven of the lead farmers each randomly selected 10 members (totalling 70), while the remaining two selected 11 members (totalling 22). Finally, the nine seeded lead farmers were added to the 92 selected members, resulting in 101 participants for the study.

3.6 Data Analysis Procedure

The Logistic Regression Model (LRM) is a statistical model was used to estimate the probability of adoption based on explanatory variables. Statistically significant variables had a p value 0.005 or less i.e. 95% probability.

Adoption of BSFL as shown by having produced and used BSFL on poultry, was the Dependent variable i.e. the variable subject to influence from other factors. The independent variable i.e. those factors that influence adoption included age, sex, level of education, occupation, Income, access to finance, cost of feed, knowledge, training, perception, cultural acceptance and substrate availability

This model was used to assess factors influencing farmers' adoption of BSFL farming in this study. The logistic regression formula (equation 1) represented the likelihood or probability of a binary result or outcome i.e.; (Yes=1 and No=0) (Greene, 2003)

The Logistic model can be specified as:

$$P(Y=1)=\phi(\beta_0+\beta 1Age+\beta 2Gender+\beta 3Income+\beta 4Education+\beta 5AcceFin\ldots.+\beta 10CulAccp+\varepsilon)$$

(Equation 1)

Where (ϕ) is the cumulative distribution function of the standard normal distribution.

To interpret results, analyse the output to understand the significance and impact of each variable on the likelihood of BSFL adoption. Look for p-values and coefficients to assess the relationship strength. During analysis of adoption factors, p value <0.005 is statistically significant and coefficients indicative of relationship strength. The dependent variable was Adoption of BSFL (Black Soldier Fly Larvae): A binary variable indicating whether a farmer has adopted BSFL farming (1 = adopted, 0 = not adopted). This variable captures the outcome of interest: the decision to adopt BSFL technology. The independent variables were:

- Age: A continuous variable representing the age of the farmer. Older farmers may have more experience, but younger farmers may be more open to new technologies.
- Gender: A binary variable (1 = male, 0 = female) that may influence adoption decisions due to differences in access to resources, knowledge, or social norms.
- Education level: A categorical variable indicating the farmer's level of education (e.g., no education, primary, secondary, tertiary). Higher education levels may increase the likelihood of adoption by improving understanding and management of BSFL technology.

- Occupation: A categorical variable representing the farmer's occupation (e.g., full-time farmer, part-time farmer). Full-time farmers may be more likely to adopt BSFL due to their greater involvement in farming activities.
- Household Income: A continuous variable representing the farmer's income. Higher income levels may enable farmers to invest in BSFL technology.
- Access to financial resources: A binary variable (1 = yes, 0 = no) indicating whether the farmer has access to financial resources, which can facilitate investment in BSFL farming.
- Cost of stock-feed: A continuous variable representing the cost of feed for BSFL production. Higher feed costs may reduce the likelihood of adoption.
- Knowledge of BSFL technology: An ordinal scale variable (e.g., low, medium, high) representing the farmer's knowledge of BSFL technology. Greater knowledge may increase the likelihood of adoption.
- Training received: A binary variable (1 = yes, 0 = no) indicating whether the farmer has received training on BSFL farming. Training can improve understanding and management of BSFL technology.
- Perceived BSFL benefits: An ordinal scale variable (e.g., low, medium, high) representing the farmer's perception of the benefits of BSFL farming. Positive perceptions may increase the likelihood of adoption.
- Cultural acceptance: A binary variable (1 = accepted, 0 = not accepted) indicating whether the farmer's community culturally accepts BSFL farming. Cultural acceptance can influence adoption decisions.
- Availability of substrates: An ordinal scale variable (e.g., low, medium, high) representing the availability of substrates for BSFL production. Greater availability of substrates may increase the likelihood of adoption.

3.7 Ethical Considerations

Informed consent is obtained from participants, ensuring anonymity and confidentiality. Necessary research approvals and permissions are obtained from relevant authorities, including the District Development Committee (DCC) and the Agricultural and Rural Development Authority (ARDA). The researcher is aware of the potential risks and benefits

associated with the research, and takes steps to minimize harm and maximize benefits. The research is designed to be respectful and sensitive to the needs and concerns of the participants.

3.8 Conclusion

The methodology is designed to extract authentic and unbiased information, providing a comprehensive understanding of the research.

REFERENCES

Barragan-Fonseca, K. B. (2023). Small Scale Blackoldier Fly- fish farming:a modelwith socio-econpmic benefits. *Animal frontiers*, 13(4)91-101.

Beesigamukama, D. e. (2021). Economic and ecologicalvalue of frassfertiliser from Blac soldier agro-industrialwaste processing. *Journal of Insects as food and feed.*, 89301-10.

Cochran, W. G. (1977). *Sampling techniques.* John Wiley & Sons.

Denzin, N. K. (1978). *The Research Act: Theoretical Introduction to Sociological Methods.* McGrow Hill.

Cochran, W. G. (1977). *Sampling techniques.* John Wiley & Sons.

FAO. (2024). *FAO Org Africa News> Zimbabwe.* Harare.

Fowler, F. J. (1977). *Survey research methods.* Sage Publications.

Gravetter, F. J. (2014). *Statistics for the behavioural Sciences* . Cengag Learning.

Greene, W. H. (2003). *Econometric analysis 5th Edition* . New Jersey: Prenciss hall, upper sandle river.

Trochim, W. M. (2006). *The Research Methods Knowledge Base.* Atomic Dog Publishing.

Tufte, E. R. (2001). *The Visual Display of Quantitative Information* . Graphics Press.

CHAPTER 4:RESULTS AND DISCUSSION

4.0 This chapter focusses on the research findings, drawing strength from previous works by other scholars.

4.1 Effect of Age (0.030) on Adaptation

The coefficient shows that each additional year in terms of age increases the probability of BSFL adoption by 3% and (p=0.045) shows that age is indeed a statistically significant factor.

Plotting frequencies of adopters' ages also depicts a similar pattern see Fig4.1 below.

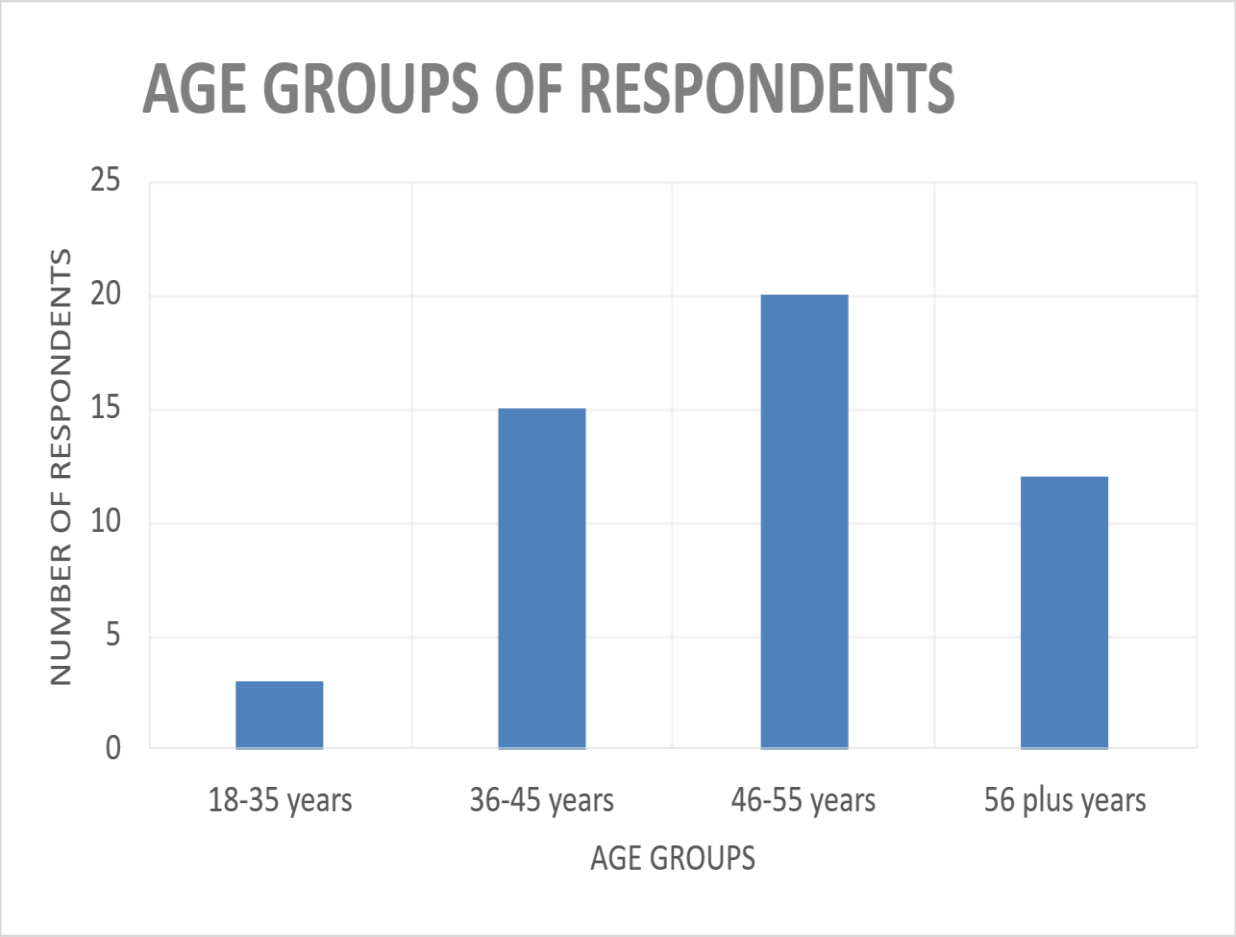


Fig 4.1. Ages of respondents

A closer examination of the data reveals that most adopters, nearly two-thirds (69.2%), fall within the middle-aged categories of 36-55 years. This demographic is particularly notable, as individuals aged between 46 and 55 represent the largest single group, accounting for 40.4% of all respondents. This suggests that middle-aged individuals are most inclined to

adopt BSF larvae technology, likely due to their established farming experience, social networks, and economic stability. The concentration of adopters within this age group has significant implications for disseminating and adopting BSF larvae technology, as it highlights the importance of targeting middle-aged farmers in extension services and training programs.

In contrast, a relatively small fraction (5.8%) of adopters is between 18 and 35, indicating limited interest or access to BSF larvae technology among younger people in Buhera District. This finding highlights the need to explore strategies to increase awareness and adoption of BSF larvae technology among younger demographics. The low adoption rate among younger farmers may be attributed to various factors, including limited access to information, lack of experience, and perceived difficulties in production due to inadequate financial and material resources. To address this gap, it is essential to develop targeted interventions, such as training programs, extension services, and social media campaigns, to raise awareness and promote the adoption of BSF larvae technology among younger farmers. It is also noteworthy that young people appreciate high-tech activities that are manually limited. Hence, there is a need to improve machinery technically. Such machines as pelletizers may generate interest. Roles such as digital produce marketing may make BSFL more appealing to the youth.

The implications of these results are significant, as they suggest that age-related factors influence the adoption of BSF larvae technology. The concentration of adopters within the middle-aged demographic highlights the importance of targeting this age group in extension services and training programs. Conversely, the low adoption rate among younger farmers underscores the need for targeted interventions to increase this demographic's awareness and adoption of BSF larvae technology. By understanding the age-related dynamics of BSF larvae technology adoption, policymakers, extension agents, and other stakeholders can develop more effective strategies to promote the dissemination and adoption of this innovative technology.

A notable proportion (25%) of adopters are aged 56+ years, showing that older adults also play an important role in adopting this technology. The data above suggests that Black Soldier Fly larvae technology adoption in Buhera South District is predominantly driven by middle-aged individuals (36–55 years), with lower participation from younger people (18–35 years) and moderate involvement from older adults (56+ years). This trend highlights

potential barriers of younger demographics while emphasizing opportunities to target middle-aged farmers for further promotion efforts in Manicaland Province's Buhera South District**.**

4.1.2 Level of Education (secondary 0,700)

Farmers who attained secondary level education have a greater probability of adopting BSFL. This is statistically significant (p=0.046)

Secondary education ensures easy transfer of new technology because farmers who attained secondary education:

make use of various mediums of modern communication such as pamphlets, various apps (Whats app; Face Book, X, You Tube, SMS, TEAMS); understand various languages including English which is commonly used in most literature on BSFL; can easily calculate gross margins realising profits from BSFL utilisation; can calibrate own feed formulation ratios; are more adaptive to change and less conservative.

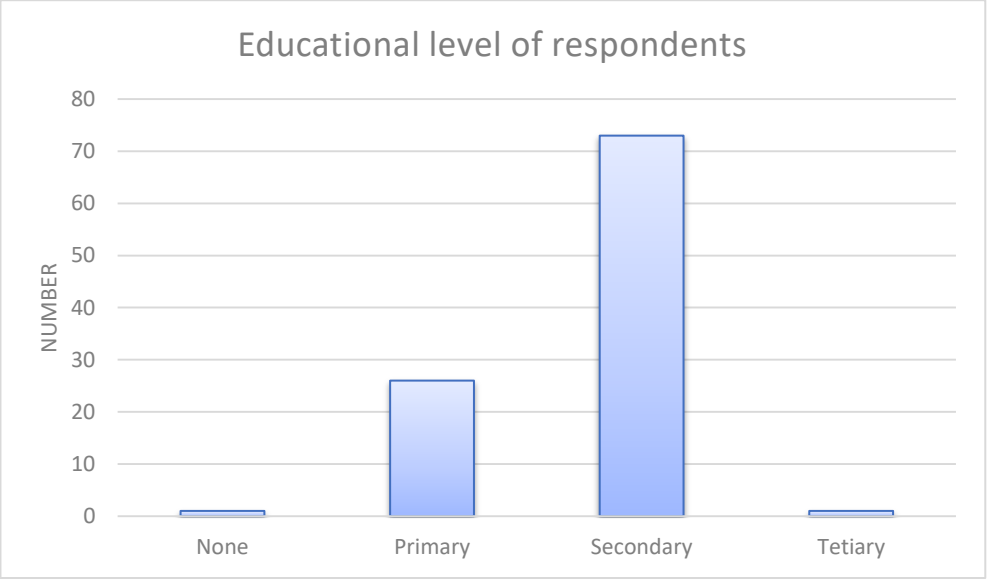


Fig 4.2 Highest Educational level of respondents

One person without education-

Implications- challenges in understanding or adopting the technology. Intensive awareness campaigns or hands-on demonstrations needed for people without education at all.

Primary Education (26 individuals):

Basic literacy could enable them to understand the simpler aspects of BSFL technology but they may still require support in the form of visual aids, training sessions, or ongoing guidance to fully adopt and utilize the technology.

Secondary Education (73 individuals):

This group offers highest potential group for adoption, especially if provided with proper training and education on the benefits, implementation, and maintenance of the technology.

Tertiary Education (1 individual): few tertiary-educated individuals may mean a lack of specialized knowledge or technical expertise in implementing or scaling the technology, implying there is need for collaboration with external experts or organizations to bridge this gap.

So, for effective implementation of BSFL technology, target farmers with secondary education for BSFL adoption and tailor-make training programs for those without education or have primary education to enable them participate effectively

4.1.3 Occupation (full-time farmers 0.600, p=0.047)

Occupation is a statistically significant factor (p=0.047) in BSFL adoption. Full-time farmers are more likely to adopt BSFL technology because they view it as an additional source of income, an off-farm activity that can enhance their agricultural productivity and utilisation of farm waste.

Fig 4.3 Main Occupation

Occupation and BSF Production Insights

Full-time farmers constitute (96%). Their dedication to farming suggests they might be highly receptive to BSF production, as a commercialisation opportunity within the farming sector. BSFL can enhance agricultural outputs and provide additional benefits like cost savings on feed as well as improve household hygiene through waste recycling. Full time farmers would effectively benefit form nutrient recycling, repurposing agricultural waste and enhancing more productive circular farming systems. These farmers should be made to realise that BSFL is an opportunity for them to commercialise within the agriculture sector.

Although part time farmers are few, (4%), these farmers may view BSF production as a supplementary activity that complements their primary occupation. Time management challenges may occur. It is therefore essential to tailor make BSFL production systems that suit them, notably simple, low-maintenance BSFL systems.

BSF production should be viewed as a cost-effective way to supplement their income or reduce farming input costs. However, to scale up, there is need to focus on the full-time farmers group, prioritize outreach, education, and resources tailored to their needs, highlight BSF's role in improving productivity and sustainability on their farms and leverage their full-time status to encourage advanced uses of BSF, like producing feed for specific livestock or implementing large-scale composting systems.

4.1.4 Access to Finance (1.200; p=0.003**)**

Farmers are more likely to adopt BSFL technology by 3,32 times if financial resources are available. With p = 0.003, this factor is a critical consideration in BSFL adoption. Farmers need finances to meet costs for construction of structures such as breeding tanks, protection nets, mating cages (love cages), feed production machinery such as grinding mills, pelletisers, mixers and harvesting machines like vibrators and driers. Without these facilities, BSFL, regardless of its glaring opportunities will remain an elusive enterprise to the farmers.

4.1.5 Cost of feed (0.005; p=0.012)

Farmers are more likely to adopt BSFL if the cost of BSFL feed is cheaper than conventional feed. This is critical because it is the main reason for seeking an alternative feed. A p value of 0.012 emphasises the sensitivity of this factor. To make BSFL feed more affordable, there is need to improve the whole production system through mechanisation and quality controls.

Nyakeri et al (2017) noted that the prospect of getting cheaper feed was a significant adoption factor. The key challenges to BSFL adoption are high capital costs of production coupled with small volumes produced by early adopters. Small volumes increased cost of production. There is need therefore to increase volumes and tap from economies of scale and reduce per unit cost of production.

4.1.6 Knowledge of BSFL technology (0.400; p=0.045) and **Training** (1.000; p=0.004)

Increased knowledge of BSFL technology shows a positive impact which is statistically significant. On the other hand, training shows that if given to farmers, the adoption probability rate is 2.72 times. These two factors emphasise the need for knowledge transfer in achieving adoption. Knowledge includes aspects of awareness, understanding and technical appreciation while training stresses the need to focus on programs designed to make targeted populations participate fully in technology adoption. These programs inherently involve knowledge transfer. BSFL technology is a new technology to both farmers and extension staff. The knowledge gap is high and the need to train staff on BSFL is a must. A low intercept (-2.000) confirms that without factoring this, the uptake of BSFL will remain low.

Knowledge transfer may be achieved through a variety of training methodologies using audio visual aids and practical activities especially for farmers with low levels of education. Extension staff should be trained on both the technical aspects of BSFL and the modern methodologies of information dissemination which take advantage of digital services which are fast and effective.

4.1.7 Perceptions (0.500; p=0.046**)**

Perception of technologies is a significant factor in technology adoption. Perceptions shape the farmers attitude and beliefs on the technology and the positive coefficient of **(0.500)** suggests that positive perceptions toward BSFL technology increase the likelihood of its adoption. Hence there is need to make farmers view BSFL as beneficial and that it can be integrated into their farming systems. Perception is a crucial factor in decision making processes involving BSFL adoption. It is critical to address these perceptions through training and taking advantage of cultural settings to address the adoption challenges. In most cases, people may have a negative attitude towards new innovations if they never used them when they were young especially food related issues. BSFL is designed to feed livestock which is then eaten by people. The feeling that one is eating BSFL indirectly may be quite strong.

However, youths were found to be more open to innovation while the elderly were very sceptical about rearing insects for food and feed (Ayieko, 2019). This is a significant barrier to adoption. To overcome these barriers, Mutenje, et al. (2019) recommend the following strategies: make use of look and learn visits, share success stories on BSFL with the target communities, more community engagement, farmer field schools, more campaigns and activities that optimise awareness

4.1.8 Availability of substrates (0.300; p=0.045)

This is a significant factor with a positive coefficient. This suggests that substrate availability is critical in BSFL adoption. It stresses the need for resource availability in technology adoption. While substrates are abundant among farmers in the wet season they tend to dwindle as the dry season sets in and agro-based waste decrease. There is need for careful planning to ensure substrate availability all year round. Substrate availability can also be achieved through "*irrigation that ensures agricultural productivity all year round* "as suggested by farmers and by careful engagement of institutions that produce waste like boarding schools and restaurants. Also processing of waste, (especially sorting, blanching, drying and shredding of waste) to increase their shelf life should be explored. In addition, substrates should be available for sale to encourage people to preserve waste. Substrate supplies could be another industry linked to BSFL adoption. However, cost benefit analyses should be done to evaluate the profitability of producing BSFL using purchased substrates. Beesigamukama et al.(2021) noted that if brewery waste is purchased as substrate, positive gross margins in BSFL production are only realised if frass is then used to enrich fields for maize production.

4.2 The technical, economic and social feasibility of producing BSFL in Buhera South district

4.2.1Technical Feasibility

The technical feasibility of producing BSFL in Buhera South district can be assessed within the context of climate, levels of awareness, knowledge of benefits of BSFL technology, access to extension services, technical expertise in terms of substrate sources and feed formulation ratios. The survey revealed that extension visits by extension staff was limited partly due to incapacity by extension staff. Four visits were modal. This is a huge technical gap that should be filled by training.

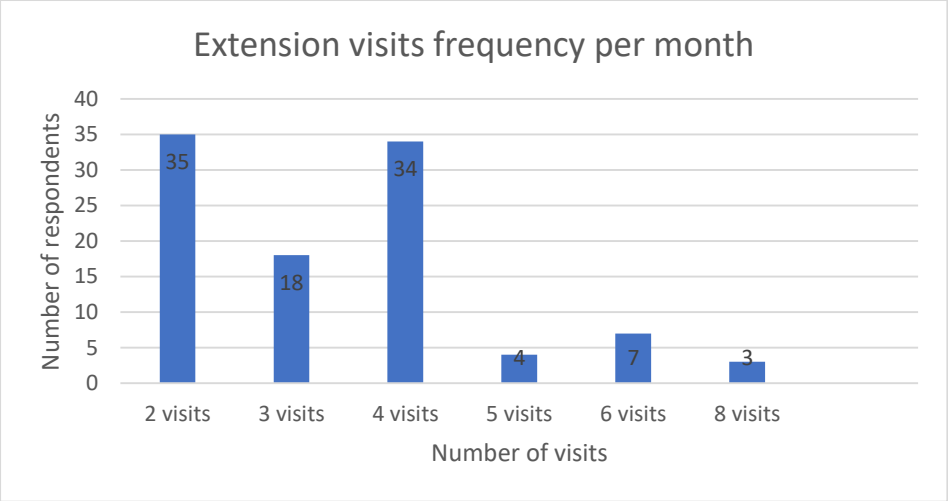


Fig.4.4 Extension Visits frequency per month

Two visits per month accounts for 35 respondents. This group represents the majority. With limited visits, there may be challenges in building deep awareness and sufficient capacity. Focused and well-structured sessions during these visits could maximize impact, but additional resources like written guides or digital support may be necessary to reinforce learning.

Three Visits (18 instances): A slight improvement over two visits, this group benefits from more frequent interaction, allowing for incremental knowledge and practice. However, consistent follow-up and supplementary resources would still be helpful to enhance awareness and adoption.

Four Visits (34 instances): Households receiving four visits have better opportunities for engagement and skill-building. This frequency allows for more hands-on training and monitoring, fostering stronger capacity building. While households with fewer visits may struggle to fully grasp and implement the technology, those with more frequent visits are better equipped to understand and adopt it. A strategy to enhance outreach could include; increasing visit frequency for households receiving fewer visits, developing supplementary resources (e.g., videos, guides), encouraging peer learning, where highly engaged households mentor others.

It is clear that those with more than four visits are the early adopters, the innovators. Given this set-up, more exchange visits are encouraged so those who do not get enough contact time with extension staff have a feel of what it takes to produce BSFL.

However, in Buhera South, extension staff were not trained in BSFL production. *Instead, only farmers went to Chinhoyi University of Technology (CUT) and got trained* (Agritex). This

was a bone of contention raised by key informants in the (KIIs). So, extension staff needs to be trained on how to produce BSFL because they are key in implementing BSFL.

Awareness programs

The need for awareness programs is a primary factor in implementing BSFL. This factor was confirmed to be statistically significant. According to Mwanza et al (2021), limited awareness was found to be a significant barrier to BSFL adoption for rural farmers in Zambia. The findings show that mediums of awareness are limited to only three see fig4.2.2 below. Most farmers got awareness from training and friends. This provides a significant gap given that modern communication mediums are left out. While family and friends pitch out prominently information shared between two people with limited information cannot be compared with a situation where podcasts, Whats app groups, you tube are utilised. Awareness and technical skills training are currently limited. There is need to train extension staff on BSFL technology and increase farmer to farmer training by organising farmer field schools.

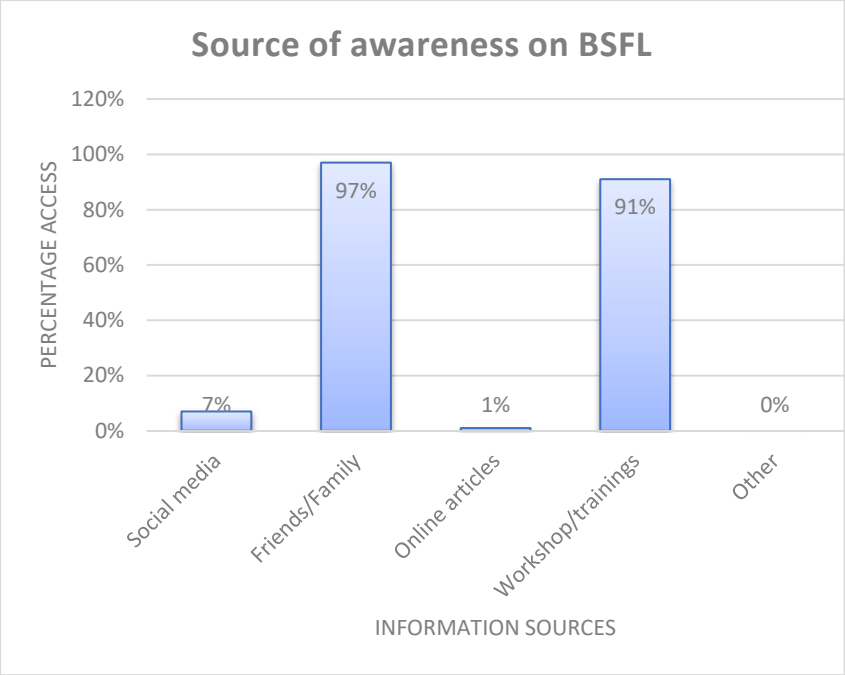


Fig4.5 Source of awareness on BSFL

The main medium of awareness on BSFL production are Friends/Family (97%): Workshops/Trainings (91%) and social media (7%): Social media accounts for a smaller portion of awareness. While social media has the potential to reach a wide audience, the lower percentage suggests limited engagement or targeted efforts on these platforms. Few people seem to use this because of limited number of people with what app compatible

gadgets like phones Currently, the WhatsApp group formed “Buhera South Protein Masters” has 22 members out of a possible 135 members (16%). This is very low. Projects should increase social media campaigns, perhaps with visually engaging content and success stories, could enhance awareness and attract more interest.

Friends/family and workshops/trainings are the most impactful awareness channels for the BSFL project. To improve reach and engagement, increase the frequency of extension visits, develop extension / learning materials like videos, guides pamphlets, exchange visits. Projects should consider providing lead farmers with smartphone to capture detail and share with other farmers.

As for family and friends, set up BSFL producers Farmer Field Schools (FFS). Here farmers come and learn as well as share experiences. Also adopt the lead farmer approach to encourage aggregation of produced BSFL and improve quality of the produce.

Knowledge of Waste streams for BSFL used in Buhera South District

Availability of substrates was proved to be a major adoption factor. Knowledge of waste streams that can be used as substrate is very critical to adoption. The wide range of waste that can feed BSFL is very much likely to encourage adoption as farmers get a sense of possibility or ease of use. The farmers use a wide range of organic waste streams as substrate material, with poultry waste being the widely used. This makes BSFL technically feasible given that farmers are using locally available and effective substrates.

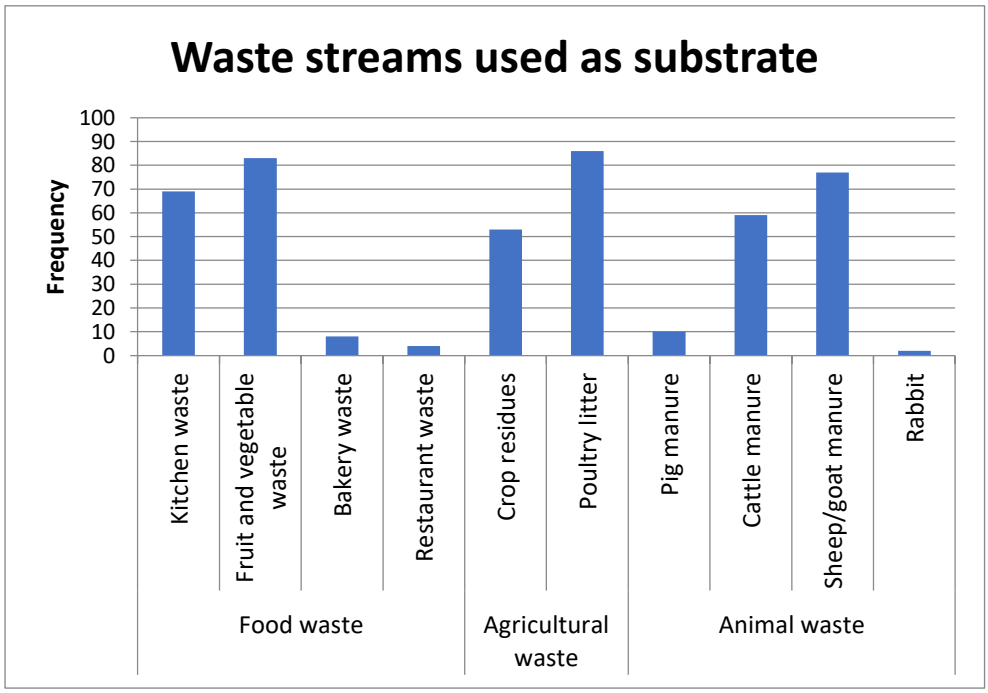


Fig 4.6 Waste streams used as substrate

Analysis of Agricultural Waste Usage:

Poultry Litter with (86 farmers) is the dominant substrate confirming that it is the most widely used waste for the purpose. This suggests that poultry litter is abundant and cost-effective in rural settings, providing the nutrients required for BSF larvae growth. Its easy availability aligns with farmers who raise poultry and allows efficient waste recycling. For broiler farmers, the litter will be carrying rich partially digested feed which is good for BSFL. Coming closely after poultry litter are the fruits and vegetable waste with 83 responses. Among food wastes this is the most popular substrate especially during the wet season.

This suggests that such waste is readily available in rural areas, likely from small-scale farms, gardens, or markets. It's a cost-effective and sustainable option for BSF farming. Within the food waste category kitchen waste comes second to fruit and vegetable waste. Two factors help explain this. There is competition for kitchen waste between BSF and domestic animals like dogs, poultry and pigs. So, there is need to emphasise the nutrient recycling component to reduce competition and make BSF as a complementing activity rather than a competitor on meagre resources. This will make farmers realise the immense opportunities embedded in BSFL. Otherwise, where possible kitchen waste can be used for BSFL because studies show that they offer some of the best nutrient rich substrates. Farmers are aware of this as well as confirmed in focus group discussions.

Among animal wastes, 77 farmers use sheep/goat manure is the most popular substrate. This indicates that sheep and goat farms are abundant in the community, providing a consistent source of manure. The nutrient profile of sheep/goat manure likely supports effective BSF larvae development.

59 farmers rely on cattle manure for BSF farming. This reflects the prevalence of cattle farming and the suitability of cattle manure as a substrate. Similar to sheep/goat manure, its high organic content makes it an excellent resource for BSF production.

Pig manure is also a possible substrate, but in this setting, it is not popular because of religious concerns. The people in this area belong to the Apostolic Faith Church which treats pigs as taboo. Hence pig manure has no positive contribution to BSFL.

Knowledge of benefits of BSFL

Knowledge of the benefits that can be accrued from adopting BSFL is critical in the adoption of BSFL technology. Successful marketing a product also depends on the sellers' knowledge of benefits the product has and if the product helps solve the immediate problems of the

client. In this case the need for a protein source that is affordable, sustainable, cost effective and environmentally friendly is the driving factor. The people's appreciation of the benefits of BSFL are shown on fif4.2.4 below. This knowledge is a technical plus for adoption of BSFL technology in Buhera South district.

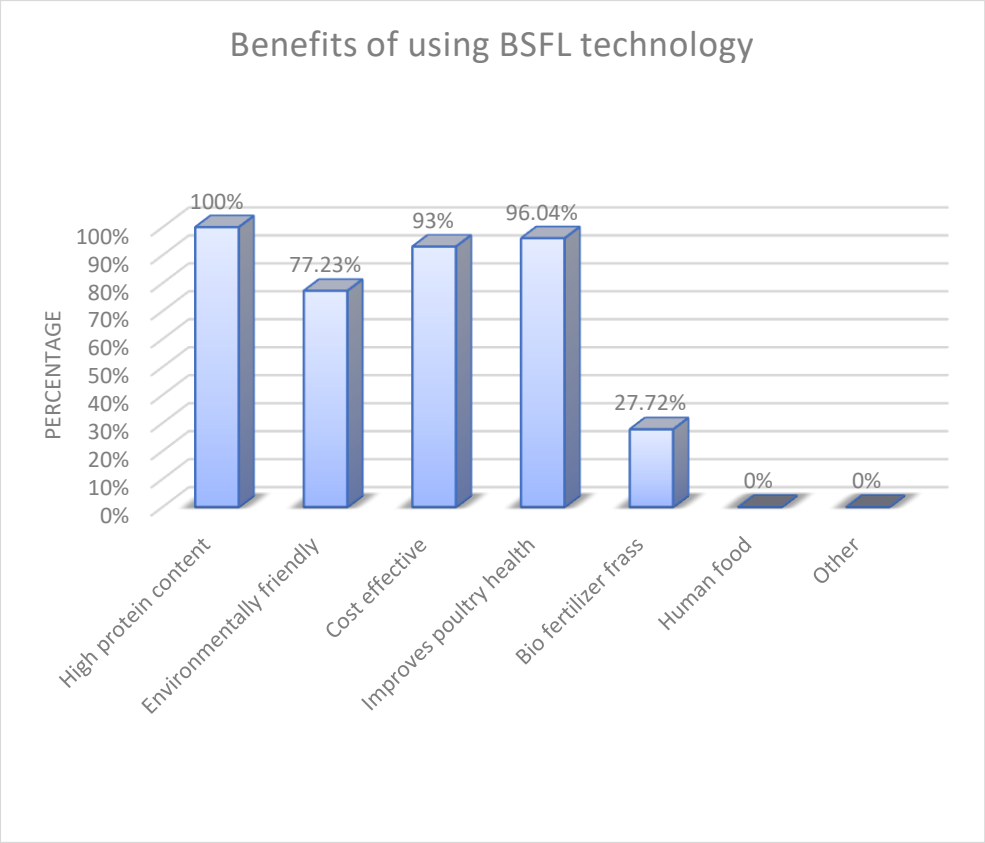


Fig 4.7 Benefits of BSFL technology

1. **High Protein Content (100%)**: This is universally recognized as the primary benefit, making BSF larvae an excellent feed supplement for poultry. It provides essential nutrients required for growth, egg production, and overall health, ensuring optimal poultry performance.
2. **Environmentally Friendly (77.23%)**: A significant percentage highlights the ecological benefits of BSF. Using BSF larvae in poultry farming reduces organic waste and minimizes the environmental impact compared to conventional feed sources, promoting sustainable agricultural practices.
3. **Cost Effective (93%)**: Alongside high protein content, cost effectiveness stands out as a key benefit. BSF production offers an affordable alternative to traditional poultry

feed, which is particularly beneficial for reducing farming expenses and increasing profitability.

4. **Improves Poultry Health (96.04%)**: The high adoption rate of this benefit underscores BSF's ability to enhance poultry health, boosting immunity and resistance to diseases due to its rich nutritional profile.
5. **Bio Fertilizer Frass (27.72%)**: While less prominent, frass (BSF by-product) is recognized for its potential as an organic fertilizer. Farmers could leverage this benefit to improve soil fertility and crop yield, providing an additional advantage beyond feed. In situations where substrates are purchased as inputs, the utilisation of frass was seen as one way of making BSFL production profitable (Beesigamukama, 2021)
6. **Human Food (0%)**: Interestingly, BSF as human food has no adoption rate. This suggests limited interest or awareness of BSF larvae in human consumption, which could be due to cultural or market-related factors.

The data highlights the protein content, cost effectiveness, and health benefits of BSFL as feed supplements for poultry as the major drivers of adoption.

Environmental benefits and frass as a bio-fertilizer add secondary advantages, while human consumption is not currently a focus. Scaling may be achieved by promoting the affordability and health benefits of BSFL, educating farmers on frass utilization for integrated farming benefits.

Climate- Buhera south district lies within the tropics. The temperatures are very suitable for the production of BSFL the temperatures of Buhera south range from 18 to 40 degrees Celsius. Buhera south district lies within the tropics (FAO, 2022). The temperatures are very suitable for the production of BSFL. The temperatures of Buhera south range from 18 to 40 degrees Celsius.

Limited knowledge and awareness pitched significantly in focus group discussions. It took the farmers almost two years to produce BSFL and some even dropped out. One farmer, Caston Chipadza wondered "*If this thing was this simple from the offset, we could have earned a lot of money and probably FAO could have given us grinding mills Imagine two years of suffering and no produce, giving false explanations for our ignorance like high temperatures and low temperatures to explain our failure to produce. Lack of knowledge is as good as death."*

4.2.2 Economic Feasibility

Economic factors comprising production costs, market demand, cost savings, profitability, and scalability are among some of the factors that motivate people to adopt BSFL technology. The cost effectiveness of BSFL feed is hinged on the fact that BSFL utilises waste to produce the much -needed protein. This arrangement is dubbed “wealth from waste”. However, there is need for a cost benefit analysis since initial capital costs are high. It was observed that farmers were reluctant to adopt BSFL if not supported with a guaranteed market (Chikodzi D. , 2016)

This is confirmed by fig 4.2.4 which gives us insights to adoption motivations. There is high expectation of getting revenue from larva sales. In addition, farmers saw BSFL as an opportunity to get affordable feed and save on feed costs (Nyakeri, 2019)The graph fig 4.2.5 gives us insights to adoption motivations.

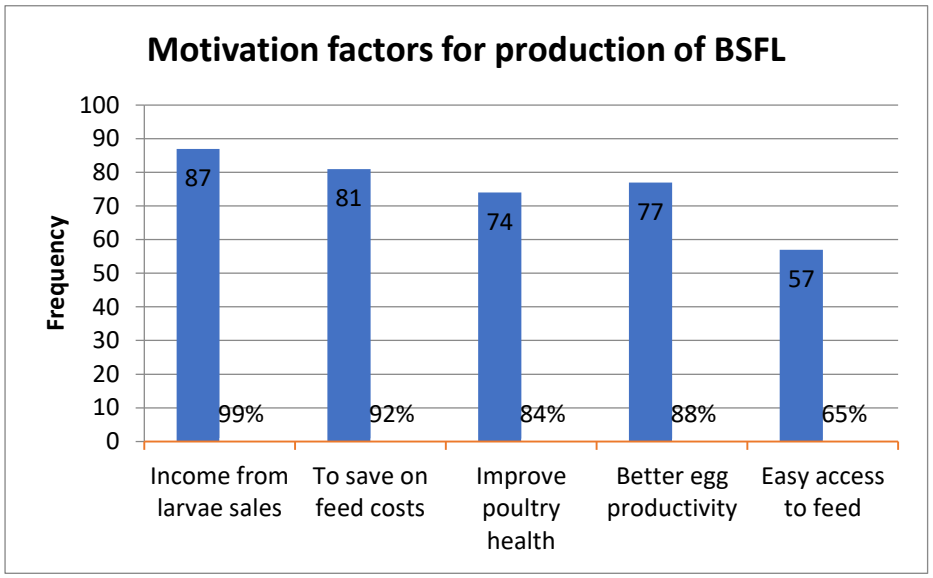


Fig 4.8 Motivation for adoption of BSFL

The analysis of pulling factors for chicken farmers adopting Black Soldier Fly (BSF) technology reveals a hierarchy of motivations. As highlighted by Nyakeri et al (2017) income from larvae sales (99%) and savings on feed costs 92% are key BSFL adoption factors in Kenya as well. These are the strongest motivators, with every farmer recognizing the financial benefits of selling BSF larvae as a key driver. The potential revenue stream offers a direct and significant incentive.

To save on feed costs (92%) Saving on feed costs is another major factor, compelling 92% of farmers to adopt the technology. BSF larvae serves as a cost-effective alternative to conventional feeds, reducing expenses.

Improve poultry health (84%) Enhancing poultry health motivates 84% of farmers. BSF larvae, as a high-protein feed, improve the nutritional profile for chickens, leading to healthier livestock and greater financial returns from livestock sales

Better egg productivity (77 farmers) The positive impact on egg productivity incentivizes 88% of adopting farmers. A healthier flock typically results in better egg production, making BSF cultivation an attractive proposition for commercial egg production.

Easy access to feed (57 adopters) Easy access to an on-site feed source influences 65% of farmers. Producing BSF larvae offers a sustainable and readily available feed solution, reducing dependence on external suppliers. This in turn cuts down on logistical expenses met in procuring feed.

The data underscores the compelling economic and practical benefits of BSF adoption, with farmers driven by profitability, cost savings, improved health outcomes, and enhanced productivity.

If BSF feed proves beneficial for poultry growth and productivity, there is a huge potential for increasing its adoption among larger-scale farmers. However, this may require education campaigns, price adjustments, or ensuring accessibility.

Farmers are particularly concerned by having an income stream. Their desire to solve cash challenges featured strongly in focus group discussions. "*We need cash from live larvae sales. People are gifted differently. Some of us are good at producing larvae while others are good in poultry. So, I would rather produce the larvae and sell and someone else may benefit through poultry feed and poultry sales" (FGD male respondent)*

"We have critical cash shortages. Its better I produce a kg and sell. My grandchild might get an exercise book." (FGD female respondent)

"*The coming of BSFL was a potential relief in that one can get cash for milling" (FGD female respondent)*

One elderly woman was adamant "*just get us buyers for our live larvae and we are done*"

Farmers also adopt a technology if it promises to address their immediate challenges. The farmers in Buhera South also feel that economic benefits of using BSFL feed to produce poultry can be accrued through cost effective poultry production means see Fig4.2.6 below which gives us the analysis based on farmer observations of the benefits of BSFL to poultry farmers.

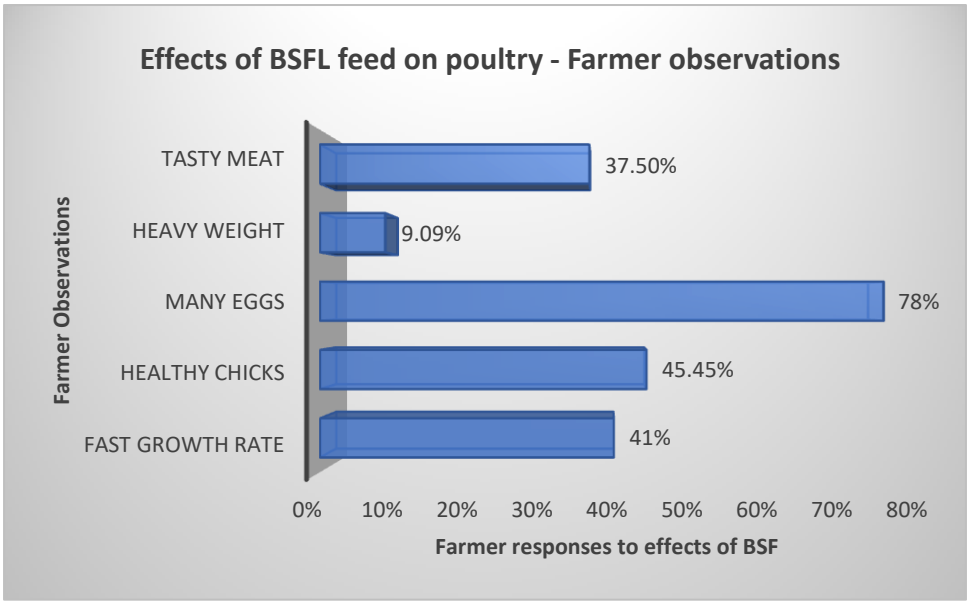


Fig 4.9 Farmer observation on impact of using BSFL as feed

Impact on improved egg production has shown a remarkable score of 78% of farmers reporting increased egg production. This highlights BSFL feed's effectiveness in boosting poultry reproductive health, making it highly appealing for farmers focusing on egg production (78%). Fast growth rate claimed 41% of farmers who observed a trend in their poultry, indicating that BSFL feed provides essential nutrients for growth and development. Additionally, 45.45% of farmers noticed healthier chicks, showing that BSFL feed likely improves overall health and immunity in poultry. In terms of meat quality factors; 37.50% of farmers reported tastier meat from poultry fed with BSFL, suggesting it enhances meat quality—potentially making it more marketable. However, only 9.09% of farmers observed heavier poultry weight. This could mean BSFL feed primarily supports lean growth rather than bulk weight gain. The data demonstrates that BSFL feed is particularly advantageous for egg production, chick health, and m eat quality.

Egg production is particularly clear because eggs are quantifiable and farmers can easily compare with non BSFL fed poultry. What is particularly clear is that nutrition improves egg productivity. Attribution to BSFL feed only may be subject to research. There is need to compare conventional feed to BSFL feed for differences or similarities. However, farmers are upbeat about BSFL feed. One farmer had this to say "*My road runner hen goes to as many as 21 eggs, up from 15. The Boshvelds, lay eggs daily and the eggs are big and shells are strong."*

While the taste of meat featured quite prominently, a lot of controls are needed to confidently consider it. The significance of taste in economic feasibility lies in its ability to create a reputation that attract customers. However, meat taste depends on number of raw materials in the feed.

The economic feasibility however depends on production efficiency that can be achieved through scale of critical mass creation. Cooperative production models can lead to shared costs, scale and ultimately profitability. Government should offer financial support for mechanisation and, incentivise adoption through subsidies. Otherwise BSFL farming is an economically viable enterprise especially when integrated with the current farming systems to maximise by-products utilisation e.g. frass for soil conditioning, larvae for feed and overall recycling of waste to cut on feed waste. BSFL offers a sustainable economically strategic alternative to conventional feed.

4.2.3 Social Feasibility

Adoption of BSFL technology, like any new technology, depends on social acceptability, cultural perceptions and community dynamics. Attitudes, prejudices, biases, and social stigma determine acceptance. Attitudes are social constructs that develop over time through community influence and may be hinged on ignorance, misinformation, and myths in the absence of awareness and knowledge. As such, the remedy is increasing awareness, knowledge, education, training and capacity building. These should override misinformation, taboos and social stigma by conferring benefits of the technology. The benefits may be in the form of inputs supply, financial support, market networks, policy support and training, among others.

Community perceptions of benefits of BSFL technology and the community's willingness to adopt it are illustrated in the two pie charts below fig. 4.2.7

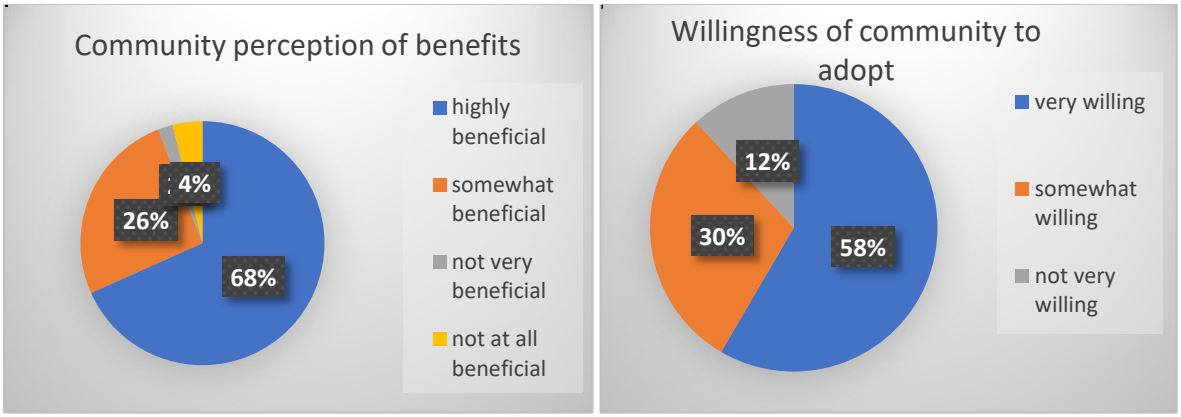


Fig.4.10 Community perceived benefits of BSFL Fig 4.11 Community willingness to adopt

A strong majority (68%) find BSF technology highly beneficial, reflecting widespread recognition of its advantages. This indicates that many people appreciate its value, possibly due to its cost-effectiveness, sustainability, or contribution to poultry productivity as confirmed in Fig4.2.6. 26% of the community perceive BSF technology as somewhat beneficial, suggesting they see partial benefits but may have reservations or need more evidence to be fully convinced. A majority (58%) are very willing to adopt BSF technology. This indicates high enthusiasm and recognition of the potential benefits, such as cost savings, improved poultry productivity, or sustainability. This group is likely to lead adoption and could become early advocates within the community.

Moderate willingness; 30% are somewhat willing, indicating an openness to try BSF technology but possibly with some reservations. Their concerns might include cost, accessibility, or confidence in its effectiveness. This group could be persuaded with more evidence of tangible benefits or practical demonstrations.

Low willingness: only 12% of the community is not very willing to adopt BSF technology. This minority may face specific barriers, such as limited resources, lack of interest, or scepticism about its practicality. Engaging with this group to understand their concerns could help improve overall willingness.

While farmers are willing to adopt BSFL, the challenges associated with marketing larvae, harvesting and shredding were raised in focus group discussions. *"If we get a market, you will be shocked by the quantity of larvae that we will bring" FGD female respondent).*

The social and cultural acceptance of BSF by the community is illustrated by the pie charts below fig.4.2.9

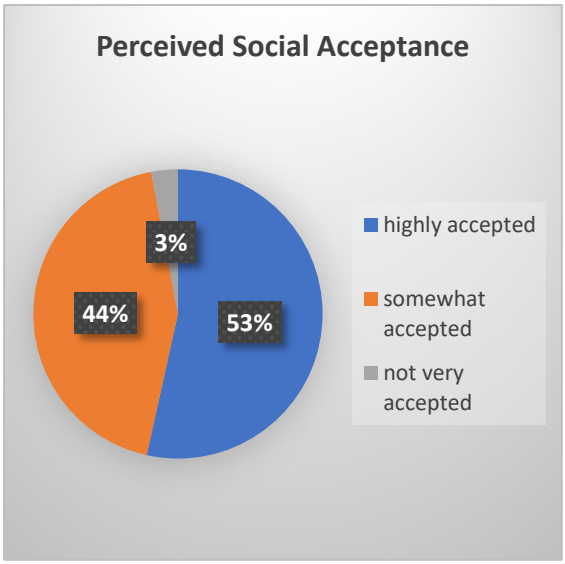


Fig 4.12 Perceived social acceptance

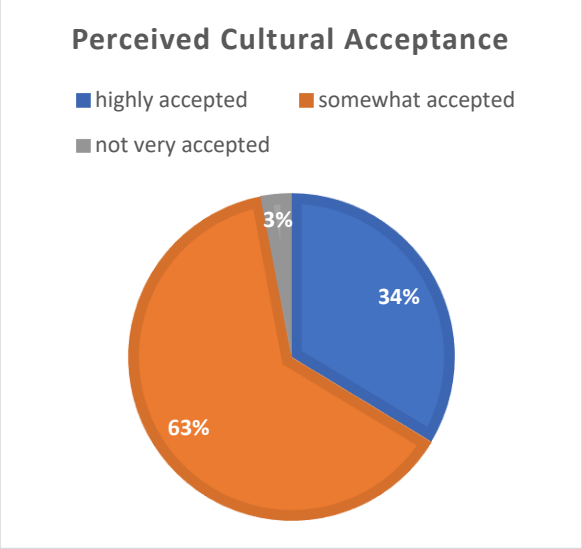


Fig 4.13 Perceived cultural acceptance

The farmers largely socially accept BSFL as 54 farmers (53%) reported that BSF technology is highly accepted. This demonstrates a strong level of social approval and alignment with community values, possibly driven by its environmental benefits, cost-effectiveness, or proven results in poultry farming. Moderate Acceptance; 44 farmers out of 101 (44%) find BSF technology somewhat accepted, indicating that while there's general acceptance, some farmers might still have reservations or be in the early stages of adoption. This group may require further engagement to fully embrace BSF technology. Of the 101 farmers reached out to, 34 farmers (34%) report that BSF technology is highly accepted culturally. This indicates that it aligns well with existing practices and values for a portion of the community. These farmers likely see BSF technology as compatible with their traditions and farming methods. Some 64 farmers (63%) find BSF technology to be somewhat accepted, suggesting that while cultural barriers may not be significant, there could still be mild hesitation or a lack of familiarity with the concept. This group may need encouragement or further integration into farming norms to feel completely comfortable.

People have gradually accepted BSFL due to awareness. There is no cultural barrier influencing its adoption. Initially, there were speculations against the larvae. Some people used to say *"You are being made to produce larvae to feed goblins. We have never seen these larvae before.*" (FGD male respondent). This position was reached because at inception, the project emphasised the pig farmers as the only ones who had the viable substrate. Buhera South is home to people who belong to the Apostolic Faith of the Marange sect. To these people, pigs are taboo. Indeed, this was a challenge because pig owners are few (only 9

people with a total of 47 pigs in the sample). It was only after it was realised that BSFL is omnivorous and anything biodegradable would constitute substrate.

Another had this to say "*We failed to provide a better Shona name and called them Honye or Gonye. This made the larvae appear like the housefly larvae which we loathe" (KI LEAD*)

Another challenge raised was that BSFL fed on human waste. This creates the feeling that people are made to eat human waste indirectly through BSFL based feed.

The technical, economic and social feasibility analysis of BSFL production in Buhera South is very positive. What is needed is to address the fundamentals and scale. In terms of substrate, the bio-digestible wastes are all suitable for BSFL substrates. The only challenge is that these wastes are more abundant in the wet season and diminish in the dry season. There is need to come up with a strategy for the dry season. A good example is to highlight the value of crop waste in substrate production. Crop wastes are abundant and can be dried, shredded and stored for future use, livestock wastes like goat and cattle manure can also be scaled especially for the dry season.

There is need for capital injection in BSFL production to cater for equipment purchases. Such equipment as breeding tanks, mills, mixers, driers and pelletisers need to be installed. This would address the social issues to do with negative attitude towards sharing grinding mills with BSFL producers and at the same time guarantee quality and competitiveness against conventional feeds.

4.3 Key drivers influencing the adoption and utilisation of BSFL production

The perceived economic benefits encouraged adoption. Farmers in Buhera south have indicated that they were mainly driven into BSFL production by the demand for cost effective feed for their poultry. The BSFL project desired to address the feed shortage and escalating feed costs. As part of the Cyclone Idai (2019) recovery program, FAO distributed Bosh-veld chicks and 10 kg feed to farmers. The biggest challenge to sustainability of the chicks was feed. Hence the BSFL project was introduced to fill this gap. BSFL was to offer feed that met the nutritional requirements of the chicks. Bosh-veld were intended to lay more eggs and help communities recover their lost poultry stock. This was the key driver to BSFL technology transfer to the area.

While the initial participants were few, as information on the prospects of benefits of BSFL technology adoption spread, more farmers came on board hoping to get financial benefits especially cash from larvae sales. Most farmers (99%) saw BSFL production as an off -farm business opportunity to earn them revenue through live larvae sales Fig 4.2.5 page 49.

The analysis of pulling factors for chicken farmers adopting Black Soldier Fly (BSF) technology reveals a hierarchy of motivations. Chiefly, income from larvae sales (99%). This is the strongest motivator, with every farmer recognizing the financial benefits of selling live BSF larvae as a key driver. The potential revenue stream offers a direct and significant incentive.

Saving on feed costs is another major factor, compelling 92% of farmers to adopt the technology. BSF larvae serves as a cost-effective alternative to conventional feeds, reducing expenses. BSFL's capacity to enhance poultry health motivates 84% of farmers to adopt the technology. BSF larvae, as a high-protein feed, improve the nutritional profile for chickens, leading to healthier livestock.

The positive impact on egg productivity incentivizes 88% of farmers. A healthier flock typically results in better egg production, making BSF cultivation an attractive proposition. BSFL is produced locally making it an on-site feed source. This inevitably leads to easy access. This opportunity was observed by 65% of farmers. Producing BSF larvae offers a sustainable and readily available feed solution, reducing dependence on external suppliers or the more expensive conventional feed. The data underscores the compelling economic and practical benefits of BSF adoption, with farmers driven by profitability, cost savings, improved health outcomes, and enhanced productivity. Adoption of BSFL production was also pushed high by the farmers learning from others who enjoyed benefits such as increased egg productivity, high chick growth rates and heavy weights among other factors. However, key enablers reported in the literature review are such as policies loans, market development etc are missing.

4.4 Limitations influencing the adoption and utilization of BSFL

The main challenges affecting BSFL production range from technical, economic and social constraints such as-- limited information on BSFL on the part of extension staff and farmers, lack of financial support to set up feed processing equipment, lack of market to buy live larvae, shortage of substrate during the lean season, lack of government support in terms of supportive legislation, production roadmap and capital injection as shown in Fig 4.2.11

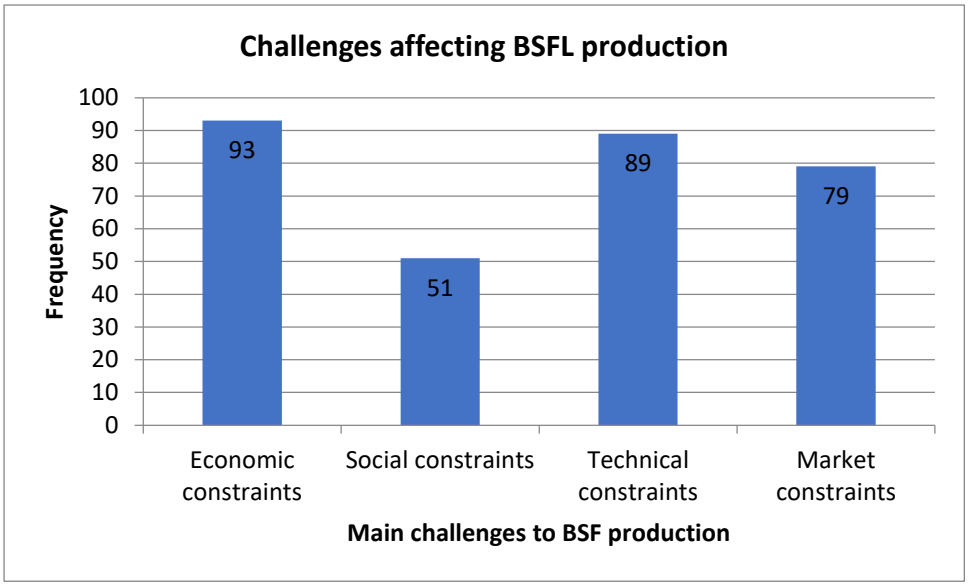


Fig4.14 Main challenges to BSFL production

Economic challenges are seen as the most critical, with an overwhelming majority (92.08%) of stakeholders highlighting them as barriers. These might include high initial investment costs, limited access to financial support or loans, and economic instability affecting production.

The economic issues raised comprise lack of financial support to purchase the much-needed mills, mixers and pelletisers. As such farmers felt that they were being taken to the times of Rhodes since most of them resorted to the pestle and mortar to shred dried BSFL This was a strong issue.

The second most significant challenge is technical in nature, affecting 88.12% of stakeholders. This could encompass issues such as insufficient expertise, inadequate infrastructure for BSF cultivation, or lack of research and development in optimizing production methods. Agritex officers confirmed limitations to feed formulations using BSFL. This is a critical area because it affects the confidence of the potential adopters as they see themselves with a commodity they cannot utilise effectively. In addition, farmers expressed frustration with rancidity. BSFL easily becomes rancid because they do not have dryness testing machines or what aught be done to counter rancidity resulting from issues to do with control of oxidation, moisture, light and heat. Rancidity is one big factor that discourages surplus production. Hence farmers produce just enough to utilise in a week or fortnight. "*My feed becomes rancid within a fortnight. This is my biggest problem with BSFL feed. My poultry rejects the feed or they eat and start to develop wet droppings or running gut*" (Focus

Group female respondent). Harvesting challenges manifest themselves as labour constraints as farmers resort to handpicking larvae in the absence of vibrators.

Market-related challenges are also substantial, impacting 78.22%. This likely includes a limited market for BSF products, lack of consumer awareness, and challenges in creating supply chains or securing buyers. There were high expectations to sell live BSFL to buyers see fig 4.2.7 above. This market did not come. The farmers had spent over 300 US trying to secure seed larvae from CUT and BUSE. They farmers hoped to rack in a lot of revenue using this experience as a benchmark.

While social barriers are the least significant of the four barriers, they still affect a notable 50.5%. These might involve cultural perceptions, community resistance to BSF as a solution, or lack of social acceptance and understanding of its benefits. In their context social issues come with regard to shredding of BSFL using grinding mills that are used for milling grain for mealie- meal. The owners of the mills expressed reservations on the use of their mills which grind food for people. *A mill that processes peoples' food cannot be used to grind your larvae. Customers shun my mill on that account"* a local miller at Murove was quoted.

The technical production process in the Buhera South District has some limiting factors that hinder the progress as farmers adopt the technology. The bar graph below indicates major limiting factors that were reported by farmers.

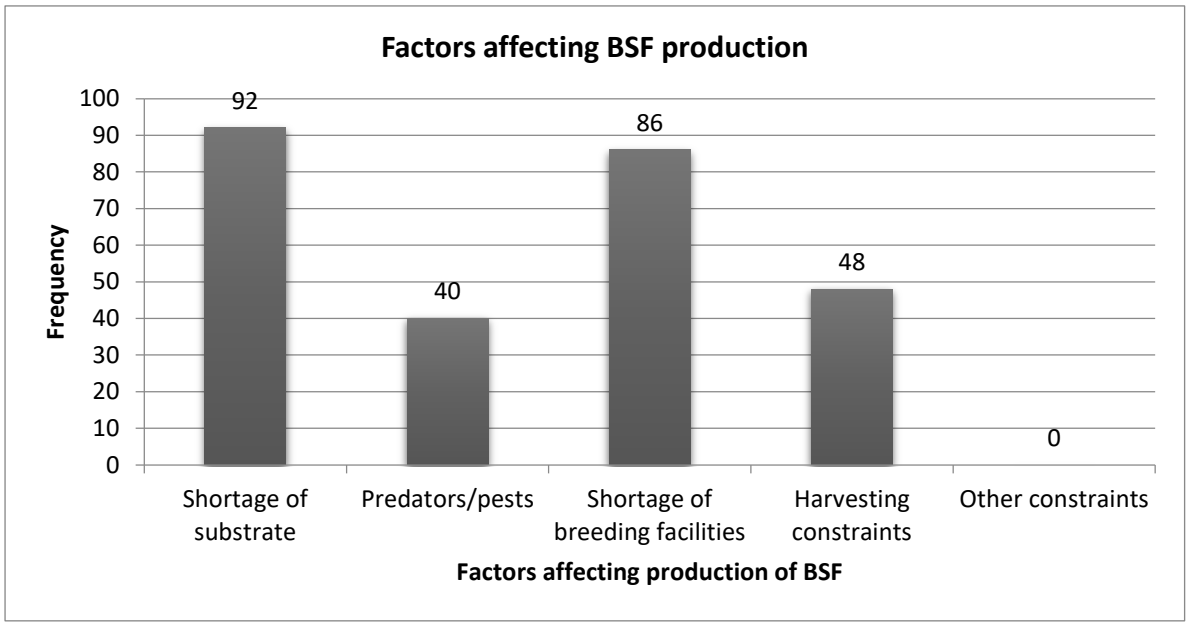


Fig 4.15 Context specific factors affecting production

Shortage of substrate scored (91.09%), Substrate availability is the most critical challenge, affecting 91.09% of farmers. Substrates are essential for BSF larvae to feed and grow, and a

lack of access severely hampers production potential especially during the lean season. Farmers highlighted that substrates become scarce during the dry or lean season. People adopt reduced number of meals and quantities as a coping strategy. This also goes on to affect kitchen waste quantities. In addition, most succulent food wastes like fruit waste, melon waste and such crop waste derived from sweet reeds, fresh maize cobs get finished as the dry season progresses.

Shortage of breeding facilities account for (85.15%) of participants. Breeding facilities are another major bottleneck, impacting 85.15% of farmers. Limited infrastructure for BSF breeding such as controlled environments for eggs, larvae, and adult flies restricts production scalability.

Constraints in harvesting BSF larvae affect 47.52% of farmers. This may include manual methods that are labour-intensive or lack of proper equipment to efficiently collect larvae.

Predators and pests also pose challenges for less than half of the farmers (39.6%). Particularly red ants can be a menace especially towards the end of the wet season. These ants have a high affinity for moist conditions. BSFL breeding tanks often remain as isolated moist points during the dry season. The red ants can wipe out the entire BSFL in the breeding tank overnight and can diminish the BSFL yield thus adversely affecting sustainability of BSFL farming.

These findings suggest that to enhance BSF production among rural poultry farmers, targeted interventions such as improving substrate shelf life and supply chains, providing infrastructure support, training for efficient harvesting methods, and pest control measures are needed. Substrate availability can be achieved by increasing shelf life of locally produced substrates through familiar processing techniques like blanching, drying, packaging g utilising bran from grain milling.

Feed formulation

Feed formulation challenges have affected the utilisation of BSF feed in various ways as reported by farmers who may lack technical expertise as well as reduced access to machinery for effectively processing the feed for poultry. Below are some major findings that farmers pointed out as stumbling blocks to the feed formulation process while using BSFL based supplements.

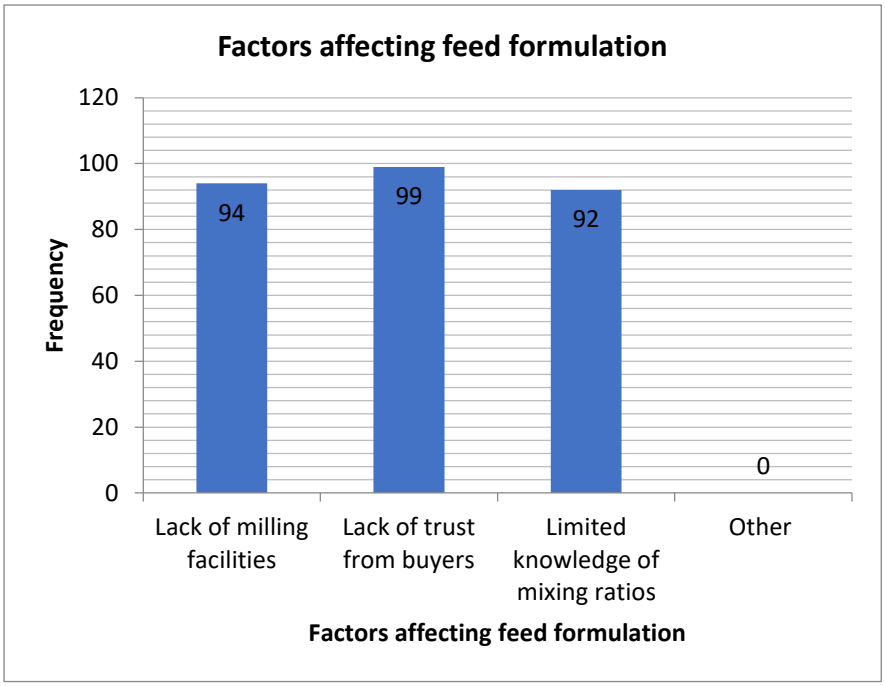


Fig 4.16 Factors affecting feed formulations

An overwhelming 93.07% of poultry farmers face challenges due to inadequate milling infrastructure. Milling facilities are crucial for processing BSF larvae into a usable feed form, and their absence hinders effective formulation. Limited knowledge of mixing ratios (91.09%) for the BSF-these farmers struggle with insufficient knowledge regarding the correct mixing ratios of BSF feeds. This knowledge gap can result in improper formulations that may impact the nutritional balance and effectiveness of the feed and even affect buyers' trust of feed quality as confirmed by (98.02%) of respondents. A lack of trust from buyers affects 98.02% of farmers being the highest factor with farmer constraint. This may stem from concerns about the quality and consistency of BSF-based feeds, as well as potential resistance to adopting non-traditional feed sources.

These findings indicate that improving milling infrastructure, offering training on mixing ratios, and building trust through education and quality assurance could significantly enhance the adoption and efficacy of BSF feed formulation for poultry. Currently farmers are using pestle and mortar to shred BSFL.

4.5 The context specific strategies that can be adopted to address identified limitations

Farmers suggested potential strategies that can be used to counter the challenges and limitations being faced in the BSFL value chain in the context of Buhera. Below is the table illustrating the weighted scores that each suggestion has as a solution to the limitations.

Table 4.2 possible measures that can be taken to enable scaling of BSFL production

Suggestions on scaling up and commercialisation of BSF production	**Frequency**	**Percentage**
Need for machinery	87	86.14%
Need for knowledge/training	96	95.05%
Need for critical mass	18	17.82%
Need for aggregators/market	69	68.32%
Need for capital	73	72.28%
Need for producer groups	9	8.91%
Need for irrigation	23	22.77%
Need for durable building materials	1	0.99%
Need for mixed farming	1	0.99%

Primary Needs (High Priority):

Capacity building-Knowledge/Training (95.05%%): This is the most unanimous need. Providing education, technical assistance, and capacity-building programs is critical. There is need to train Agritex staff on BSFL technology. These are the main gatekeepers for BSFL production. Areas of special interest include- breeding facilities, management of larvae from egg to prepupa, harvesting, drying of the larvae, feed formulations, processing and packaging.

Machinery (86.14%): Mechanization is a significant concern, indicating the need for scalable processing equipment for harvesting and quality as well as specifications concerns. The machines would address issues to do with rancidity, harvesting and shredding constraints. Substrates-there is a lot of waste that can be used as substrate during the wet season. However, these dwindle in the dry season. There is need for machinery to grade, dry and shred this waste and keep them safe for use in the drier months.

Market development -Aggregators/Market Access (68.32%): There's a strong demand for systems or agents to link producers to buyers, ensuring stable and profitable markets. Farmers are used to selling their produce at various stages of production to cover pressing expenses. The same should apply to BSFL. They need to sell BSFL as live larvae, dried larvae or processed feed. So, there is need for local based feed producers who should readily aggregate live larvae from farmers. This is a critical step towards addressing other challenges like critical mass creation, standards, market confidence and scaling. This also means there would be feed processing centres where machinery is available and farmers would benefit from

either easy access to affordable feed or may take their raw materials for processing into feed at a minimal cost. These are familiar business operational models to farmers.

Capital (72.28%): Access to financial resources is also pivotal to scaling production successfully. Financial support from government to secure production equipment like mills, mixers and pelletisers. This would easily address social issues to do with sharing of grinding mills that are used to produce human food. This aspect of sharing equipment is the main bone of contention prompting social concerns.

Predators and pests can be controlled by improving structures and transitioning from open systems to closed ones. Well-constructed water proofed breeding tanks can be used to counter red ants while nets will prevent birds from coming in.

Substrates shortage featured prominently. This aspect can be addressed by sourcing from outside. While this could constitute an additional cost, a cost benefit analysis can be applied. Cities and towns desperate to dump waste may as well be roped in.

There is need therefore to come up with a BSFL production process framework to enhance community ownership, adoption and scaling. The suggested framework below, Fig 4.2.11 shows a possible flow chart that can be adopted by Buhera south district farmers so that the following may be achieved; i) community structure; ii) Production infrastructure; iii) Quality assurance; iv) ready cash for live larvae sales; v) critical mass creation; vi) improved shelf life of products; vii) ease access to capital as well as skills sharing.

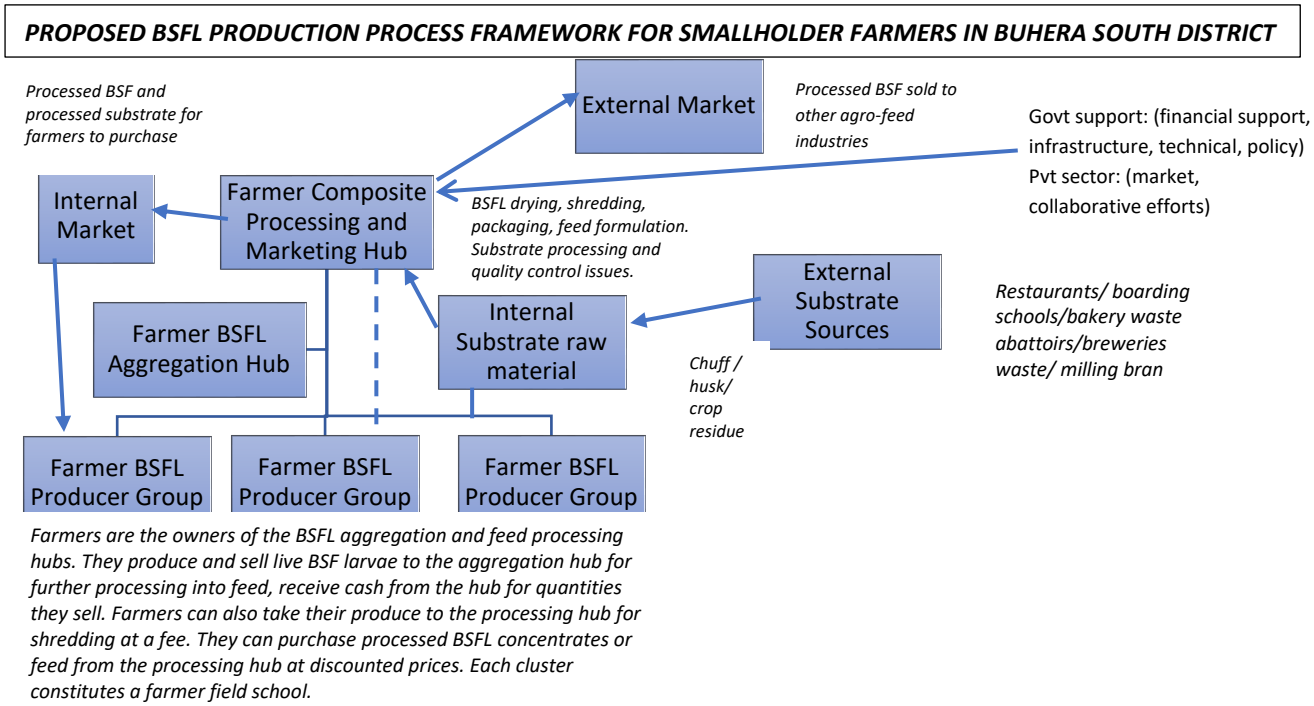


Fig 4.17 BSFL production process framework for smallholder farmers

4.6 Conclusion

This chapter analysed the factors that influence adoption of BSFL technology, the feasibility of adopting BSFL as a protein source for livestock farmers in Buhera South District in Manicaland Province, Zimbabwe, the drivers of BSFL adoption as well as the context specific challenges and possible solutions. Demographics such as age, sex, level of education, occupation income, as well as perceptions, availability of capital and substrates were statistically significant factors to adoption. The findings show that farmers perceive BSFL as a practical reality and a very relevant intervention given that three years on, after project close out, the farmers are still carrying on with production of BSFL using rudimentary implements because the project left the farmers without any machinery to process their feed. This shows that the intervention is addressing their immediate challenges. In addition, other farmers are also adopting. However, to scale, there is need for thorough awareness, targeted trainings, availing of capital to purchase machinery, a market to buy live larvae and aggregate. Centralised processing is necessary to uphold standards and make BSFL feed competitive in the face of competition from conventional feeds. A clear road map supported by government policies is required to promote scaling.

REFERENCES

Ayieko, e. a. (2019). Insects as food and feed: a review of challenges and prospects in Africa. *Journal of Insect science*, 19 (1)1-7.

Chikodzi, D. (2016). Crop Yield sensitivity to climatic variability as tjhe basis for creating climate resilient agriculture. *American Journal of Climate Change*, 5(1)69-76.

Chikodzi, D. (2022,). Unlocking the potential ofcircular Bio-economy: prospects for BSFL production in Zimbabwe. *Zimbabwe Journal of Science and technology*, 17(2) 89-98.

FAO. (2024). *FAO Org Africa News> Zimbabwe.* Harare.

FAO. (2022). *Black Soldier Fly Production mnual: A step by Step Guide/ a Zimbabwean Case.* Harare: Sub regional office of southern Africa.

Mutenje, e. a. (2020). Adoption of climate smart agriculture technologies in Zimbabwe: insects as food and feed. *International journal of Agricultural Sustainability*, 18(4) 377-390.

Mwanza, e. a. (2021). Exploring the potential of Blacksoldier farming in zambia's rural economy. *Zambian Journal of agricultura sciences*, 10(1),55-67.

Nyakeri, E. S. (2019). An Optimal Feeding Strategy of BSFL Biomass Productionand Faecal Sludge Reduction. *Reserachgate- Journal of insectsas food and feeds*, 5 (3) 1-14.

CHAPTER 5: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.0 Introduction

This chapter summarises key findings of the research and their implications as well as suggest areas that can be pursued by other researchers.

5.1 Summary of the Study

This study evaluated the adoption of Black Soldier Fly Larvae (BSFL) as a sustainable protein source for livestock feed among smallholder farmers in Buhera South District, Manicaland Province, Zimbabwe. The mixed-methods research employed quantitative surveys, focus group discussions, and key informant interviews to gather comprehensive data on the drivers and barriers to BSFL adoption

The key research findings on BSFL production and adoption in Buhera South District underscores the potential of BSFL as:

- **a sustainable high protein source** - containing up to 60% protein, making it an excellent supplement for poultry and other livestock, (Siddiqui S. G., 2024)
- **Environmental Sustainability** -a cost-effective solution to organic waste management through recycling (Dzepe, 2021) and re-purposing, and a versatile agent for circular farming systems using protein and frass (Kahunde, 2024).
- **an economic benefit to farmers**,- a source of income and employment to rural farmers (Matuku, 2021), van Huis, 2013) and cost effective source of feed (Beesigamukama, 2021),

Despite these benefits, the study found several constraints limiting adoption:

- **Limited Awareness**: Many farmers lack knowledge about BSFL technology and its benefits.
- **Technical Expertise**: There is a gap in skills related to BSFL production and feed formulation.
- **Financial Barriers**: High initial capital costs for setting up production facilities deter farmers from adopting the technology.
- **Market Access**: Lack of established markets for BSFL products hinders economic viability in the face of competition from traditional protein sources-soya bean and fishmeal.

The research underscores BSFL's potential to enhance livestock productivity, improve food security, and contribute to sustainable agricultural practices in Zimbabwe.

5.2 Conclusions

The study concludes that BSFL has the potential to transform livestock feed production in Zimbabwe, particularly for smallholder farmers who face challenges related to feed costs and environmental sustainability. The low production and adoption rates highlight the need for targeted interventions to address the identified barriers such as lack of production facilities and capital to scale up production.

Key conclusions include:

- **Feasibility and Benefits**: BSFL production is technically, socially and economically feasible, with numerous benefits for livestock health and productivity. The technology aligns well with the needs of smallholder farmers in a resource-constrained environment.
- **Importance of Education**: Knowledge gaps among farmers and extension workers significantly hinder the uptake of BSFL technology. Education and training are critical for fostering confidence and competence in BSFL farming.
- **Need for Supportive Policies**: A conducive policy environment is essential to facilitate investment in BSFL production and ensure the long-term sustainability of this innovative approach to livestock feeding.

5.3 Recommendations

1. **Capacity Building**:
    - **Comprehensive Training Programs**: Develop tailored training initiatives for farmers and extension staff focused on BSFL production techniques, feed formulation, and business management. Practical workshops should be organized to enhance hands-on skills. Start off by engaging farmers on open systems to make them appreciate how BSFL thrives naturally and then come up with closed systems as a way of improving production efficiency. This demystifies the BSFL production concept.

- **Utilize Digital Platforms**: Leverage mobile technology and social media to disseminate information, share success stories, and provide ongoing support to farmers.

2. **Financial Support**:

    - **Establish Financial Assistance Programs**: Create grants or low-interest loans specifically for smallholder farmers to invest in necessary infrastructure, such as breeding tanks, feed processing equipment, and harvesting tools.

    - **Facilitate Access to Microfinance**: Partner with local financial institutions to develop tailored microfinance products that address the unique needs of smallholder farmers involved in BSFL production.

3. **Market Development**:

    - **Create Market Linkages**: Facilitate connections between BSFL producers and potential buyers, including feed companies and agricultural cooperatives. This can help stabilize prices and increase demand for BSFL products.

    - **Support Cooperative Models**: Encourage the formation of cooperatives among farmers to aggregate produce, share resources, and negotiate better prices for their products. Consider the suggested production flow diagram **fig. 4.17 page 51.**

4. **Awareness Campaigns**:

    - **Targeted Marketing Initiatives**: Launch awareness campaigns that highlight the benefits of BSFL through local media, community meetings, and farmer field schools. Emphasize success stories from early adopters to inspire confidence.

    - **Leverage Community Leaders**: Engage local leaders and influential farmers to advocate for BSFL adoption, enhancing credibility and outreach within the community.

5. **Research and Development**:

- **Invest in Local Research Initiatives**: Fund research projects that explore the best substrates for BSFL production, optimal feeding strategies, and the economic impacts of BSFL on local livestock productivity.

- **Collaborate with Universities**: Partner with local universities and agricultural research institutions to develop innovative solutions and disseminate findings to farmers.

6. **Policy Support**:

    - **Advocate for Supportive Legislation**: Work with government agencies to develop policies that promote BSFL production, including regulations that support waste recycling and the use of alternative protein sources in livestock feed.

Create a Regulatory Framework: Develop guidelines for BSFL production to ensure safety, quality, and market confidence. This can help facilitate wider acceptance of BSFL products among consumers and industry stakeholders.

Overall BSFL production model that is suited to beginners in Manicaland is the Open System. The open system aligns well with the traditional livestock breeding models where farmers raise their livestock through a free-range approach. Regardless of the inefficiency in terms of leakages associated with this method, for beginners, the advantages outweigh the disadvantages as follows:

- Very low capital cost for construction of breeding structures. Farmers take advantage of recycling farm waste as BSFL substrate, old fertiliser bags and leaking drums as breeding facilities.
- It is a hands-on approach that makes farmer learn more and generate interest through discovery in a natural breeding set up unlike highly technical set ups typical of closed systems.
- It promotes farmer to farmer extension and demystifies highly technical requirements in BSFL production associated with the Closed system. The requirements tend to scare away potential adopters because of labour intensiveness.

- It has greater reach among low income participants since any farmer can adopt it even without injecting a cent into the enterprise. All that is needed is awareness, knowledge, interest and zeal.

However, as the farmers gain more knowledge on the characteristics and breeding habits of BSFL, the farmers should transition to the Closed System to achieve optimum efficiency, greater output and better returns per dollar invested. Meanwhile the proposed BSFL production framework, (Fig 4.17 page 51) must be developed to come up with a self-contained BSFL production entity that empowers the smallholder farmer and ensures scale and commercialisation of production and ultimately food security.

By implementing these recommendations, stakeholders can significantly enhance the adoption of BSFL technology in Zimbabwe, contributing to sustainable livestock production, improved food security, and environmental resilience. The successful integration of BSFL into the agricultural system has the potential to create a more sustainable and prosperous future for smallholder farmers in the region

New areas of research

- Infrastructural designs for cost effective production of BSFL.
- The effectiveness of feed developed using various locally available carbohydrate sources (sorghum, pearl millet, rapoko and maize) with BSFL in feeding poultry, pigs and goats.
- Market research and the possibility of BSFL displacing conventional protein sources
- Generating BSFL production models that encourage adoption and farmer ownership
- Investigate suitable substrates for optimum BSFL breeding
- Waste preservation for lean season substrate
- Creating suitable conditions for producing BSFL in winter in Zimbabwe.

References

FAO. (2024). *FAO Org Africa News> Zimbabwe.* Harare.

Ayieko, e. a. (2019). Insects as food and feed: A review of challenges and prospects in Africa. *Journal of Insect science*, 19 (1)1-7.

Barragan-Fonseca, K. B. (2023). Small Scale Blackoldier Fly- fish farming:A model with socio-economic benefits. *Animal frontiers*, 13(4)91-101.

Beesigamukama, D. e. (2021). Economic and ecological value of frass fertiliser from Black Soldier Fly Larvae agro-industrial waste processing. *Journal of Insects as food and feed.*, 89301-10.

Braun, V. &. (2006). Using thematic analysis in Psychology. Qualitative research in psychology. 2(2) 77-101.

Burgess, G. W. (2021). *Application of the The technology Acceptance Model.* Pressbooks.

Chikodzi, D. (2016). Crop Yield sensitivity to climatic variability as tjhe basis for creating climate resilient agriculture. *American Journal of Climate Change*, 5(1)69-76.

Chikodzi, D. (2022,). Unlocking the potential ofcircular Bio-economy: Prospects for BSFL production in Zimbabwe. *Zimbabwe Journal of Science and Technology*, 17(2) 89-98.

Chineme, A. &. (2023). Open and closed Blacksoldier Fly systems trade offs analysis. *Sustainability*, 15(24)16677.

Choudhury, A. e. (2018). Technical feasibility of Hermetia illucerns in Integrated waste management renovated with sewagewater: an Over view. *Open Access Library Journal*, vol5(4) 1-27.

Cochran, W. G. (1977). *Sampling techniques.* John Wiley & Sons.

Davies, F. (2024). *The Technology Acceptance Model30 years of TAM.*

Denzin, N. K. (1978). *The Research Act: Theoretical Introduction to Sociological Methods.* McGrow Hill.

Diener, S. Z.-G. (2011). BSF Larva for Organic Waste treatment_ prospects and Constraints-conference paper. *Researchgate*.

Drury, A. (2025). Feasibility study,what it is, benefits and examples. *Investopeddia*.

Dzepe, D. N. (2021). Feeding strategies for small-sczle rearing of BSFL (Hermetia illucens)as organicwaste recycler. *SN AppliedSciences*, 3:252.

Facebook. (2020). Buhera Zimbabwe map.

FAO. (2022). *Black Soldier Fly Production mnual: A step by Step Guide/ a Zimbabwean Case.* Harare: Sub regional office of southern Africa.

Ferrarezi, R. L. (2016). Alternative sources of food for Aquaponicsin the USVirgin islands: A case study with Blacksoldier Fly. *Rresearchgate*.

Fowler, F. J. (1977). *Survey research methods.* Sage Publications.

Giacomo, K. (2023). BSF larvae protei production in Australia. *Animal Frontiers*, Vol13(8) 8-15.

Gravetter, F. J. (2014). *Statistics for the behavioural Sciences .* Cengag Learning.

Greene, W. H. (2003). *Econometric analysis 5th Edition .* New Jersey: Prenciss hall, upper sandle river.

Hopkins, N. L. (2021). Influence of food waste rearing subtrates n BSF larvae composition: A systematic Review. *Insects*, 12(7),608.

Kahunde, B. W. (2024). BSFL a Sustainable Solution for Protein, Waste Management and Crcular Bio-economy. *Researchgate*, 2 (3) 822-834.

Kelly, V. (2006). Factors affecting demand for fertiliser in Sub Saharan Africa. *Agricultur and rural development Discussion paper, World bank*.

Kutama, D. a. (2023). Opportunities and challenges of BSFL farming in rural Zimbabwe. *Journal of Environmental Science and Agriculture*, 11(3)211-222.

Lalander, R. e. (2019). Black Soldier Fly Larvae for organic waste treatment and production and of protein-rich biomass. *Journal of Insect Science*, 19(4) 1-12.

Liu, e. a. (2018). Pathogen reduction in organic waste by Black Soldier Fly Larvae. *journal of Environmental Science and Health*, part B53, 247-254.

Makkar, H. P. (2013). State- of- the- art on use of insects as animal feed. *Animal Feed Science and Technology*, 197, 1-33.

Mapanje, O. S. (2021). The impact of Climate Informationn services on smallholder farmers' livilihood outcomes. *Researchgate*.

Matuku, K. e. (2021). Determinants of profitability of BSFL farming enterprise in Kenya. *Journal of insects as food and feed*, 8(6)1-8.

Mbunge, E. S. (2024). Leveraging mobile phones to improve malaria heatlhcare service delivery inBuhear communities:Implications for practice and policy. *Behaviour and information Technology*.

Mertenat, A. D. (2019). Environmental Impacts of insect farming. *Journal of Cleaner Production*, 225 p1154-1164.

Mujuru, e. a. (2023). Empowering youths through insect farming- Lessons from Mashonaland East. *Zimbabwe Dgriculture Journal*, 105(1), 33-40.

Mukonoweshuro, T. C. (2023). *Green Protein: Farming BSFlarvaein Zimbabwe.* Harare.

Munthali, M. a. (2023). The Economic Cost Benefit Analysis of BSFL as an alternative animaland fish feed ingredient. *MwaPATA Institute*, 23/01.

Musau, s. (2024). Cost of production and financial perfomance of selected poultry rearing farmers in Kuambu County, Kenya. *International Journal of general aspects in Finnce Banking and Accounting*, 6(2)14-30.

Mutenje, e. a. (2020). Adoption of climate smart agriculture technologies in Zimbabwe: insects as food and feed. *International journal of Agricultural Sustainability*, 18(4) 377-390.

Mutungi, C. e. (2022). Insect farming in East Africa: Environmental constraints and adaptive practices. *Journal of Insect Agriculture*, 7(1)12-24.

Mwaniki, S. e. (2020). Scaling up BSFL farming in Africa: Lessons from Kenya. *Insects as food and feed*, 5(2)101-115.

Mwanza, e. a. (2021). Exploring the potential of Black Soldier Fly farming in Zambia's rural economy. *Zambian Journal of Agricultura Sciences*, 10(1),55-67.

Newsday . (2024, 8 July). *Livestock Poverty Death grips Zimbabwe.* Harare: Newsday Co.ZW.

Nguyen, e. a. (2015). Ability of a Black soldier fly to recycle food waste. *Environmental Entomology*, 44(3) 406-410.

Nyakeri, E. S. (2019). An Optimal Feeding Strategy of BSFL Biomass Productionand Faecal Sludge Reduction. *Reserachgate- Journal of insectsas food and feeds*, 5 (3) 1-14.

Nyamuhirwa. (2025). Perspectives on adoption of Black Soldier Fly Larvae for animal feed among livestock farmers in Sub- Saharan Africa. *Frontiers in Environmental Economis*.

Prihartini, E. e. (2022). Financial analysis of Business feasibility and maggot BSFcultivation development strategy. *Journal of Economics, Financeand management studies*, Vo5(1)15-25.

R. J. (2024). Assessing the ecconomic viability and factors affecting farmer adoptionof BSFL as broiler feed in Bangladesh: A comparative analysis. *Discover Agriculture*.

Ramachandra, S. B. (2024). Effective utilisation of BSFL(Hermetia Illucens) as a poultry feed. *International Research Conference of Sri Lanka Technology campus,.* Colombo.

Raman, S. e. (2022). Opportunities, challenges and solutions for Blacksoldier Fly larvae based animal feed production. *Journal of Cleaner production*, 373(40)133802.

Rehman, K. H. (2022). BSFHermetia illucens as a potential innovative and environmentally friendly tool for waste management: A review. *Wste Mangement*, 41(1) 81-97.

Roy, J. (2024). Assessing the economic viability and factors affecting farmer adoptionof BSFL as broiler feed in Bangladesh: A comparative Analysis. *Discover Agriculture*.

SADC. (2022). Food, agriculture and natural resources- Livestock Production.

Sanchez -Muros, M. e. (2016). *Insects as Sustainable Feed Ingredients.* Almeira: Alsevier Inc.

Siddiqi, S. R. (2022). The Blacksoldier FlyLarvae (BSFL)and their affinity for organic waste. *Waste Management*, 1040(3) 1-13.

Siddiqui, H. .. (2024). Future opportunities for products derived from black. *Environment,Develoment and Sustainability*.

Siddiqui, S. G. (2024). Future opportunities for products derived fromBSF treatmentsas animal feedand fertiliser- A Sysstematic Review. *Environment, Development and sustainability*.

Smertana, e. a. (2019). Sustainability of insect-based food and feed production. *Journal of Cleaner Production*, 225p1154-1164.

Smetana, t. a. (2019). Sustainability of insect-based food and feed production. *Journal of Cleaner Production*, 225 1154-1164.

Tanga, e. a. (2021). Enhancing food security through insect farming: The case of BSFL in Uganda. *FAO REPORT*.

Tomberlin, e. a. (2009). Development of the Black Soldier Fly in relation to temperature. *Environmental Entomology*, 38(3)530-539.

Trochim, W. M. (2006). *The Research Methods Knowledge Base.* Atomic Dog Publishing.

Tufte, E. R. (2001). *The Visual Display of Quantitative Information .* Graphics Press.

van Huis, e. a. (2013). *Edible insects: Future prospects for food and feed.*

Veldkamp, T. B. (2015). Insects:Protein -rich feed ingredientin pig and poultry diets. *Animal Frontiers*, 5 (2)45-50.

Veldkamp, T. e. (2017). Insects as feed: A review of the economic and environmental implications. *Journal of Insects as Food and Feed*, 3(2) 115-126.

Vilela, J. A. (2021). Blacksoldier inclusion in broiler diets. *Animal Nutrition*, 7(9).

Worthington, A. (2021). *Persuasion Theory in action: an Open Reource.* Pressbooks.

Zimunya, L. T. (2021). Profitability of broilers contractgrowers in Chegutu District Zimbabwe. *Scholars Journal of SAgriculture and veteriary Science*, 8(9)87-94.

APPENDICES

Appendix 1 -Household Questionnaire for BSF adoption (to be completed by consent)

My name is George Baloyi. I am a student for a Master's degree in Food Security with Bindura University of Science Education (BUSE). I am conducting research on the drivers and limitations of Black Soldier Fly Larvae (BSFL) production and utilization as poultry stock feed protein source in Buhera South District. Please assist me by answering the questions, The research is purely for academic purposes. Your participation will be confidential and greatly appreciated.

Section 1: Demographics of respondents

First Name only…….

Village----------

1 Age ……. years

2 Sex M F M

3 Educational level 1=None 2=primary level 3=Secondary level 5=Diploma 5 University 99=Other (specify)……...

4 Main Occupation 1=Full time farmer 2=Part time farmer...

5 Main Source of Livelihood

1= Farming only_____

2= Farming and non-farm business_____

3= Farming and formal employment_____

4=Non-farm business only____

5=Formal employment only____

6= Remittances_____

7=Other (please specify) _____

6 Primary Reason for Farming

1=Food security_____

2=Income generation_____

7=Employment Household size…….

8 Access to extension 1=yes 2=no

9 Frequent of extension contact/month……. times

10 Poultry ownership specify number

Category	Number owned
Exotic (Broilers, layer	
indigenous chickens	
Turkeys	
Ducks	
Guinea Fowl	

Other livestock Ownership

Cattle	
Goats	
Sheep	
Donkeys	
Pigs	

Section 2 Black Soldier Fly (BSF) Awareness, Perception & adoption

12 Have you ever heard of BSFL as a feed supplement 1=yes 0=No ...1

13. If yes, where did you hear about BSF? (Check all that apply)

1= Social media_____

2= Friends/family_____

3=Online articles_____

4= Workshops/training..._____

5= Other (please specify) _____

14. What do you know about the benefits of using BSF as a feed supplement for poultry? (Check all that apply)

1= High protein content___

2= Environmentally friendly____

3= Cost-effective____

4= Improves poultry health...4_____

5= Bio fertilizer frass____

6=Human food_____

99= Other (please specify) _____

15. Are you interested in using BSF as a feed supplement for your poultry?

1=Yes____

0=No..1____

3=Undecided_____

16 Have you ever produced BSF used BSFL for your poultry? Y /N... ____

17 Have you ever used BSF for your poultry Y/N.____

18 If yes for how long ----------months

19 How much was fed weekly……Kg

20 Number of poultry fed per week……

21 What observations did you make ----------

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22 In what form do you feed BSF 1=dried larvae 2= Ground larvae mixed with feed...3=both

23What are the proportions of feed give to poultry

	Proportion fed to poultry
Home-made feed	
Bought feed	
BSF feed	
Other specify	
Total	100%

24 Do you generate excess BSFL? 1== yes 0=No..0

25 If yes how much is excess----------Kg
26 Excess BSF sold at how much/Kg…….
27 Who are customers of excess BSF? 1= neighbors 99=Other (specify)
SECTION 3: Perception of Community you live in
28 Level of Awareness
1= Highly aware. _____
2=Somewhat aware. _____
3=Not very aware_____
4=Not at all aware____
28 Perceived Benefits
1= Very beneficial. ___

2= Somewhat beneficial. ____
3= Not very beneficial_____
4= Not at all beneficial_____
29. Willingness to Adopt
1=Very willing____
2= Somewhat willing. _____
3= Not very willing. _____
4= Not at all willing_____
30 Perceived Social Acceptance
1=Highly accepted: ____.
2=Somewhat accepted: ____
3=Not very accepted: ____
4=Not at all accepted: ____
31 Perceived Cultural Acceptance
1= Highly accepted_____
2=Somewhat accepted. ____
3=Not very accepted____
4=Not at all accepted____

SECTION 4: Waste Streams Used to Feed BSF

32Food waste

1=kitchen waste. ____

2= Fruit and vegetable waste. _____

3= Bakery waste_____

4=Restaurant waste_____

4. Other (please specify). brewery waste____

33. Agricultural waste

1= Crop residues. _____

2= Manure..._____

3= Poultry litter. ____

4=Other (please specify)

34. Animal waste

1=Pig manure____

2=Cattle manure. ____

3=Sheep/goat manure..._____

4=Other (please specify)

Section 5 Drivers of BSFL Production

35 What re the main challenges of producing and utilizing BSFL in Buhera South District?

Economic constraints. capital to start BSF project

Social constraints

Technical constraints... technical

36 What motivated you to produce BSF (tick all that apply)

A, income from larvae sales. ☐

B to save on feed costs. ☐

C improved poultry health ☐

D better egg productivity ☐

E any other specify ------high yields of larvae----------

37 What factors are affecting production of BSFL *(tick all that apply*)

Shortage of substrates ... ☐

Predators/ pests ☐

Shortage of breeding facilities... ☐

Harvesting constraints ☐

other specify----------

38 What factors affect Feed Formulations

Lack of milling facilities ... ☐

Lack of trust from buyers ... ☐

Limited knowledge of mixing ratios ☐

Any other specify----------

39 How much labour is needed to look after BSF…… for……hrs. daily
40 How much BSF is produced per week?...
41 How big is your BSF housing on average (……length*……width*……...height
42 How many Kg of waste is put in the housing/week……. Kg

Section 6 attitudes

Rating scale 0 = not at all, 5= strongly agree	0	1	2	3	4	5
43 How easy is it to produce BSFL						
44 How useful is BSFL as poultry feed						
45 How confident are you in using BSF as poultry feed						
46 Would you recommend use of BSF to other farmers						

47 What do you think should be done to scale up and commercialize BSFL production and utilization as poultry feed------ ----------
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Appendix II Key informant implementing partner- (*to be completed by consent)*

I George Baloyi (Student ID no. B232387B am carrying out academic research on BSFL with BUSE at Masters level. The data collected will be treated with the confidentiality accorded to such information. May you please kindly furnish me with the following information as guided by the questions below.

Please paraphrase your responses. And keep them context specific.

You implemented a Black Soldier Fly Larvae (BSFL) project in Buhera South District in 2021/22

1 What were the objectives of the project?

- To equip farmers with basic BSFL production, processing and feed formulation for poultry.

-To assist small holder farmers, increase poultry production by producing on farm high protein poultry feed.

- To assist smallholder farmers, increase income from the use of low cost BSF formulated feed on their poultry and sale of feed.

2 What was done to sensitize and support communities on BSFL? - focus on software (look and learn visits, trainings etc) and hardware (capital structures machinery etc).

i*)Sensitization of the BSF technology, group formation and registration.*

ii) Training groups on group dynamics, BSF technology i.e. life cycle, conducive environmental conditions, substrate and substrate management, harvesting and processing, feed formulation and feeding. Shared production handouts to individual farmers.

iii) Conducted group exchange learning visits, field learning days.

iv) Linked groups to machinery manufacture and distributors and other value chain players.

3 Organisational structure- how were farmers organised to effectively participate in BSFL production and utilisation

i*) Farmers formed groups of 12 farmers across the ward i.e. ward 27. Each group with a leadership committee and a formal constitution. Groups were then clustered according to location/geographical distances. A cluster leader responsible for training new farmers and registering was selected.*

4 Achievements- what were the outputs of the project? (farmers reached, structures built, birds distributed, feed etc)

- 12 groups were reached with an average of 15 farmers hence 180 individual farmers were reached in total.

-12 production structures were built which includes greenhouse (with hygrometers), production tanks, solar driers.

- each of the 12 lead farmers received 5 Sasso/Sussex pullets and 1 Cock as breeding stock with a feed starter pack of 50kg roadrunner breeder.

5 Outcomes-how did the project impact on the peoples' livelihoods?

i*) Farmers were equipped with basic poultry production practices.*

ii) Increased their income by sale of roadrunner fertilized eggs, chicks locally.

iii) improved nutrition by consumption of eggs and roadrunner chickens.

iv) improved social cohesion through group and cluster coordination.

v) improved market networking with input and output market. Improved negotiation skills on other value chains on their farms.

6 What do you think contributed to adoption/ non adoption of the BSFL innovation

i) Enough training with easy to interpret and simplified training material and handouts facilitated the understanding and adoption.

ii) the use of waste material locally available on -season and off-season

iii) high costs of poultry feeds pushed farmers to adopt the low-cost feed produced on farm to feed their chickens

7 What do you think should be done to make BSFL technology improve the livelihoods of the smallholder farmers in Buhera South?

i) There is need for government departments like Agritex, Mechanization, Veterinary Services to incorporate the technology into their trainings

ii) Commercialize the technology by funding such groups until they process, pelletize, pack and sell feed.

8 What are the potential benefits and impacts of integrating BSFL production and utilization into local food systems, with a focus on enhancing the livelihoods and resilience of smallholder farmers of Buhera South District?

i*) waste management on-farm i.e. instead of letting farm produce like tomatoes, watermelon shells rot and pollute the environment can be used as substrate to feed BSF- nutrient recycling*

ii) the frass from utilized substrate becomes organic fertilizer which can be used to increase production of other crops - nutrient recycling thereby improving nutrition and the risk of health effects of consuming crops produced using inorganic fertilizers.

9 Any challenges and limitations faced (technical, social, cultural, economic etc)

i) *local belief and culture take it as a taboo to rear flies*

ii) there is lack of technical expertise in extension personnel on the BSF technology

10 What are the context specific- strategies that can be adopted to address the identified limitations and enhance the production and utilization of BSFL as a sustainable protein source in poultry feed production in Buhera South District?

i*) There is need to train extension staff on BSF technology.*

ii) Produce detailed training manuals for staff as well as handouts for farmers.

iii*) Demonstration sites showcasing production of BSF production, feed processing as well as poultry feeding be set up just as crop demos are done across the wards.*

iv) Conduct livestock learning days incorporating BSF seasonally.

Appendix IV-Key informant Agritex- (*to be completed by consent*)

I George Baloyi (Student ID no. B232387B am carrying out academic research on BSFL with BUSE at Masters level. The data collected will be treated with the confidentiality accorded to such information. May you please kindly furnish me with the following information as guided by the questions below.

Please paraphrase your responses. And keep them context specific.

You implemented a Black Soldier Fly Larvae (BSFL) project in Buhera South District in 2021/22 .

1 *What were the objectives of the project?*

It was the cyclone Idai Recovery project

-meant for farmers to produce cheap and reliable source of protein for the production of feed for their livestock especially poultry

-to provide farmers with a sustainable money generating project after they fully adopt and produce more for sale to help farmers recover and bounce back to their original status before Cyclone Idai

-to make BSF a substitute foe Soya beans and fish meal in feed formulation

2 What was done to sensitize and support communities on BSFL? - focus on software (look and learn visits, trainings etc) and hardware (capital structures machinery etc).

i*)the leading organization LEAD caried out door to door sensitizations on BSFL*

-they also used SMS to contact farmers

-They formed Whats app group for messaging

They conducted look and learn visits

Farmers supplied with solar dryers, tanks, greenhouses

3 Organisational structure- how were farmers organised to effectively participate in BSFL production and utilisation

-we had a lead officer on the ground

-lead farmers and their groups

- then Agritex staff

4 Achievements- what were the outputs of the project? (farmers reached, structures built, birds distributed, feed etc)

13 groups formed in ward 27

-some farmers benefitted tanks, greenhouses, larvae, solar dryers

- although we later produced BSFL, it was not easy. We really needed training

5 Outcomes-how did the project impact on the peoples' livelihoods?

i*) Farmers were equipped with basic poultry production practices.*

ii) Increased their income by sale of roadrunner fertilized eggs, chicks locally as well as Birchenough and Chimanimani

6 What do you think contributed to adoption/ non adoption of the BSFL innovation

i)those who got equipment adopted.

-those who did not get support did not join.

- some farmers complained of too many trainings now and again during planting season

-production took too long almost 2 years before we got larvae

-Agritex was left out of training at Chinhoyi. So, some slow learner farmers did not understand how to produce and Agritex didn't know either

7 What do you think should be done to make BSFL technology improve the livelihoods of the smallholder farmers in Buhera South?

i) Agritex need to be trained
ii) Loans to buy equipment. Farmers need loans to buy equipment such as mills and pelletisers. Its tough operating without these machines.

ii) Provide market for larvae so that many farmers quickly get cash and participate

What are the potential benefits and impacts of integrating BSFL production and utilization into local food systems, with a focus on enhancing the livelihoods and resilience of smallholder farmers of Buhera South District?

i) *waste management on-farm i.e. instead of letting farm produce like tomatoes, watermelon shells rot and pollute the environment can be used as substrate to feed BSF- nutrient recycling*

ii) *improved standard of living*

iii) *reduced domestic violence as everyone will be producing their own BSFL and more money*

iv) *reduced malnutrition because people eat eggs*

v) *provides employment*

9 Any challenges and limitations faced (technical, social, cultural, economic etc)

i) *local belief and culture take it as a taboo to rear flies. Initially it was not easy but now people understand*

ii) there is lack of technical expertise in extension personnel on the BSF technology

10 What are the context specific- strategies that can be adopted to address the identified limitations and enhance the production and utilization of BSFL as a sustainable protein source in poultry feed production in Buhera South District?

i*) There is need to train extension staff on BSF technology.*

ii) Produce detailed training manuals for staff as well as handouts for farmers.

Get us equipment, buyers and training

Formation of BSFL producing groups

- *more training on production and the business behind BSFL*

iv) Conduct livestock learning days incorporating BSF seasonally.

Complied by:-Agritex

Appendix V Consolidated Focus groups- (*to be completed by consent*)

I George Baloyi (Student ID no. B232387B am carrying out academic research on BSFL with BUSE at Masters level. The data collected will be treated with the confidentiality accorded to

such information. May you please kindly furnish me with the following information as guided by the questions below.

Please paraphrase your responses. And keep them context specific.

You implemented a Black Soldier Fly Larvae (BSFL) project in Buhera South District in 2021/22

1 What were the objectives of the project?

- *To generate money from larvae sales,*

-To get high quality affordable feed for our poultry

-to get more eggs for consumption

-Eggs with big yolk and strong shells for hatching

-To produce more chicken

. -to restock since we were affected by Cyclone Idai

2 What was done to sensitize and support communities on BSFL? - focus on software (look and learn visits, trainings etc) and hardware (capital structures machinery etc).

i*)we went to Chinhoyi University for training on BSF life cycle and how to breed it.*

Ii) we also got training manuals

iii)we were trained by LEAD

iv) We had a field day on 28 March 2022 where we were trained, saw machines like grinding mills, pelletizers etc.

v)FAO bought us seed larvae to start BSF project

vi)we were grouped under lead farmers with each lead farmer having 15 members

-vii had a breeding tank, love cage, dark cage, thermometers as a group at the lead farmer

3 Organisational structure- how were farmers organised to effectively participate in BSFL production and utilisation

i) *Each lead farmer had 15 members in the group*
ii) *Each group to produce as a group and produce feed as a group*
iii) *We had a constitution for our operations*

4 Achievements- what were the outputs of the project? (farmers reached, structures built, birds distributed, feed etc)

-to produce larvae was not easy I tell you.

-we were heart broken by failure to produce larvae for two years

-we managed to produce towards the end of the project and had a field day

- although we later produced BSFL, it was not easy. We really needed training

5 Outcomes-how did the project impact on the peoples' livelihoods?

i*) we were equipped with basic poultry production practices.*

ii) we Increased our income by sale of roadrunner fertilized eggs, chicks locally as well as Birchenough and Chimanimani

iii) children nutrition improved by consumption of eggs and roadrunner chickens.

Home hygiene improved as all waste from sweet reeds went to BSFL.

6 What do you think contributed to adoption/ non adoption of the BSFL innovation

i)Training, yes. some dropped out when things were not working. However, they later joined especially after the field day.

ii) substrate is available especially in the rain season.

iv) *high costs of poultry feeds pushed us to adopt*
v) *we disliked the idea of producing at one point. It's not tenable. Each farmer ended up producing their own feed without going to the lead farmer*
vi) *we were fed up by lack of support, especially when we were promised grinding mills pelletisers which never came to help us produce feed. These machines never came and we are struggling even now. We can't harvest a lot of larvae because it gets bad and there are no buyers*
vii) *I joined hoping to get some money to buy my grandchild exercise books but no one bought my larvae.*
viii) *The idea of working with waste is hard especially harvesting*
ix) *Lack of knowledge made us climb mountains to trap the BSF and that was terrible and many farmers left. To imagine we went to Chinhoyi and Bindura to buy larvae which is locally available at no cost, zvakaoma hazvo.*

7 What do you think should be done to make BSFL technology improve the livelihoods of the smallholder farmers in Buhera South?

i)Avail markets

ii)Loans to buy equipment. We don't have mills and pelletisers. Its tough operating this way

iii) Buy our larvae at least we can start collecting money for the mills

IV everything aside, just buy live larvae and cut on labour. Harvesting is labor, so is drying them and sometimes the larvae get rancid if there is cloud cover. And you also have to make sure you are there to chase chickens from eating it, even birds and ants and lizards

Provide loans so we buy ourselves the machines because begging is painful

What are the potential benefits and impacts of integrating BSFL production and utilization into local food systems, with a focus on enhancing the livelihoods and resilience of smallholder farmers of Buhera South District?

-more eggs, poultry, income if you buy our larvae

-Nice meat

-manure for our gardens

9 Any challenges and limitations faced (technical, social, cultural, economic etc)

i) Initially *local belief and culture take it as a taboo to rear flies. Initially it was not easy but now people understand. They said we were being used to produce feed foe goblins*
ii) *there is lack of technical expertise in extension personnel on the BSF technology*
iii) *Like we said before we are having challenges in knowledge. We suffered guys.*
iv) *We even prayed to just catch a BSFL fly. Now here we are again with no equipment to process our BSFL harvest.*
v) *Rancidity*
vi) *Red ants*
vii) *Lack of finance*

10 What are the context specific- strategies that can be adopted to address the identified limitations and enhance the production and utilization of BSFL as a sustainable protein source in poultry feed production in Buhera South District?

i*) There is need to train extension staff on BSF technology.*

ii) Produce detailed training manuals for staff as well as handouts for farmers.

Get us equipment, buyers and training

- *just do what is happening with the bee project at Chapanduka where farmers own their project, buy honey from whoever and process*
- *iv) Conduct livestock learning days incorporating BSF seasonally*.

-loans

Government loans

Secure substrate for the drier months

Irrigations

Some people should know that they can't be all-rounders. So, men are good at BSFL production. Let's just divide ourselves accordingly

Quotes

"*If this thing was this simple from the offset, we could have earned a lot of money and probably FAO could have given us grinding mills Imagine two years of suffering and no produce, giving false explanations for our ignorance like high temperatures and low temperatures to explain our failure to produce. Lack of knowledge is as good as death."*