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Original article

PARTICIPATORY APPROACHES' OPERATIONALIZATION ON SCALING-UP BLACK SOLDIER FLY LARVAE AS AN ALTERNATIVE PROTEIN SOURCE FOR LIVESTOCK FEED.

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Abstract

Background:

Demand for proteins has increased beyond supply due to the duo competition between humans and animals. Flora and fauna are depleted for proteins used in livestock feeds, this has raised production costs. Current protein insecurity can be solved by the black soldier fly larvae technology that uses organic waste to produce nutritive biomass rich in proteins. However, the innovation has not scaled up among farmers even though participatory approaches have always been employed to scale up different agricultural innovations.

Methodology

A cross-sectional study design with both qualitative and quantitative approaches was used with a sample of 397 respondents selected randomly and purposively among the livestock sector stakeholders.

Results

The animal sector has not effectively employed participatory approaches unlike the crop sector since most livestock farmers get extension and advisory services from radios and fellow farmers and share knowledge on innovations from farmer research groups and On-farm demonstrations which show a higher percentage of participatory approaches utilized by the farmers.

Conclusion

Effort is required to emphasize farmer research groups and On-farm demonstrations with the help of researchers, district veterinary officers, and Sub-County animal husbandry officers to scale up BSFL breeding among livestock farmers as an alternative protein for livestock feed.

Recommendation

The animal sector should streamline training and knowledge sharing of research findings to farmers instead of being only service providers i.e treating sick animals and selling drugs; more emphasis also should be put on training more animal scientists to bridge the gap between animal research scientists, Veterinary Officers, husbandry officers, and farmers to allow sharing of knowledge and diffusion of innovations like BSFL breeding using participatory approaches, the animal sector should put in place demonstration centers at both national and village level to allow farmers appreciate the innovation before taking it up.

Keywords: Black Soldier Fly Larva breeding, Participatory approaches, operationalization.,
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1. Background:

The raising world population has resulted in food scarcity in general and protein deficiency in particular., food production systems of crop, fish and livestock rearing are unable to cope with the demand (Cochrane *et al.*, 2009; Mekonnen and Hoekstra, 2012).

Livestock, poultry and aquaculture farming are needed to solve the food scarcity but these require proteins in feed diets to improve productivity (Mutafela, 2015; FAO, 2016). However, approximately 30% of the fish catch (55.86% wild catch and 44.14% aquaculture) is diverted from human consumption to make fish meal, a source of protein for animal feeds (FAO, 2016).

The duo competition between humans and animals has led to degradation of aquatic life and consequently, the cost of feeds has become expensive and unaffordable to for most farmers (FAO, 2016). This has necessitated the search for alternative feed stocks such as plants and edible insects, which in turn can allow more fish to be used for human consumption (Devic and Maquart, 2015). These insects are considered to have additional benefits such as usage of fewer resources like land and water than crop proteins, and are suitable for feed, unlike plant proteins (Nguyen *et al.,* 2015).

Entomophagy has gained popularity recently (van, 2013), some species have been cited and propagated as novel sources of alternate high-quality proteins and contributors to global food security, to augment current conventional food production methods (Makkar *et al.*, 2014). Black Soilder Fly larvae have gained popularity both for their ability to decompose organic waste and serve as a source of proteins for domestic livestock with 44.4% dry matter (DM) crude protein, 23% DM lipids and several important macro and micro nutrients (Banks *et al.,* 2014; vaHuis *et al.,* 2013). These values compare favourably with fishmeal and soya beans which when combined; supply over 90% of the protein requirements of animal feeds (Yu and Chen, 2009).

Fish and plant proteins from soya bean currently are cthe two are consumed by humans and demand has outstripped supply thus casting doubt on their future availability in sufficient quantities, livestock feeding trials on BSF larval biomass have yielded promising results bringing hope to replace fishmeal and soy in animal feeds (Kröckel *et al.*, 2012; FAO, 2013). Therefore, successful development and adoption of Black Soldier Fly larvae farming technology are relevant and can contribute towards food security (Van Itterbeeck *et al.,* 2014; Devic, 2016).

Consequently, campaigns on the creation of awareness on the potential role of insects as an innovative feed resource to supply the needs of an ever-increasing human population have gained pace (van Huis, 2013; Schönfeldt and Gibson, 2012). However, usage is low due to lack of insect breeding technologies and inadequate knowledge about their potential (Devic and Maquart, 2015; Kelemu *et al.,* 2015).

Abdoulaye *etal.,* 2017, 2012 states that, participatory approaches have over time been employed to scale-up different agricultural innovations especially crop and soil related innovations because they allow primary stakeholders to be active participants not just sources of information, build capacity of local people to analyze, reflect and take action, allow Joint learning of stakeholders at various levels and catalyze commitment to taking corrective actions. Thus, the study aimed at assessing the effect of participatory approaches' operationalization on scaling-up BSFL breeding for livestock feed.

2. Materials and Methods:

2.1. Area of Study :

The study was conducted in Nkozi Sub-County in the Mpigi district situated in the Central Region of Uganda. Nkozi Sub-County is situated along the Kampala-Masaka Highway, approximately 88 kilometers (55 mi), southwest of Kampala. Its location is approximately 8 kilometers (5.0 mi), north of Lake Victoria, at the point

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where River Katonga, exits the lake to begin its 220 kilometers (140 mi) journey west to Lake George. The coordinates of Nkozi town are 00 00 36N, 32 00 00E (Latitude: 0.0100; Longitude: 32.0000). It has 8 parishes and 78 villages, data was collected from different villages in selected parishes of Busese, Nakibanga, and Nabusanke and Kayabwe.

2.2. Study design:

A descriptive and analytical cross-sectional study was used, with both qualitative and quantitative dimensions to assess the effect of participatory approaches operationalization on scaling-up BSFL breeding for livestock feed among farmers.

2.3. Bias:

For the study to be carried out amicably without any bias, in preparation for the collection of data, appropriate permission was acquired to conduct the study from the university as well as livestock farmers. The information gathered from respondents was treated with utmost confidentiality given the sensitivity of some of the information.

2.4. Study population:

The population included livestock farmers, veterinary and animal husbandry officers, researchers, village Chairpersons, farmers group leaders and feed input dealers to provide extensive and reliable information required to accomplish this research.

2.5. Sampling procedure and techniques:

2.5.1. Sample size:

The Taro Yamane formula (1967) was used to provide a simplified formula to calculate sample sizes (Israel, 1992; Polonia, 2013). Assuming a 95% confidence level and maximum degree of variability of the attributes in the population, p = 50% (0.5), the sample size was calculated as below;

Thus, using the formula; **n** =

Where **n** is the sample size, **N** is the population size and **e** is the level of precision (Sampling error – 5%).

Based on UBoS statistics, the sample was derived from 48,200 people who constituted the target population in Nkozi Sub-County. The researcher computed the sample with a precision of 95% or a sampling error of 0.05 for the study.

n = =397

This implies that the study collected data from 397 respondents in Nkozi Sub County.

2.5.2. Sampling procedures:

A purposive sampling technique was used to identify the key informants from among the researchers, veterinary and animal husbandry officers, local leaders, farmers group leaders and feed input dealers. However, a Simple random technique was used to identify the respondent live stock farmers.

2.6. Data collection methods:

A questionnaire was administered face-to-face to a random sample of the sample size to provide the opportunity for further probing. Data was collected on socio-demographic information at the farm level, in the themes including Household details, communication details, the demographic status of the farmers, size of the farms, cost of materials, and product preferences.

The interviews were conducted using guides varied in content depending on the category to which the informant belonged. Key Informants like the veterinary and animal husbandry officer, village chairpersons, input dealers, and researchers were interviewed.

Focus Group Discussions (FGD), were used to concretize the thoughts and feelings of the farmers and to obtain detailed information about the subject in question. Pertinent issues on attitude, insights into needs, expectations, perceptions, and feelings that have a bearing on the adoption of BSFL were expected to be raised and captured for the study and the groups were approximately 7-8 members who belonged to farmers groups. The discussions did not last more than one and a half hours.

2.7. Data analysis:

Data was gathered, cleaned, and processed by sorting the questionnaires (removing half-filled or

Table 1: **Sample categories**

Category	Number
1. Livestock farmers	200
2. Agricultural Researchers	62
3. Veterinary and Livestock Husbandry officers	5
4. Village Chairpersons	30
5. Farmers groups	60
6. Input dealers	40
Total	**397**

wrongly filled questionnaires). Entry of data collected was done manually with the use of MsExcel to form an Excel file. Entry of data collected by the key informants was done manually by generating themes and into MsWord. Qualitative data analysis was done using content analysis and presented as narratives in the next chapter. Quantitative analysis, on the other hand, was done using simple descriptive methods (frequency tables and charts) where conclusions were based on proportions as well as generating inferences (correlation and regression using SPSS 22) and conclusions were based on the p-values. Chi-Square cross tables were generated to establish whether the stated demographic characteristics of the respondents affect the responses provided by the respondents regarding the variables under this study.

3. Presentation and discussion of finding

Participatory approaches to operationalize in scaling-up BSFL breeding for livestock feed.

3.1. Received a training.

The study identified whether farmers had ever received any training on Livestock production and inform us of the methodology used in order to find out which participatory approaches can be taken up to scale-up BSFL breeding (**Figure 1**).

Many farmers had not received any livestock management related training compared to the crop sector since most of our respondents mentioned that they have only received trainings in crop production management and this was attributed to the limited number of animal husbandry officers allocated to Sub-Counties.

"We only have one government animal officer in the whole Sub-County so it is hard for him to reach us all since he mainly focuses on treating sick animals".

3.1.1. Who provided the advisory services?

Distribution of where famers have received advisory information about Livestock production in Nkozi Sub-County is presented in the **Figure 2** below;

Most farmers receive extension services from radios and from fellow farmers because animal officers have not taken initiatives to reach out to the farmers yet farmers can easily have access to a radio talk show and receive various information from experts.

"There is a program on CBS FM every Sunday that discuses improved methods of livestock production that we tune on but also share information to our fellow farmers about what we learnt".

3.1.2. Participatory approaches used.

The study assessed the different participatory approaches that have been used when disseminating livestock technologies to farmers as shown in **Figure 3**.

Farmers' research groups (52%) and on-farm demonstrations (34%) show a higher percentage of participatory approaches utilized by the farmers than farmer field schools because the use of demonstration trials encourages the most participation and subsequent adoption and adaptation of the technologies to suit specific needs. The participatory nature of the process encourages greater knowledge sharing among farmers and gave them more confidence in the technology.

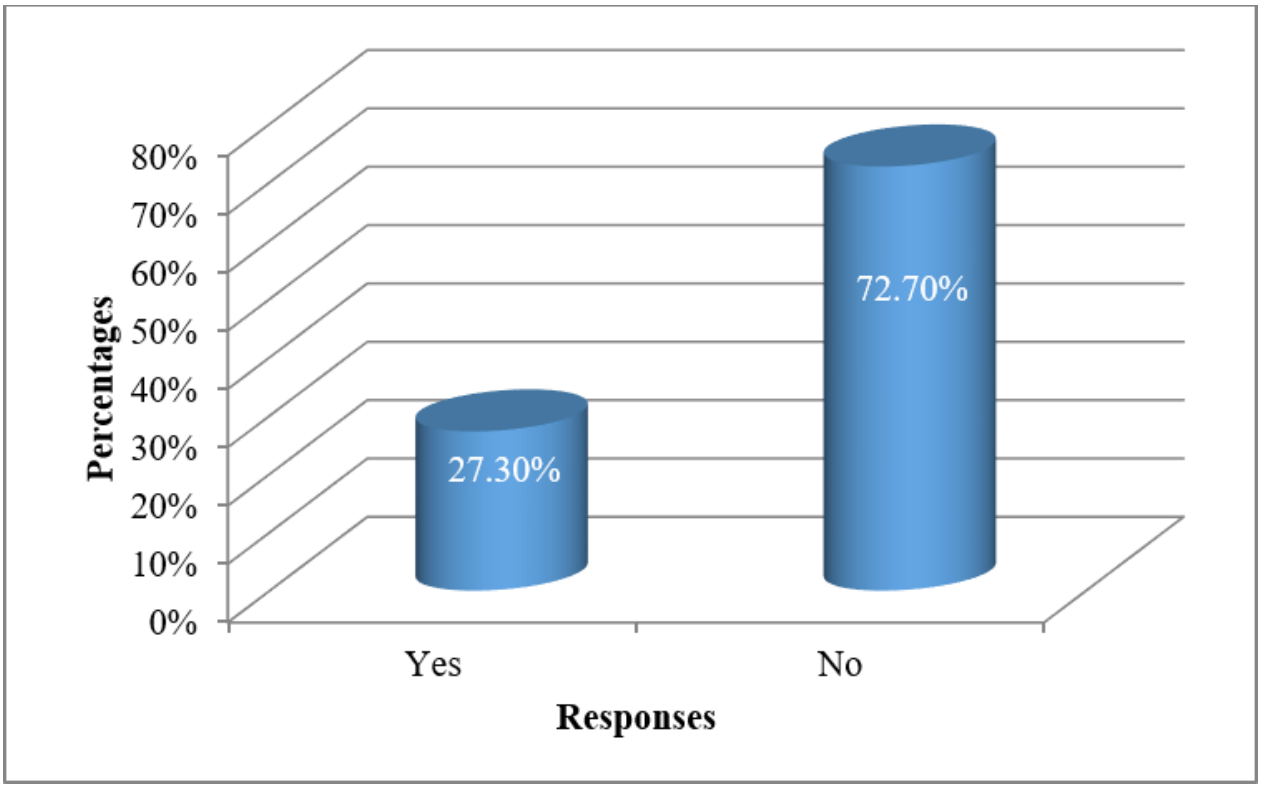

Figure 1: Proportion of farmers who have received training on livestock production: **Source: Primary data**

The model allows open participation of farmers in the research system thereby improving communication and information exchange and hence it empowers farmers both technically and economically (Hauli, 2007). Farmers' research groups act as focal points for on-farm observation, problem identification, prioritization, experimentation, analysis, and monitoring; together with the evaluation of the planned activities. Under this approach, there are attempts to involve farmers in the whole process of technology development and dissemination. All research efforts are also being directed toward solving the major priority problems identified. Working with farmer research groups in both livestock and crop research considerably improved communication and information exchange, empower farmers both technically and economically, and opened doors for on-farm participatory research approaches (Hailu, 2007). If the farmer research groups approach can be managed properly it can provide a significant contribution to the research and development activities of developing countries.

Farmer field schools performed the least (14%) because most farmers are not aware of existing schools to visit but also have no facilitation to reach out to those centres.

"we do not know which places to go for livestock trainings but it is also expensive to go to there even if the opportunity was availed so we would prefer trainings conducted in our locality".

Evaluate the relationship between participatory approaches operationalisation and socio-economic factors affecting scaling-up of BSFL breeding among farmers

3.1.3. Age

Data on age of respondents as a factor that influences adoption of innovations was collected as presented in **Table 2**;

Majority of the respondents were between 18-55 years (**see Table 2**) deemed the produc-

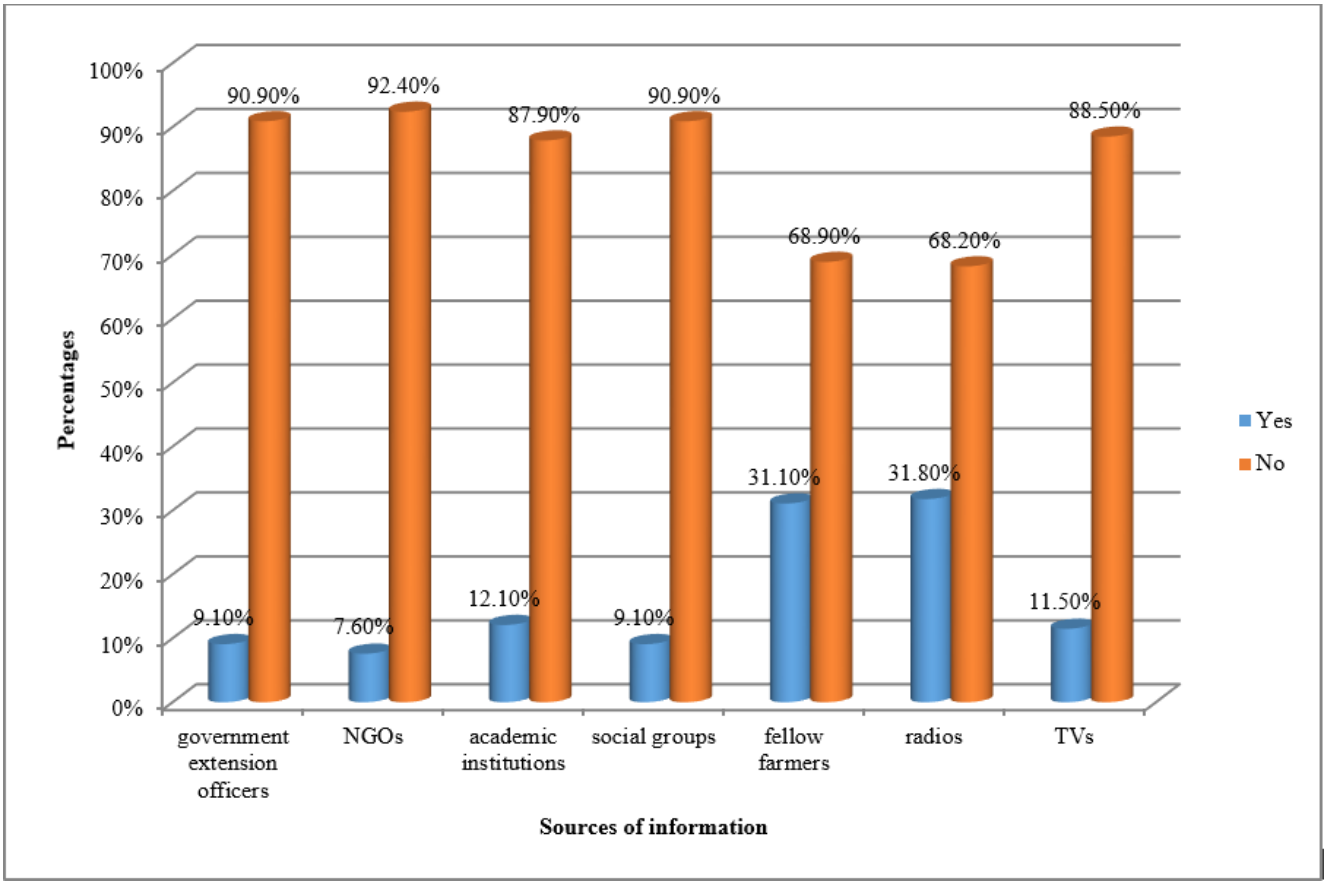

Figure 2: Source of advisory information on livestock production and management. Source: Primary data

Table 2: **Age of respondents**

		Age category of respondents				Total
		18-35	36-55	56-75	76+	
Gender	Male	29	25	15	1	70
	female	14	44	19	3	80
Total		43	69	34	4	150

Source: Primary data

tive age group that is involved in livestock farming. However, there was no significant relationship (P>0.05) between age and acceptance of the BSFL breeding technologyy. This justifies why majority of the respondents age groups were willing to take up the BSFL breeding technology due to the urgency of the population to reap from the benefits of the technology. These findings are in agreement with Edoge (2014), the age distribution is strongly associated with labour force to be used in the introduced technology. However, eversion and decreased long-term investment occur with the farmers' increase in age.

3.1.4. Gender of respondents

Gender distribution was assessed to examine how it affects adoption of innovations.

The study accepts the null hypothesis (P>0.05) since there is no significant relationship between gender and scale-up of BSFL breeding.

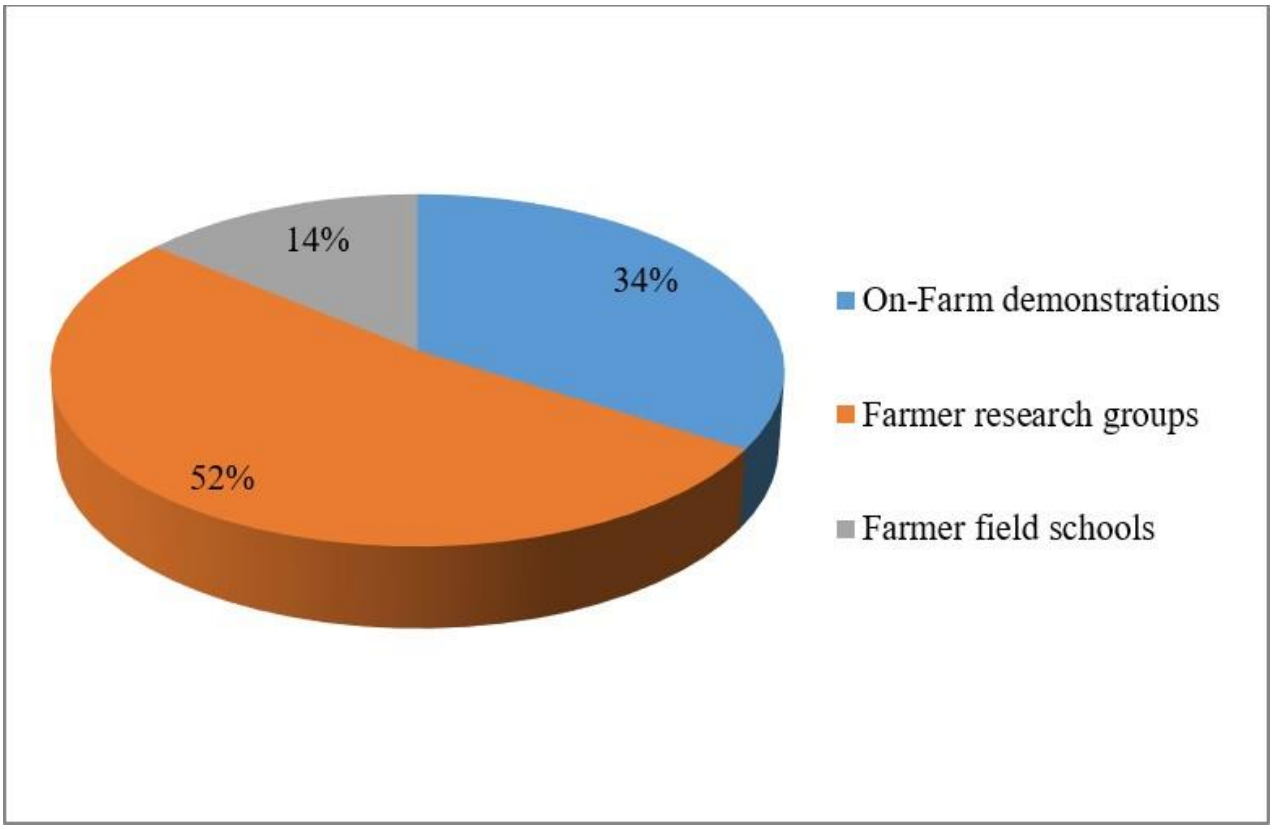

Figure 3: Proportion of participatory approaches employed: Source: Primary data

Women got more involved in farming activities most compared to men (see figure 4). This is attributed to the fact that women are easily found in the farms, plantations and the kitchen compared to their counterparts because attitudinal differences by gender usually exist.

However, different studies have mixed results about male versus female attitudes to the adoption of new technology. Asiedu-darko (2014) argued that women would be the fast adopters of any agricultural technology if they were not limited by their vulnerability. This argument corroborated with Mensah *et al.,* (2012), and Mwangi and Kariuki (2015); whose studies indicate that women neither have control over land, nor control the labour of the households. Despite this, if men have access to the improved technology and thus adopt it, its impact is often less felt than agricultural technology adopted by women (Bwogi *et al.,* 2014).

3.1.5. Respondents' education level

Distribution of livestock farmers education level in Nkozi Sub-County is as presented in figure 5;

Majority of the respondents had primary and secondary education (see figure 5 above). There was no significant relationship between education level and accepting the BSFL breeding technology since most people in the sector do not have adequate skills of keeping livestock.

The study findings are contrary to Uaiene (2011), Kansiime *et al.*, (2014) who state that education helps individual farmers to assess the capability to use the adopted technology and increase the ability of the farmers to adopt, process and use the obtained information through training

However in some cases, education does not influence farmers to adopt improved agriculture technology since farmer who have had no formal and less formal education levels (primary and sec-

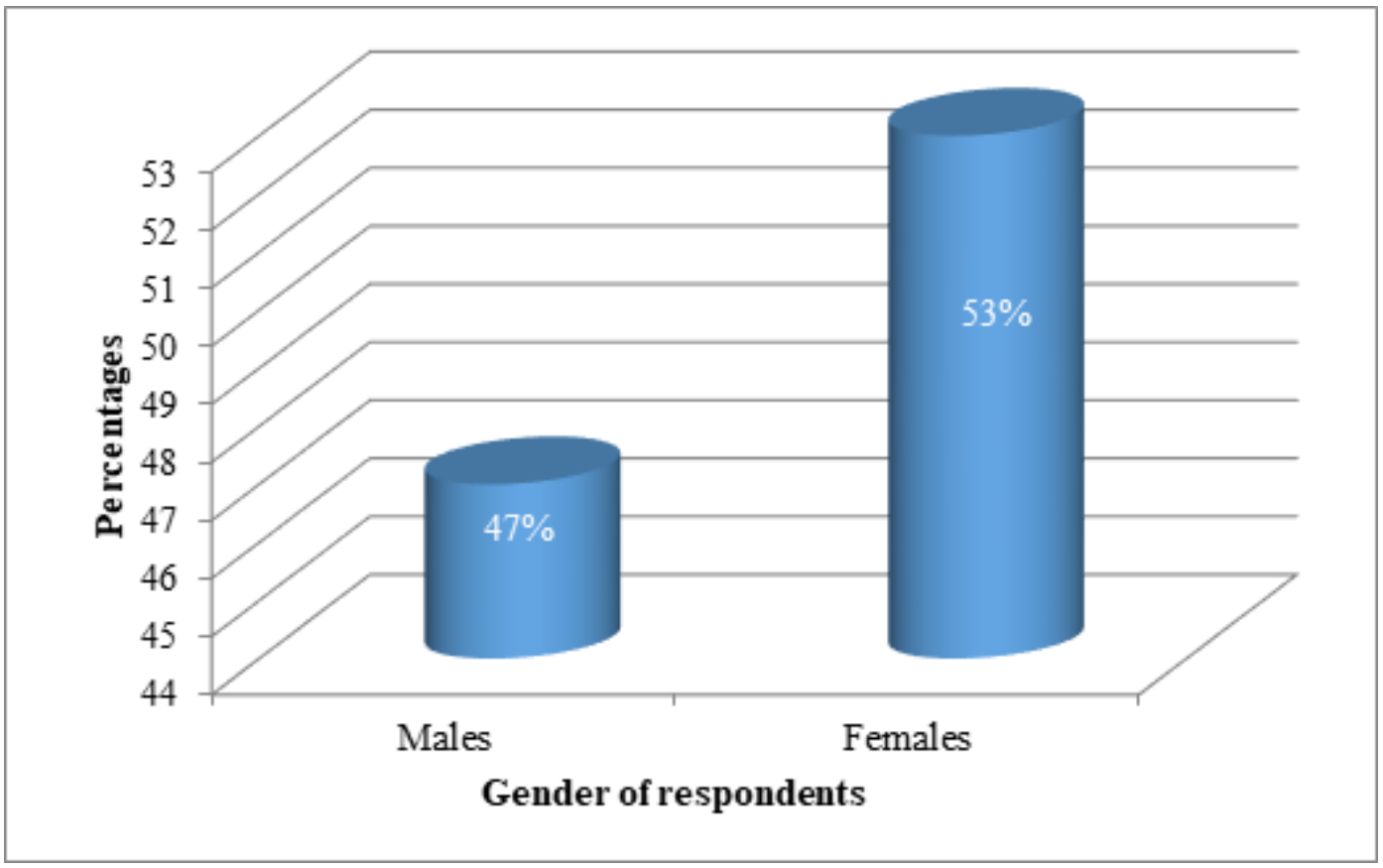

Figure 4: Gender of respondents: **Source: Primary data**

ondary level) adopte new technologies faster in comparison to farmers with tertiary and post-graduate education. It can thus be concluded that while education is significant in information access and understating, it may not be a prereq-uisite in some cases of adoption.

3.1.6. Employment status

The study assessed the employment status of livestock farmers in the area of study as presented below;

75.3% of the total respondents are self-employed. This means that they have enough time to take care of their farms and thus increased productivity at the farm by the household heads.

3.1.7. Farm size

The study assessed the size of farmers farms and ownership of land to a certain its impact on scale up of innovations.

There was no significant relationship between farmers' farm size and participatory approach to employ because at least all farmers had land and were willing to take up BSFL breeding since the innovation does not require a lot of land to set up.

Most farmers have untitled land however, Doss *et al.*, (2011) states that women can fail to adopt new technology because they have no control over land ownership although they can access it.

3.1.8. Belonging to association

The study found out if livestock farmers have membership to any association and results are presented below;

Most farmers do not belong to farmer groups however, results show that there is a significant relationship between belonging to an association or group and taking up BSFL breeding.

This explains why most of the respondents didn't have knowledge on improved livestock pro-duction methods since not belonging to any group makes it expensive to get peer advice and also fi-nancial assistance in times of need the social net-works among farmers of the same living standards

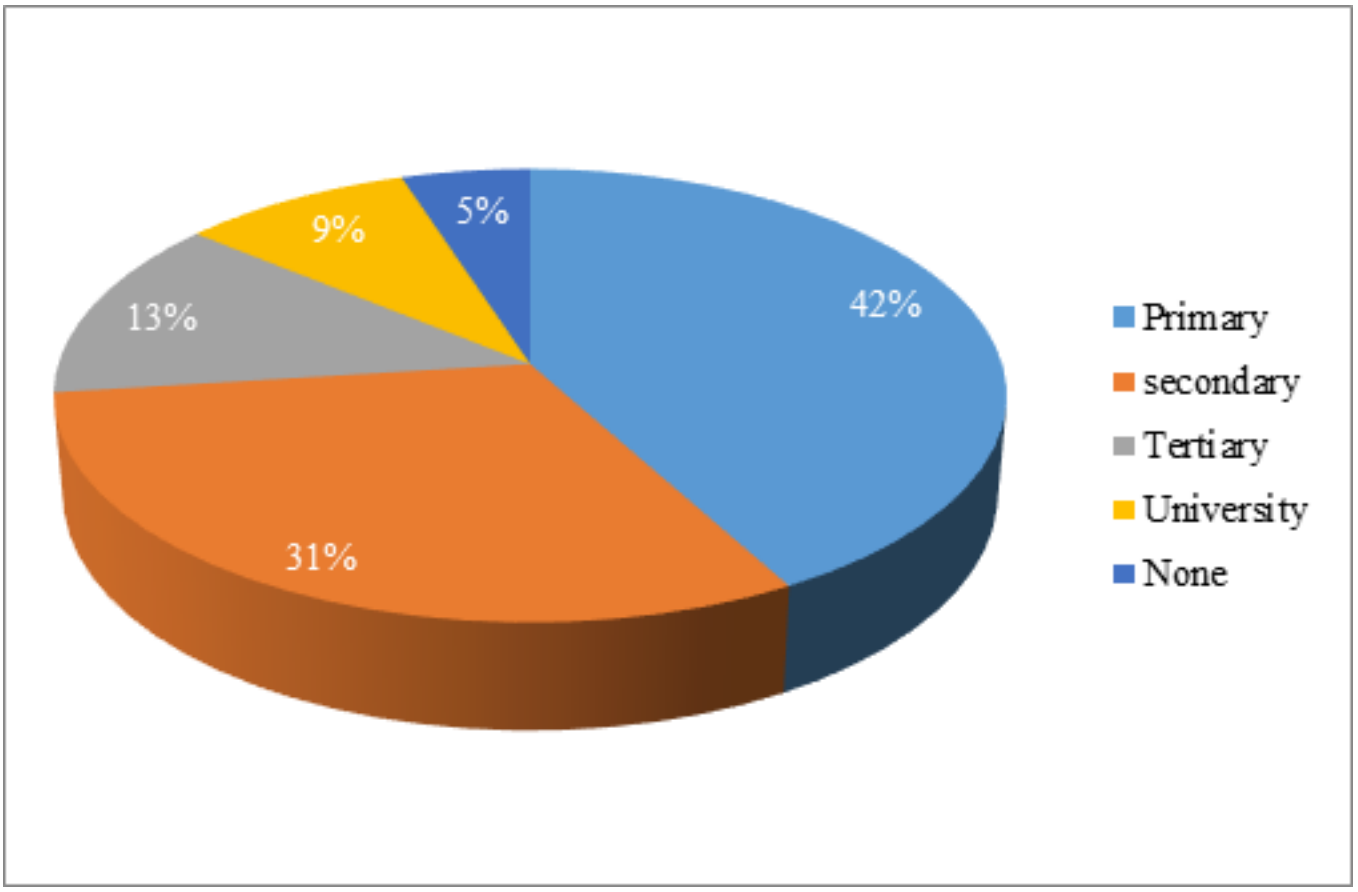

Figure 5: Proportion of farmers' education level: Source: Primary data

Figure 6: Occupation of the head of the household: **Source: Primary data**

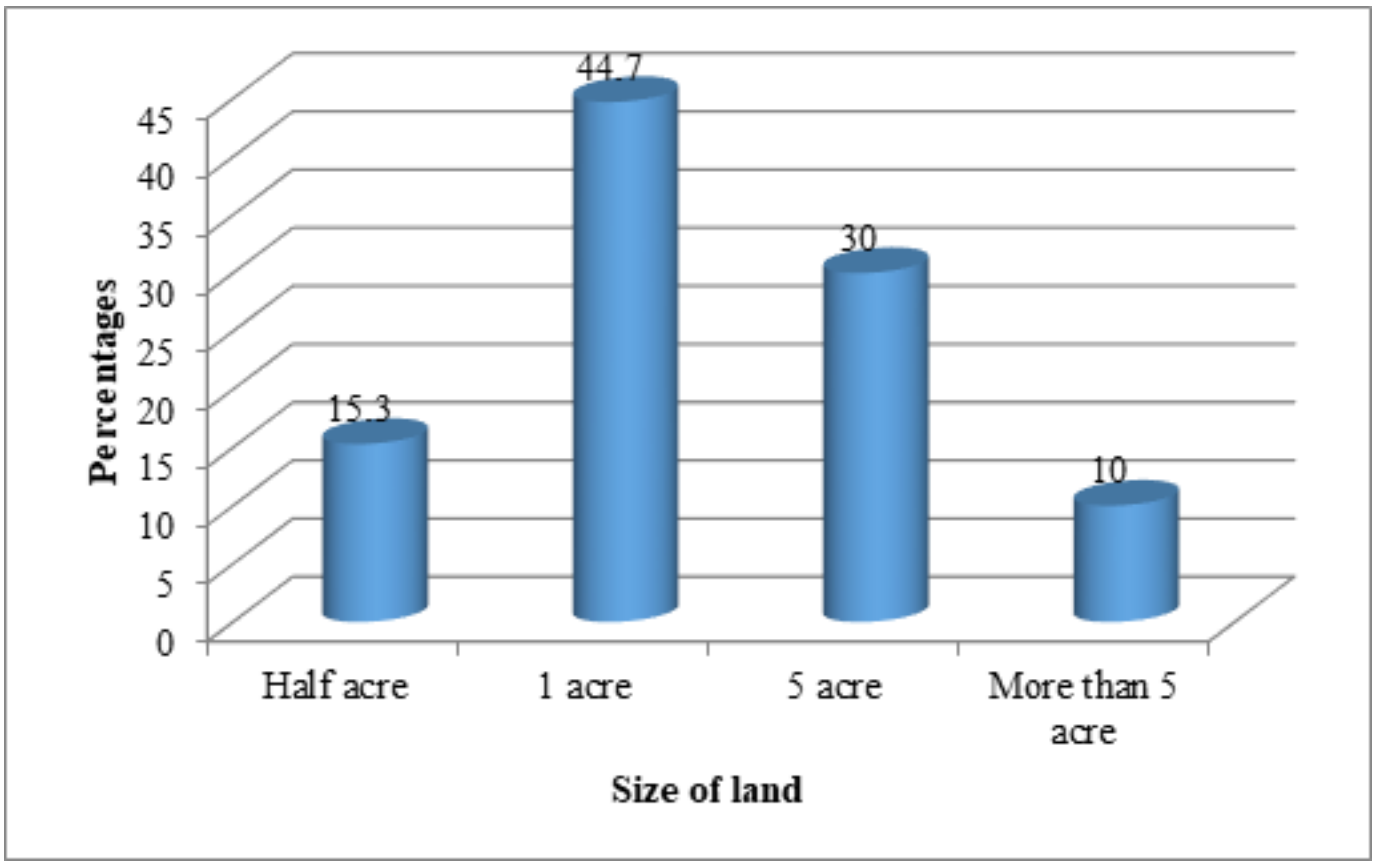

Figure 7: **Farmers farm size: Source: Primary data**

Table 3: **Groups farmers belong to**

	Yes	No	3.00
Youth group	18	114	0
Women group	21	111	0
Saving and credit society	40	91	1

Source: Primary data

can easily influence either to adopt the new technology or not.

Female farmers are highly networked and can easily access information about any new technology as compared to males and this is in agreement with Benyishay et al., (2015) who stated that belonging to a group improves access to information amongst peers.

3.1.9. Income

The study assessed the income status of farmers and results are as presented in figure 8;

The majority of the farmers get less than one million from their livestock sales per month, this is attributed to the poor methods of rearing animals and the high cost of keeping livestock.

There was a significant relationship between the income of a household and the adoption of an innovation introduced in the community since the factor that links the social and economic issues in the adoption of technology is the cost. The cost of adopting any agricultural technology has been found a major hindrance to adoption (Chepng'eno et al., 2012). These include the purchase of farm inputs, costs of labor, transportation, and mechanization. It is for these factors that farmers' income is a major determinant for

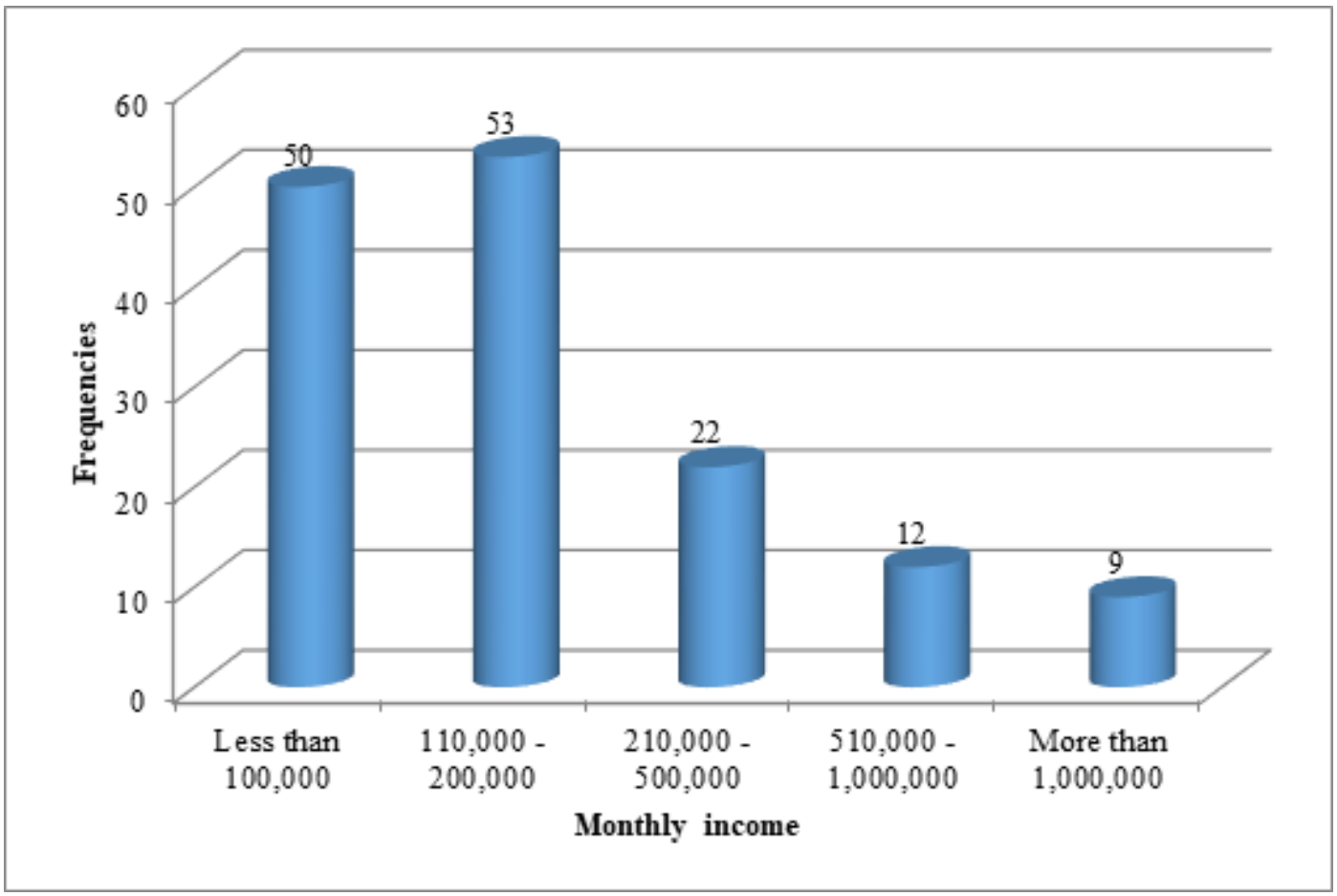

Figure 8: House hold incomes of farmers per month. **Source: Primary data**

the adoption of such technology. Other economic factors for the adoption of agriculture technology include off-farm activities (Derpsch *et al.,* 2010; Mwangi and Kariuki, 2015). Hence, strategies that assist smallholder farmers with cheap and sustainable inputs enhance the uptake of the technology associated with those inputs.

3.2. Participatory approaches used on the farm status of livestock farmers

Members of a FGD reported that farmers who have always been involved in participatory approach activities had improved farms and practiced better methods of rearing animals.

3.2.1. Types of animals reared

The study further assessed the different animals that are mainly kept by farmers.

It is evident from the findings that majority of the farmers rear pigs and poultry which mandatorily need proteins feed ration to increase productivity this there for justifies the need for BSFL as an alternative protein source since an innovation is easily taken up if it benefits are evident.

"A group of farmers in a FGD reported that the cost of Mukene and soya is very high yet pigs and chicken need proteins in their diet, we will very much welcome an alternative cheaper protein source".

3.3. Method of rearing animals

The study assessed the methods used for rearing animals in the area and results indicate that farmers use different methods for various animals i.e. majority used free range for poultry, zero grazing for cattle, goats were tethered, and pigs were kept under closed units. A few farmers had knowledge about proper housing for animals.

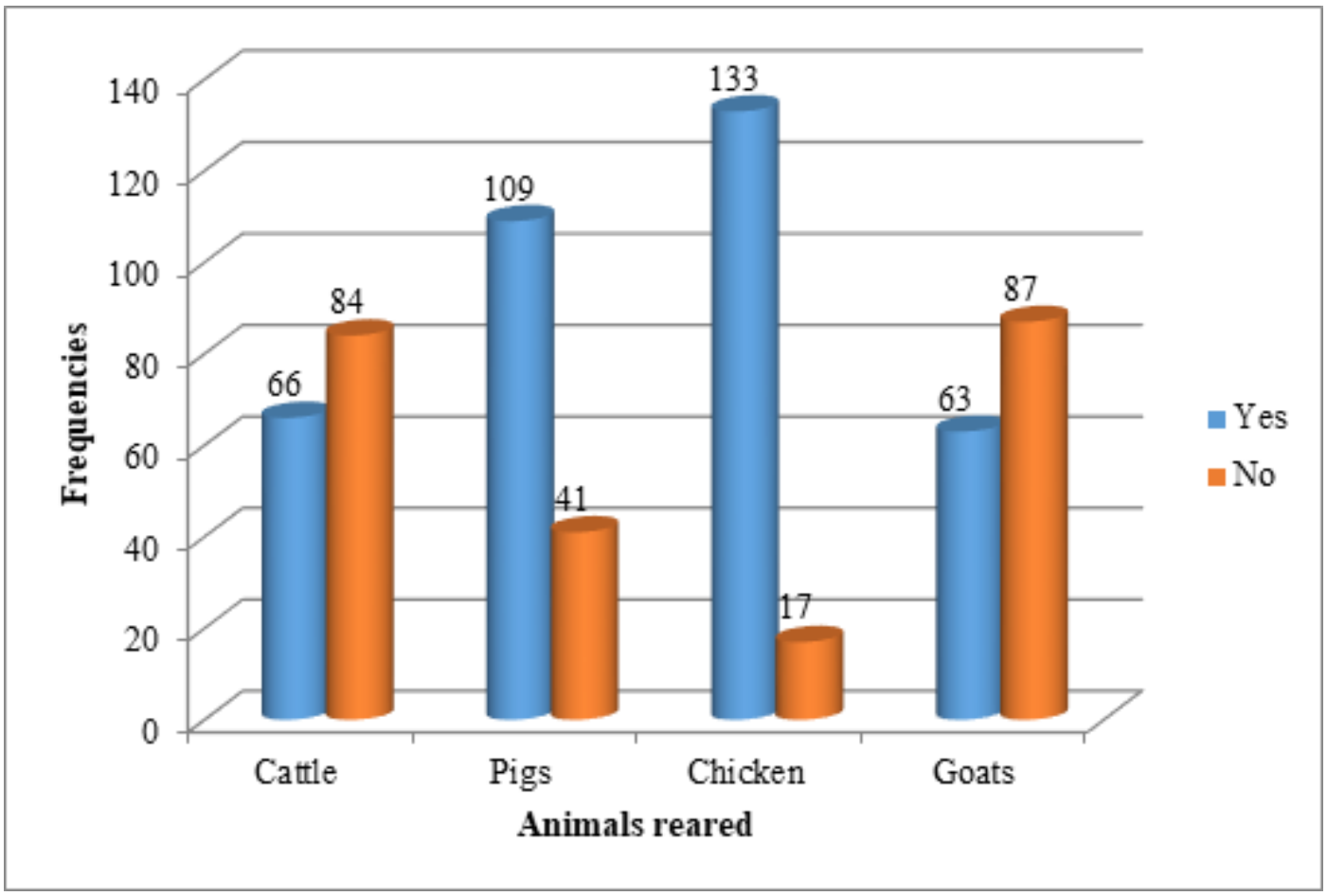

Figure 9: Animals mainly kept by farmers: **Source: Primary data**

3.3.1. Feed protein source

The study analyzed what livestock farmers use as proteins in their feed ration and where they get it. Results indicate that the majority of the farmers did have knowledge about protein sources as a prerequisite for livestock feeds because they only fed their animals on what was readily available within their reach i.e. grass, banana peels, and chicken refuse. A few farmers that had knowledge about protein sources, pointed out soya and silverfish as the most commonly used in the area though their prices fluctuate a lot with changes in season. The majority of the farmers were positive about taking up BSFL as an alternative protein source since they thought it could be a cheaper and environmentally friendly alternative.

3.3.2. Mixing of a feed ration

The study found out if farmers feed their animals on a complete mixed ration and findings show that most farmers have inadequate knowledge of feeding animals on a complete ration since the majority do not know how to mix the different inputs though others attributed it to the high cost of different fed inputs like soya and silverfish. The ignorance about mixing feeds was attributed to the lack of sensitization from animal husbandry officers deployed in the area.

4. Conclusion

The dynamic role of participatory approaches cannot be underestimated since they allow primary stakeholders to be active participants not just sources of information, build the capacity of local people to analyze, reflect and take action, allow Joint learning of stakeholders at various levels, and catalyze commitment to taking corrective actions.

Farmer research groups and On-farm demonstrations show a higher percentage of participatory approaches utilized by the farmers thus effort is required to emphasize these two approaches with the help of researchers, district veterinary officers, and Sub-County animal husbandry officers to scale up BSFL breeding among livestock farmers for livestock feed.

5. Limitations of the study

The study was limited by the COVID-19 pandemic Lockdown since data collection was done during the lockdown period which seriously affected the movement of data remunerators also gathering members for the focus group discussions was difficult because of the government restrictions.

6. Recommendation.

The study results show that participatory approaches have been under-utilized by animal scientists and animal husbandry officers compared to crop scientists when disseminating innovations to farmers, the study thus recommends that the animal sector should streamline training and knowledge sharing of research findings to farmers instead of being only service providers i.e treating sick animals and selling drugs.

The study results indicated that at least every household keeps livestock but the ignorance on how to manage their animals affects them since the veterinary officers, animal husbandry officers, and researchers have not extended a hand to them but the husbandry officers attributed this to poor staff- farmer ratio. With this, the study recommends that more emphasis should be put on training more animal scientists but also bridging the gap between animal research scientists, Veterinary officers, husbandry officers, and farmers to allow sharing of knowledge and diffusion of innovations like BSFL breeding using participatory approaches.

The results show that most commercial livestock farmers fear taking up innovations before seeing how they perform, the study thus recommends that the animal sector should put in place demonstration centers at both national and village levels to allow farmers to appreciate the innovation before taking it up.

7. Conflict of interest

The author had no conflict of interest to declare.

8. Acknowledgment

This study was funded by the Government of the French Republic through the Embassy of France to Uganda under a project 'Demonstration of a sustainable farm ecosystem for improved livelihoods of smallholder farmers in Uganda

9. List of Abbreviations

BSFL	Black Soilder Fly Larvae
FAO	Food Agricultural Organisation
PA	Participatory Approaches
UMU	Uganda Martyrs University

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