Photo 1 *Workshop attendees by Mr. Charles Mbauni Kanyugutuo*

Black Soldier Fly Larvae (BSFL) and Spirulina

- As protein ingredients in affordable, accessible and sustainable feed in Uganda & Kenya?

Time: 17.11.2022 at 09.30-13.30
Venue: ACACIA PREMIER HOTEL KISUMU
Achieng' Oneko Rd, Kisumu, Kenya
Link: Click here to join the meeting
Attendances online: 74 people
Attendances in person: 33 people

Reporting by: Katrine Soma (WUR), Mary Opiyo (KMFRI), Adriaan Vernooij (WUR), Rafael Cubero (WUR), Margaret Aanyu (NARO), Hassan Pishgar Komleh (WUR), Jeroen Kals (WUR), Maria Barbosa (WUR), Eugene Rurangwa (WUR), Benson Obwanga (Laikipia University), Charles Mbauni Kanyuguto (FOSPA), etc.

Background

The demand for protein is growing worldwide as a result of growing populations and increase in welfare among low income groups. With the increasing demand for protein, new protein ingredients for fish and livestock feed based on use of various organic waste streams are investigated as alternative sources to ensure low carbon emissions and low environmental footprints of future food systems.

In the Lake Victoria Region, efforts have been made to produce alternative feed ingredients locally, such as insect production using Black Soldier Fly's Larvae (BSFL) (*Hermetia illucens*) as feed ingredients, which are welcomed contributions to the protein transitions. Small-scale farmers, often combining fish, poultry, pig, livestock, etc. production, share one challenge, namely that the cost of feed is claiming a high share of the cost price, often up to 70%. If the protein transition could support the fish farming by offering low environmental footprint alternatives to feed at low costs, this would allow small-scale farmers to extend investments in fish farming, and through extension of this sector, contribute even more to the protein transition. Use of BSFL and spirulina as fish feed ingredients are currently investigated by WUR and local partner institutes in Kenya and Uganda.

Financing:

Wageningen University and Research, WUR, projects:
1) Alternative fish feed sources from local resources in Lake Victoria region (KB-35-008-015), and
2) Feeding cities and migration settlements are research (KB-35-102-001), which are subsidized by the Dutch Ministry of Agriculture, Nature and Food Quality.

Welcome

Dr. Mary Opiyo, KMFRI/ Ms. Susan Adhiambo; Kisumu County Government, Kenya/
Dr. Jonathan Munguti; KMFRI, Kenya

"This workshop addresses the urgencies of making feed sustainably, affordably, and accessibly to small-scale farmers in Kenya, which is also highly relevant in Uganda, and other countries bordering Lake Victoria", were the main messages provided by Dr. Mary Opiyo and Dr. Jonathan Munguti in their welcome speeches. Warm welcome words were also provided by Ms. Susan Adhiambo, representing the Kisumu County. A large share of the small-scale fish farmers attending in person explained they were currently involved in the trials taking place in Busia on BSFL and Caridina shrimp. Others were operating in and around Lake Victoria with cage fish farming or producing BSFL or spirulina. Moreover, several research institutes such as KMFRI and Laikipia University took part in the meeting. Online, participants represented research institutes, as well as international organisation, local producers and policy makers. See overview of attendances in the program, Appendix 1.

Photo 2 *Workshop attendees, by Dr. Jonathan Munguti*

Exploring spirulina as protein source in feed in a trial measuring fingerling growth in Kenya, in Sagana

Dr. Mary Opiyo, KMFRI

Spirulina trials
The spirulina trials have been carried out at KMFRI Sagana Hatchery, using Nile tilapia fingerlings of 2g in a flow-through system. The results presented are preliminary results, se are just temporarily results, as the trials will continue until the beginning of in 2023. The aim is to determine whether different inclusion levels of spirulina, as an alternative protein source, in feed for fingerlings as an alternative protein source have different impacts an effect on growth and survival rate of the fingerlings. Four experimental feeds were formulated, in which the protein fraction of fishmeal was replaced by either 0%, 10%, 20% and 30% by spirulina protein, respectively. In addition to these four experimental feeds, a commercial feed (with 40% crude protein and 8% fat) was included as a reference diet (Table 1, Figures 1,2,3). The composition of the feeds are isonitrogenous and isoenergetic based on the composition of the commercial diet. The five diets were tested in triplicate, resulting in 15 experimental units. Per unit 35 tilapia fingerlings of ± 2 grams were used.

Feeding strategy was to apparent satiation in order to achieve maximum feed intake. Growth, apparent feed conversion and survival rate were determined.

Photo 3 *Visit to KMFRI, by Dr. Katrine Soma*

Table 1 *Experiment overview spirulina*

A	Basal diet with 0% spirulina
B	Basal diet with 10% spirulina
C	Basal diet with 20% spirulina
D	Basal diet with 30% spirulina
E	Commercial diet (40/8).

Preliminary results

At day 21 no statistically significant differences were found in growth, apparent feed intake and apparent feed conversion ratio ($p>0.05$). The final results will be published in 2023 and distributed to Workshop participants.

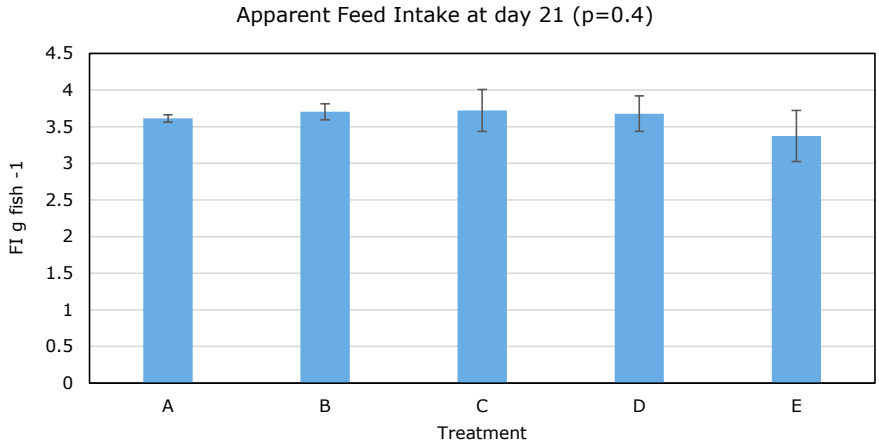

Figure 1 *Apparent feed intake of the fish in g per fish fed the different diets (A-E)*

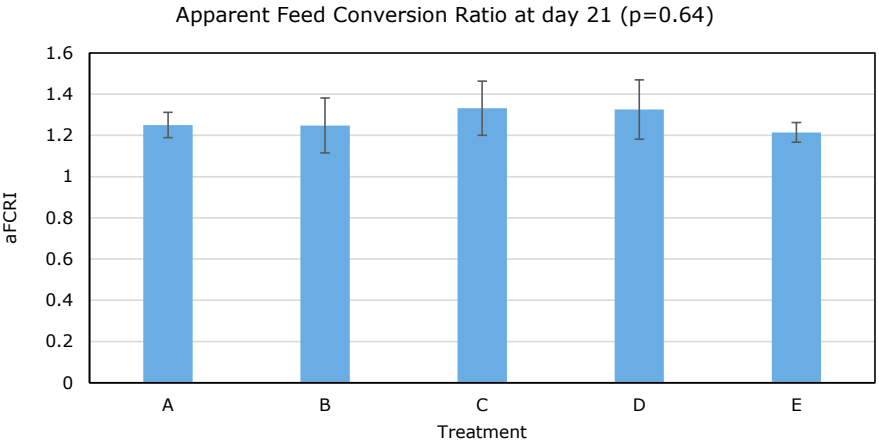

Figure 2 *The Apparent Feed Conversion Ratio (AFCR) of fish fed the different diets*

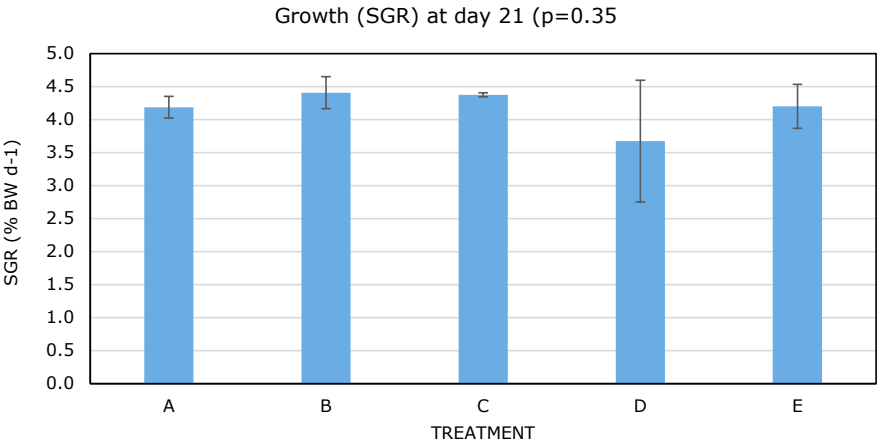

Figure 3 *Specific growth rate (% BW d^{-1}) of fish fed the different diets*

Exploring BSFL as protein source in feed in a trial measuring growth of fingerlings in Bukana aquapark

Dr. Mary Opiyo, KMFRI

The trial in Bukani aquapark is running from September 2022 and will continue in until January 6, 2023, after this report is published. The aim is to determine whether feeding partly a supplementary diet of chopped dried BSFL and chopped dried Caridina freshwater shrimp alongside a commercial feed to on-growing Nile tilapia in ponds owned by small-scale farmers are suitable and cost-effective alternative feeding strategies compared to feeding a commercial diet only. In this experiment three dietary treatments, A (100% commercial diet (CD)), crude protein 35% fat 2.58%, B (CD + 20% chopped dried BSFL) and C (CD + 20% Caridina freshwater shrimp) were tested in triplicate resulting in nine experimental units (Table 2). Nile tilapia fingerlings of 10-12 g were stocked at 3 fish/m^2 in nine earthen ponds. The fish were fed to apparent satiation in order to achieve maximum feed intake. Growth and economic feed conversion rate were determined every 21 days. At the end of the trail, growth, economic feed conversion rate and survival rate will be determined, after which the optimal dietary treatment can be estimated based on the performance of the fish.

Table 2 *Experiment overview BSFL*

A	Feeding 100% commercial feed (CF*)
B	80% CF+ 20% BSFL**
C	80% CF+ 20% chopped CFWS***

* CF, Commercial feed, Optinile.

** BSF, chopped BSF larvae.

*** CFWS, chopped Caridina freshwater shrimp.

The preliminary results show that there are no significant differences in the feed given and specific growth rate (SGR) between the different diets or feeding strategies ($p > 0.05$). Numercially, the growth of fish fed the commercial diet with Cardina freshwater shrimp (C) as a supplementary diets is higher than the other two alternatives (Figures 4 and 5). These are preliminary results. The final results will be published in 2023 and distributed to Workshop participants.

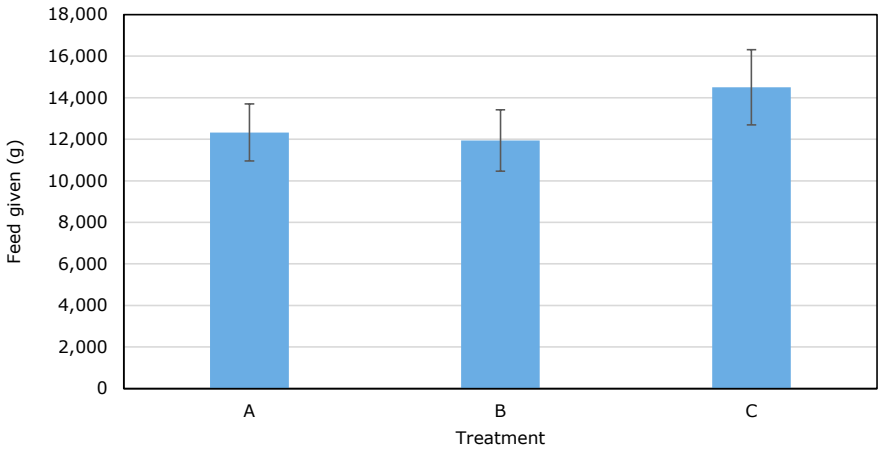

Figure 4 *The apparent feed intake of the fish fed*

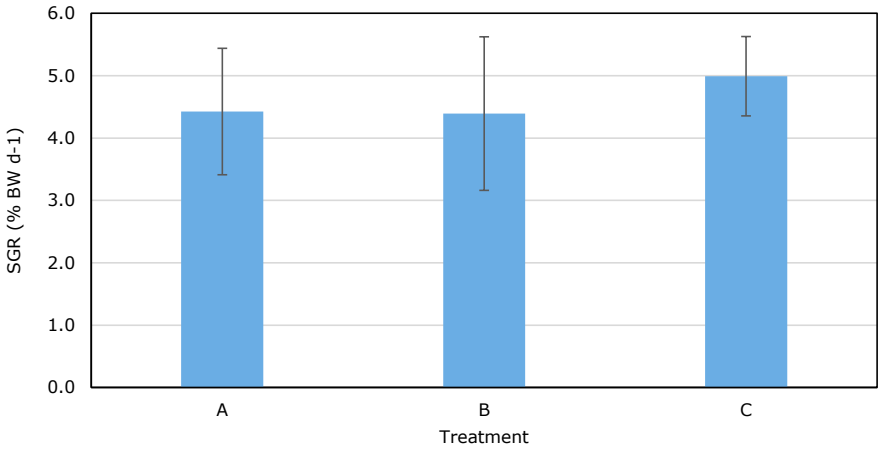

Figure 5 *The specific growth rate (SGR)*

Photo 3 *Farmer representatives at the workshop, by Dr. Jonathan Munguti*

Exploring BSFL as protein source in feed in a trial measuring growth of fingerlings in Uganda

Dr. Margaret Aanyu, NARO

BSFL trial

In Uganda, a trial of using BSFL protein to substitute fish meal protein is carried out at NARO Kajjansi ARD Centre. For this trial six experimental feeds were formulated, of which the protein fraction of fishmeal is replaced for 0%, 25%, 50%, 75% and 100%, respectively, by the protein fraction of defatted BSFL meal from locally grown BSFL. In addition, to these five experimental feeds, a commercial feed is included as a reference. The composition of the feeds are isonitrogenous and iso energetic based on the composition of the commercial diet. The six diets are tested in triplicate, resulting in 18 experimental units with 20 tilapias of ± 30-40 grams each. The fish are fed to apparent satiation in order to achieve maximum feed intake. Growth, feed conversion and survival rate are determined.

Preliminary results

Growth of fish was lower as expected due to large variation in temperature during day and night due to power shutdowns. At day 30 no differences were found in growth expressed in the specific growth rate (SGR) in % BW d^{-1}. ($p > 0.05$) (Figure 6). Though, when leaving out the commercial diet, which is use as a benchmark, the exchange of fishmeal protein by protein from defatted BSFL meal affect specific growth rate (Figure 7, $p < 0.05$). From the preliminary results, with the low growth figures in mind, it seems replacing protein from fish meal with protein from defatted BSFL meal in the range of 25-75% positively affected growth.

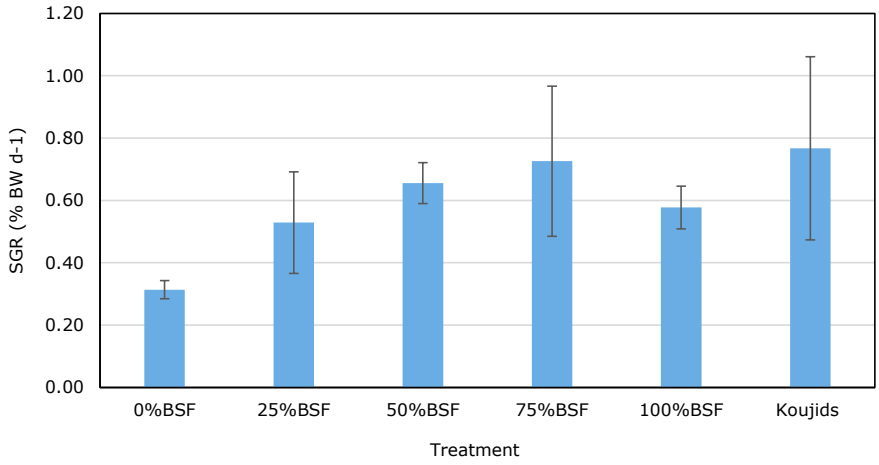

Figure 6 *The specific growth rate (SGR) expressed in % BW d^{-1} of fish fed the different diets at day 30*

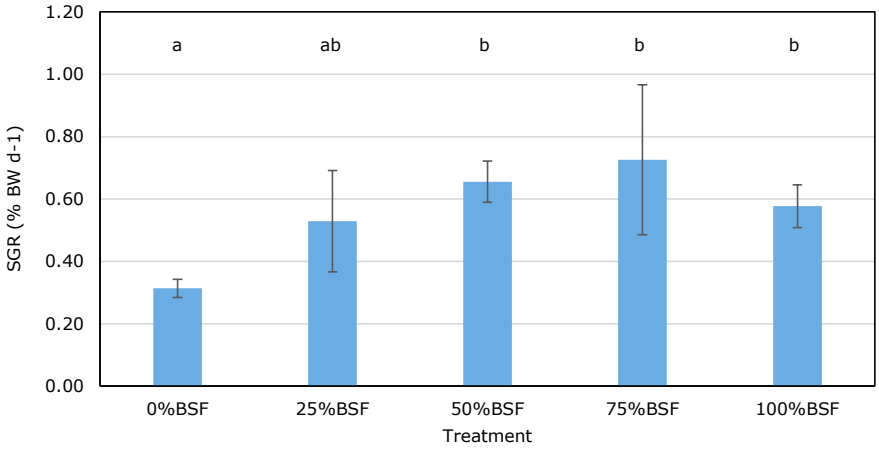

Figure 7 *The specific growth rate (SGR) expressed in % BW d^{-1} of fish fed the different diets at day 30, excluding the commercial diets. Means with a common superscript are not significant different using the Fisher LSD post hoc test ($p < 0.05$)*

Photo 5 *Dries Caradina niloticus (shrimp), by Dr. Mary Opiyo*

Photo 6 *Shopped and dried Black Soldier Fly Larvae (BSFL), by Dr. Mary Opiyo*

Using BSFL instead of soya in feed will reduce GHG emissions with at least 68%

Dr. Hassan Pishgar Komleh, WUR

It is of interest to the Ugandan and Kenyan farmers to know whether BSFL is an environmentally friendly alternative to feed based on protein sources such as soyabean meal and fish meal. Therefore, a Footprint analysis has been applied to investigate greenhouse gas (GHG) emissions in the larvae production process, investigating both environmental burdens and benefits. To calculate the GHGs emitted during the production of the BSFL, direct (on-farm) and indirect (off-farm) foreground and background data were used to measure direct (on-farm) and indirect (off-farm) emissions. Foreground data include all the data related to BSFL production in the production unit such as the mass of consumed inputs (e.g., organic waste, electricity, diesel, etc.), while background data consist of emissions associated with the production of a unit of inputs consumed in the production process. The on-farm emissions were collected in a production unit of Marula agribusiness located in Kampala, Uganda[1].

The results (Figure 8) showed that the processing of larvae (energy use) gave some negative contributions, as well as transport, to the GHG emissions (i.e., production of one kg dried larvae emits 3.1 kg CO_2eq). At the same time, emission was avoided, such as avoiding emissions from landfill, replacing livestock feed ingredients and replacing chemical fertilizer (i.e., production of BSFL prevented 9.7 kg CO_2eq).

[1] See full report at: Pishgar-Komleh S.H, Vernooij A., Straub P.T. Carbon footprint of processing city market waste for animal feed with Black Soldier Flies in Kampala, Uganda. Wageningen Livestock Research, Public Report, 1382.

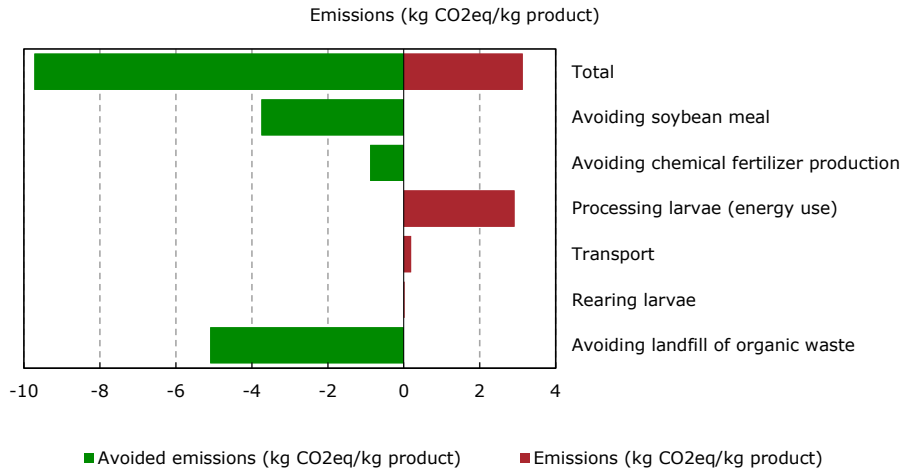

Figure 8 *Emissions made by BSFL (red) and avoided emissions by producing BSFL as protein source (green)*

Notably, the avoided emissions by using BSFL depends on what protein source is replaced by BSFL in the animal feed. This could be fish meal or soyabean meal. The difference is shown in Figure 9. The protein content of soybean and fishmeal by the BSFL was determined as 2.7 kg CO2eq per kg soybean meal and 0.52 kg CO2eq per kg BSFL for fishmeal. The lower carbon footprint of fishmeal and the lower protein content of the soybean meal were the reasons of lower avoided emissions for replacing fishmeal by BSFLs. The protein content of soybean meal and fishmeal were 453 and 630 g protein per kg, respectively.

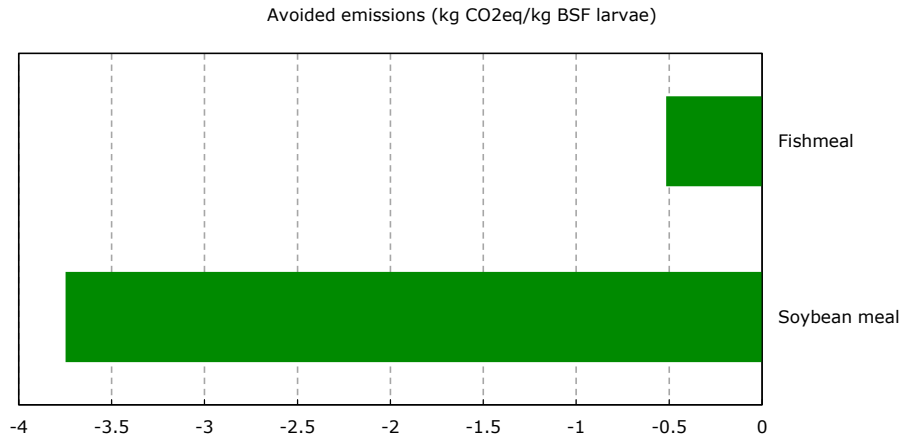

Figure 9 *Avoided emissions by replacing BSFL with soyabean meal and fish meal*

Spirulina as feed ingredient is protein productive, lipid productive and carbohydrate productive

Dr. Rafael Cubero, WUR

The powder of spirulina has been used as a nutrient supplement in human consumption. However, lately research has been focused on its potential use in feed formulas for livestock and aquaculture. spirulina is a microalga characterized by high content in proteins (up to 60% dry weight), a profile of amino acids and is a rich source of polyunsaturated fatty acids (PUFAs) and vitamins. Around Lake Victoria, spirulina is highly valuable due to the conditions of; availability of sun (up to 9h/day), fair temperatures (15-30C), water (some parts, slightly alkaline, pH 9) and fertilizers (mainly P&N substituted by local sources). In the future it is interesting to investigate; 1) local algae strains, in isolation and characterization (protein content and composition), 2) options to customize algae

production and processing with local resources (Local and circular), and 3) techno economic analysis on the microalgae production costs in Kenya, considering local resources, social and climatological parameters. While at this stage, the spirulina processing often takes place in laboratories, increasingly it is reported that practical applications take place implementing the spirulina on farms as a feed ingredient. For implementation, it is relevant with reactor and process design, scale-up, biorefinery and chain analysis. There are already some companies and small enterprises that are dedicating their efforts to produce spirulina in the region of Sub-Saharan Africa like Thriving Green, Nasio Trust or Antenna Foundation. Figure 10 shows why microalgae is a highly valuable protein to be included in feed.

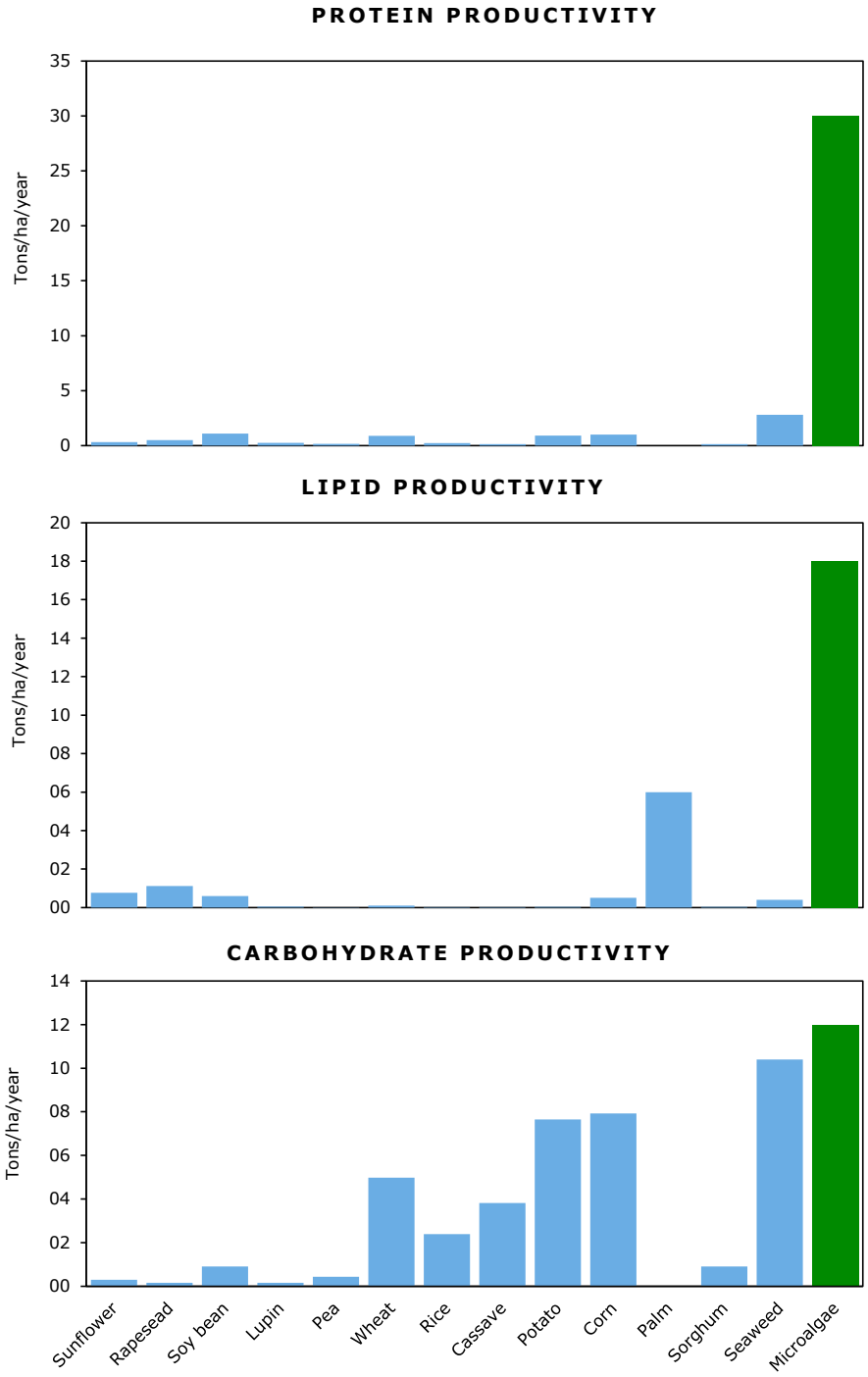

Figure 10 *Why spirulina microalgae? Comparing with other products, they are protein productive, lipid productive and carbohydrate productive*
(Data retrieved from FAOSTAT /Microalgae date retrieved from AlgaePARC (https://www.algaeparc.com/))

Small-scale farmers highly demand spirulina and BSFL as ingredients in feed

Charles Mbauni Kanyuguto, FOSPA

A total of 95 small-scale farmers have been interviewed by means of a questionnaire survey October/ November 2022 on farm in the Nyeri County in Kenya by the Nyeri Fish Farmer Cooperative/ FOSPA to respond to the question of demand of feed made by BSFL and spirulina. Through cooperatives of pigs, poultry, livestock as well as fish, farer groups were selected who were judged suitable locally. The survey is financed by WUR[2], in cooperation with Laikipia University, and will be finalised when a total of small-scale farmers has been interviewed. The results provided are preliminary, and final results will be published in 2023.

The results show that almost all the farmers interviewed are interested in buying feed with BSFL ingredients if quality is high (98%) and prices are low (97%). Moreover, a large share of the farmers is interested in producing the BSFL for feed if having access to funds to invest (69%), and if getting instructions on how to produce (62%). However, only 10% are interested in production if it is to supply own farm only. See Figure 11.

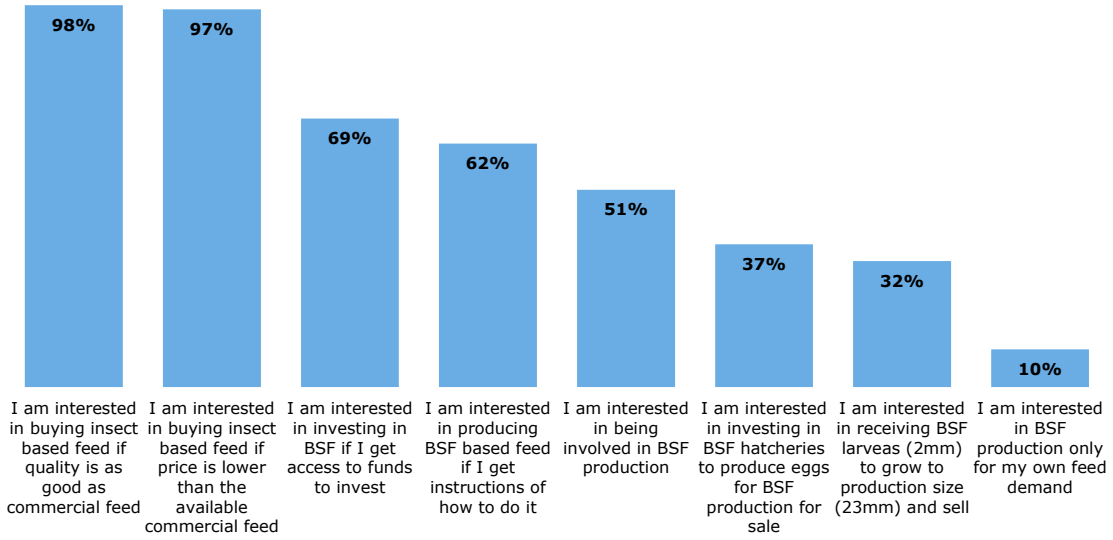

Figure 11 *Almost all small-scale fish farmers are interested in buying feed made by BSFL as ingredient if quality is good and price is low. More than half are interested in investing in BSFL production*

Respondents were even more enthusiastic about Spirulina than about BSFL. Only 2% said they are not interested in spirulina. The larger shares of the farmers were interested in buying feed with spirulina as ingredient if price is low (92%), if spirulina gets available on the market (87%) and if spirulina is one of many ingredients in commercial feed (70%). Moreover, large shares of the farmers would be interested in producing spirulina on the farm if investment costs are low (73%), if access to financing (66%) and if instructed on how to do produce it (58%). See Figure 12.

[2] The survey is carried out in the project: Feeding cities and migration follow-up project: Food and nutrition security of low-income groups in settlements 2019-2022. The analyses of the data collected will by a rural-urban food systems in the global south (2023-2024).

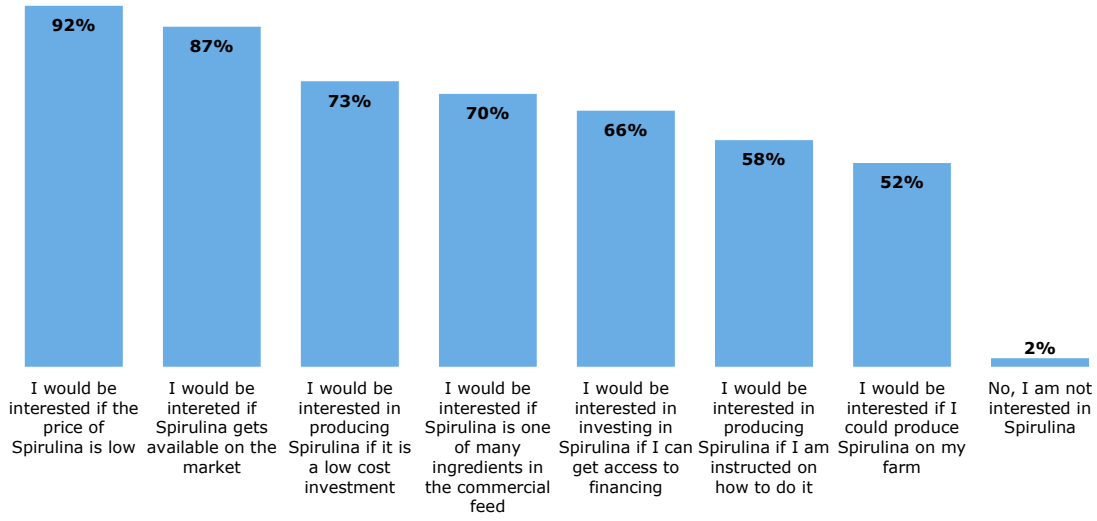

Figure 12 *Almost all small-scale fish farmers are interested in buying feed made by spirulina ingredient if price is low and it gets available on the market. More than half are interested in investing in spirulina production*

What is needed in future to make the feed affordable and accessible to small-scale farmers?

Panel discussion led by Dr. Katrine Soma, WUR

The representatives who took place in the panel included; Margaret A.M. Otwaui (Chairperson): Busia Cooperative Union; Ruth Wamukoya (Consultant): Nasio Trust spirulina; Rodah Ochieng (Manager): Biofit; Fredrick Juma (Director): Hydro Victoria Insect Feed & Fish Farm LTD; Patrick Nyamori (Chairman): Bukani Aquapark; Fred Omondi (Director): Feed Grate Lakes; Phillip Straub (Director): Proteen. The main points made included **Question: what is needed in future to make the feed affordable and accessible to small-scale farmers?** Responses to this question included.

1) Feed producers agree future must be provided by feed produced in sustainable manners

- One of the challenges for scaling up is related to the availability of waste to feed the BSFL. Another challenge is related to capacity building of farmers. Moreover, there must be a match between what is produced and what is demanded. At present, from a commercial producer perspective, it is unclear who is demanding, where the market is, and therefore difficult to reach potential clients. **At present feed costs are too high, because the price of the protein ingredients, such as fish meal and soya bean meal, are too high.** Lower prices on protein will decrease prices of feed, so if BSFL can lower the prices this will make a big difference. However, for commercial producers, large quantities of protein are needed. This is still not solved by the BSFL production.
- The expensive sources of protein brought in from other countries and continents often in formats of imported fish meal and soya beans drive the prices of feed up. Therefore, the BSFL based feed is a great opportunity contributing with a sustainable alternative of a high-quality protein source which can be produced locally. This transition may require some governmental support in terms of tax exemptions and incentives for change. Also, **investments in BSFL and spirulina are still too low, and there is a need to invest on a commercial scale.** Therefore, investments of UK and the Netherlands are welcome. At present, 5kg bags are offered do not benefit of economies of scale because the bags are too small. This can be solved by offering bags of 10kg. More than

10 tons of BSFL are needed every day to supply current demand in this region. If not offered, the alternative is to buy feed using soybean.

- **Sustainability is difficult to achieve given the distances from waste to farmer to producer to market involve too many players and bring prices of feed up.** There is therefore a need for feed companies to partnership with cooperatives, farmer groups, etc. At present, farmers are trained, provided with BSF eggs, and commercial companies buy the larvae back, after feeding them on on-farms organic waste, in a series of new commercial business models.
- Further, **the sector can benefit from more cooperation, more research, and from a governmental contribution to organise waste streams to make the feed more available.** This will help to increase the feed conversion ratio, which is critically important to scaling the BSFL and spirulina as ingredients in feed, while enhancing the sustainability of the circular economy locally.
- While spirulina is produced mainly for human consumption, it is provided as an alternative to small-scale farmers to feed their livestock. Nasio Trust is encouraging the small-scale farmers to produce it by a simplified way, using a normal pump to press, with holes helping water to disappear. Instead of using advanced generators and separate dryers, greenhouses can be used to dry. **In small ponds the spirulina can grow fast, up to 7-14 days before harvesting. This is cheap to produce and there is consequently no need to buy spirulina.** This can become a gamechanger to small-scale farmers, but knowledge is still low, so training will be needed.

2) Farmers are concerned about being excluded from the BSFL and spirulina development

- The farmers confirmed that BSFL is very interesting to the small-scale farmers because they can have an extra income. **Still, the alternative feed ingredients, such as BSFL and spirulina, are not available to the small-scale farmers.** Spirulina as input in feed production is not accessible to small scale farmers. When it becomes available, the farmers will need explanations and the knowledge on how to access it and how to produce spirulina. Many farmers have heard about it, but never seen it.
- An issue difficult to address is the relationship between the County government and the small-scale farmers. **Often the farmers do not feel they are represented and do not benefit from programs and project as intended.** For instance, it was informed that machineries for feed cottage industry to support the farmer group are successful in producing feed. However, it brings uncertainties to the farmers when working well due to shared ownership with the County government resulting in what the farmer interprets as interferences. Hence, rendering the intended purpose fruitlessly.

Photo 6 *Panel participants, by Dr. Jonathan Munguti*

Improved logistics, reduction of costs, use of other protein sources, recommended as ways forward

Discussion led by Dr. Munguti, KMFRI

- There is need to improve on logistics of BSF production:
  - To connect producers to cut down the cost of BSF production. There is need to bring down the cost of BSF. For instance, BSF is about 40% crude protein and costs about KES80 while Freshwater Shrimps have a crude protein content of 60% but costs about KES50 per kg.
  - To link all producers of BSF to the markets and link the fish feed producers to the BSF farmers.
  - To geographically map out farmers interested in BSF production, organize them into clusters then organize trainings. However, there can be a challenge of aggregation, which can be tackled by linking the farmers to the feed producers where the feed producers supply the farmers with fish feed and collect the BSF. This then brings down the cost of production.

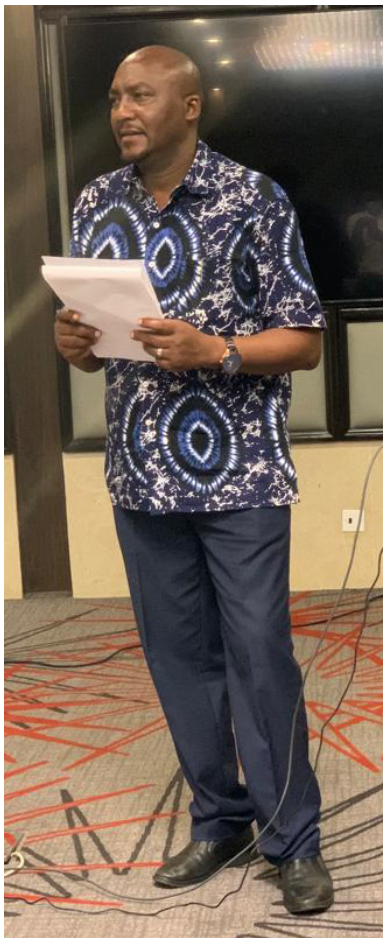

Photo 7 *Dr. Jonathan Munguti*

- A spirulina farmer, until now focused on producing spirulina for human consumption considers venturing into production of spirulina for incorporation into fish feed. According to her, **the cost of production is very high, specifically due to high cost of fertilizer.** This is therefore a great impediment.
  - One solution is to develop a different line for production of spirulina for fish feed which is cheaper and easy to set up. Studies have shown that in Asia farmers produce spirulina for use in animal and fish feed using chicken manure which is cheaper.
  - The farmers are also advised to use cheaper production equipment e.g., plastic basins as long as the farmer ensures that the favorable conditions are maintained. spirulina is a good

ingredient for use in fish feed since it enhances the quality of the fish farmed. It actually increases the quantity of Omega 3 in the fish.

- There is a protein source that is **an alternative from spirulina and BSF is redworm**, which is a species of Earthworm. This is being cultured by some farmers, to understand how it can be explored for viability in use for fish feed.
  - Can we come up with a strategy e.g., a program that will bring on board all small-scale feed manufacturers to bring the cost of the expensive protein component of feed down. E.g., is it possible that in addition to the Great Lake Company we can have 5 more small feed manufacturers coming together. On this platform we can also add the BSF producers and use the platform to train farmers. In fact, the strategy should bring on board all value chain actors on one platform to discuss how to reduce costs of production. This will be a good strategy that will build on best practices.
- **Earthworms are also a good source of protein** and can be considered for production because:
  - They feed on wastes just like BSF. Facilities used for production of earthworms are cheaper to set up compared with for the BSF and the spirulina, and the waste material from earthworm production has been used as a pesticide in kitchen gardens as well as a fertilizer, while the broken-down organic material is used as organic manure in farms or commercial flower farms.
  - They have a great multiplication capacity; one individual can produce about 198 young ones in every cycle of production.
  - They have a high crude protein content, however, are limited by their high fats (crude lipid levels).
- Concern on smell of waste used in production of BSF, can the smell interfere with the neighbors?
  - The smell is a result of the bacteria breaking down the waste. Once the BSF is introduced, it first feeds on the bacteria then starts feeding on the organic material. **The smell disappears after 24hrs.**
- A large share of the participants raised their hand to agree with the comment that BSFL and spirulina could be a game changer to future (See picture).

Photo 8 *Workshop attendances, by Dr. Jonathan Munguti*

Use of alternative feed produced locally, such as BSFL and spirulina, can become a gamechanger if inclusion is ensured

This workshop illustrates the urgencies related to the topic of increasing sustainability of protein in feed, and thus ensuring acceptability. To address challenges and opportunities for protein transition in the region of Lake Victoria, in this workshop, we have explored how to operationalize the use of

fish feed containing Black Soldier Fly (BSFL) and spirulina for (fish) farmers in Kenya/Uganda. The trials presented contribute with information about growth feed conversion and survival of tilapia fingerlings with different feed composition, using BSFL, spirulina and Caridina shrimp, often in combination with the commercial feed. Companies are already scaling up the BSFL ingredient in feed, and some can already compete in price of commercial feed without reducing quality. Because the BSFL containing feed currently brings high costs to the small-scale farmers, different opportunities have been discussed for supplying the small-scale farmers with affordable protein rich feed based on BSFL. The strategies include; 1) commercial feed companies producing high quality feed affordable, 2) feed companies cooperating with small-scale farmers by ensuing larvae production on farms, and 3) on-farm hatcheries to produce dried or fresh larvae which can contribute with some 20% of feed needed, in addition to the commercial feed. The role of cooperatives is critically important to allow economies of scale to benefit small-scale farmers, so that commercial fish producers can sell larger quantities at lower price. The workshop also unraveled that spirulina as feed ingredients for use by small-scale farmers is not only a future vision, but is already taking place.

This workshop links up with to a range of the UN Sustainable Development Goals (SDGs) includes climate action (SDG13), preservation of natural resources on land (SDG15) and life below water (SDG14), as well as zero hunger (SDG2), decent work and economic growth (SDG8), reduced inequality (SDG10), sustainable cities and communities (SDG11), and responsible consumption and production (SDG12).

Photo 9 *Workshop attendances, by Mr. Charles Mbauni Kanyuguto*

Photo 10 *Workshop attendances, by Dr. Jonathan Munguti*

Photo 11 *Workshop attendances, by Dr. Jonathan Munguti*

Photo 12 *Workshop attendances, by Dr. Jonathan Munguti*

Appendix 1 Program Workshop KISUMU 17.11.2022

Black Soldier Fly Larvae (BSFL) and spirulina
- As protein ingredients for affordable, accessible and sustainable feed in Uganda & Kenya?

Venue
ACACIA PREMIER
HOTEL KISUMU
Achieng' Oneko Rd,
Kisumu,
0709 850000

When
17.11.2022
09.30am-13.30pm

Program

09.30	Arrival & tea
10.00	Welcome remarks *(Ms. Susan Adhiambo; Kisumu County Government, Kenya/Dr. Jonathan Munguti; KMFRI, Kenya)*
10.10	Trials *(Dr. Mary Opiyo; KMFRI, Kenya/Dr. Margaret Aanyu; NARO Kajjansi ARD Centre, Uganda/ Dr. Hassan Pishgar Komleh; WUR, the Netherlands)* BSFL trials Spirulina trials Environmental footprint analyses
10.40	Q&A
10.45	BSFL - how to begin? (Did not attend) *(Dr. Chrysantus Tanga; ICIPE, Kenya)*
11.00	Spirulina – how to begin? *(Dr. Rafael Cubero: WUR, the Netherlands)*
11.10	Users of feed *(Mr. Charles Mbauni Kanyuguto: FOSPA, Kenya)*
11.20	Q&A
11.30	Panel discussion on production & market (BSFL/spirulina producers & users) *(Mr. Benson Obwanga; Laikipia University, Kenya/Dr. Katrine Soma; WUR, the Netherlands)*
11.55	Wrapping up *(Mr. Benson Obwanga, Laikipia University, Kenya)*
12.00	Discussions on ways forward *(Dr. Jonathan Munguti, KMFRI, Kenya)*
12.30	End of meeting/Lunch

Appendix 2 Following the presentations, some questions were asked and here are some responses

Dennis Ayimba: Demsa Fish Farm (Director) (In the meeting):

1. Needs for some clarifications of the feed trials about the shares of 20% shrimp/ BSFL and 80% commercial feed:
   Answer by Mary Opiyo: The 20% Shrimp was dried and chopped freshwater shrimp *Caridina niloticus* which was mixed with Commercial feed 80%. This was calculated based on the weight of feed on dry matter. The weight of feed to be used was determined and apportioned to 20% and 80% before mixing the two together for feeding. (See Chapter 3 above for more information).
2. Given potential demand – how much is needed to substitute fish meal in terms of dried or fresh larvae and what are the costs?
   Answer by Mary Opiyo: Trials have indicated that replacement of fish meal up to from 30% to 50% leads to better growth of fish. This is calculated on the quantity of protein used in feed formulation of a Particular diet. BSF costs ranges from €10 to €12 in Kenya while fish meal costs €12 to €15.
3. Regarding the availability of organic waste especially in rural areas – could water hyacinth, which is a weed, be used instead? How much organic waste is needed to produce how much protein and feed?
   Answer by Fredrick Juma: Water hyacinth is being used in the production of BSF by a company in Homabay. From one tonne of organic wastes one can get 150-250kgs of live BSF. However, it needs some food remains to be added so that it is not only plants but a mixed diet for better quality of BSF.
4. What are the production costs per kg, and price in the market? This can become an extra income for the farmers.
   Answer by Fredrick Juma: The feed used for BSFL (e.g., organic waste, fish waste, brewers waste, blood) will dictate the amount of BSF produced, and the cost can range between KES 70-140/kg for fresh, while the price for dried larvae will double.

Madeline Mung'ei (online):

5. Based on an example of milk, where new more advanced treatments that improve the preservation of it, using BSFL instead of fish meal – will the quality go down when using the BSFL as a compromise with all the other benefits?
   Answer by Mary Opiyo: The quality of BSFL depends on the feed. With high protein levels in feed, the quality of the protein becomes better. With organic waste, the comparison in protein levels in BSF larvae fed on kitchen wastes or fish wastes is better that BSF larvae fed on plant materials only. The quality of the BSF also affects the quality of the fish reared and this needs to be considered while producing the BSF larvae. The BSF should not be fed to the fish alone but should be mixed with other ingredients to ensure that quality feed which results to good flesh quality is achieved.

Shaphan Yong Chia (online):

6. Looking at the Footprint Analyses, are the impacts dependent on the composition of the organic waste compared with landfill?
   Answer by Dr. Hassan Pishgar Komleh: Composition of the organic waste is one the most important factors in environmental analysis of BSFL. It has impact on:
   - The amount of GHG emissions in the landfill (higher organic matter, higher methane emission)
   - The amount of GHG emissions during rearing process
   - The quality of final product (nutritional value). Higher quality BSFL means more GHG emissions can be avoided
7. When replacing the BSFL with fish meal – is the replacement made based on weights or nutrition (protein level?)

Answer by Mary Opiyo: the replacement is done based on the protein level. For our trial, we were not replacing the protein level but adding *Caridina niloticus* or BSF larvae to commercial feed as a feeding strategy to reduce the cost of feed.

Nicolas Umuhizi (online):

8. It is not clear what the role of the private sector is exactly, could you specify?
   Answer by Katrine Soma: The private sector includes the commercial feed producers. The commercial feed producers today have an urgency of getting enough waste to feed the BSFL. They have therefore engaged a lot of farmers to feed the BSFL on their own farm, as this will reduce the transport costs. They also engage the public sector to assist in selecting organic waste from e.g., schools, hospitals, community markets, or by other firms (e.g., slaughterhouses or fish processing firms). In this way they are contributing to reducing climate footprints of feed production, increasing opportunities for small scale farmers to earn extra income, supplying farmers with high quality fertiliser converted from the feed, and contributing to a high-quality feed product, with possibilities to reduce price in future.

More information
Dr. Katrine Soma
T +31 (0)623259872
E katrine.soma@wur.nl
www.wur.eu/economic-research

2023-007