# Alternative proteins

*Unlocking the potential of circular proteins for animal feed in Tanzania*

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# Abbreviations

| | |
|---|---|
| ASDP | Agricultural Sector Development Program |
| BSE | Bovine Spongiform Encephalopathy (mad cow's disease) |
| BSF | Black Soldier Fly |
| EKN | Embassy of the Kingdom of the Netherlands (in Tanzania) |
| EUR | Euro |
| FAO | Food and Agriculture Organization of the United Nations |
| FDOV | Facility for Sustainable Entrepreneurship and Food Security |
| HPFI | High Protein Feed Ingredient |
| kg | Kilogram |
| Larive | Larive International B.V. |
| MN | Million |
| MT | Metric Tonnes (1,000 kg) |
| NEA (RVO) | Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland) |
| PIB | Partners for International Business |
| PPP | Public-private partnerships |
| PSD | Private Sector Development |
| R&D | Research and Development |
| SDGP | Sustainable Development Goals Partnership |
| TBC | Tanzania Broadcasting Cooperation |
| TBS | Tanzania Bureau of Standards |
| TZS | Tanzanian Shilling (TZS 1,000 = EUR 0.38*) |
| USD | United States Dollar |

*As of December 22, 2021.

# Introduction & Executive Summary

# Introduction

*The East African feed market struggles with limited raw materials and high prices*

**Animal feeds are prioritized by the Tanzanian government**

As the population and level of income in Tanzania are rising the demand for animal protein will likely increase. In particular, the poultry sector is expected to grow, requiring 18 million MT of feed per annum by 2050. The Agricultural Sector Development Program (ASDP) by the Tanzanian government mentions that Animal feeds are the largest constraint to animal productivity improvement. The need for local fish feed production was mentioned as the most important constraint for aquaculture sector development by Deputy Minister for Livestock and Fisheries Hon. Abdallah Hamis Ulega. Furthermore, the Aquaculture Association of Tanzania also mentioned feed as the sector's most significant challenge during Aquaculture Working Group Discussions. The Tanzania Livestock Master Plan (TLMP), based on a 15-year sectoral analysis (2016-2031), aims to create a livestock sector model and quantitative analysis of the present technical performance of the sector. It also models the economic contribution of potential interventions to households, value chains, the livestock sector, the agricultural sector, and the national economy.

In Tanzania, the feed industry relies heavily on a narrow protein source base, namely fishmeal and soybean meal. Soybean meal has been a major source of protein for feed millers in Tanzania. Most soybean meal is imported from Zambia and Malawi, but the availability of soybean meal is decreasing, and the prices are rising, directly impacting feed prices. In 2020, soybean meal sold for USD 0.76 per kg, and in 2021, the price had risen to USD 1 per kg. Because of heavy rainfalls and decreasing harvests, it is expected that the prices will continue to rise.

**The East African feed market**

Tanzania Is not the only country struggling with the problem of high prices for raw materials for feed. The Kenyan government dropped the duties on imported feed ingredients (e.g., yellow corn) in December 2021, encouraging increased production and improved livelihoods of farmers. With shortages of raw materials and rising prices, production became more unsustainable. Many feed manufacturers and farmers had to close businesses. The Citizen of Tanzania reported the closing of 30 feed manufacturers in Kenya in August and September 2021. Farmers suffered losses as well, with one Kenyan farmer reporting that his cooperative reduced from 750 members to less than 450 in the recent months.

**The interest of regional and international feed producers in the Tanzania market**

Because of the high potential of the livestock sector, several international feed producers follow the development of the Tanzanian animal production segment closely. Besides the international producers, several regional feed producers currently produce feed with locally sourced raw materials and sell their products on the Tanzanian market. This includes producers from Kenya, Zambia and Uganda. Tanzanian and international feed millers are important stakeholders as they will drive the development and uptake of the alternative raw materials sector.

Sources: Feed Strategy (2021), Lamtey, G. (2021), Ministry of Livestock and Fisheries (MLF) 2017, Tanzania Livestock Master Plan; 2020; EKN (2020), Poultry Study Tanzania.

# Introduction

*Alternative protein feed ingredients potentially offer sustainable solutions to feed millers*

**Alternative protein feed ingredients**

Alternative feed ingredients are feed ingredients that have not previously been used in Tanzania on a commercial scale. They require additional research to discover their full potential. A successful alternative protein substitute has an adequate supply, is readily available, is affordable and has proper nutrient levels. Furthermore, it should not contain high levels of anti-nutritional factors or other harmful components. In this study, a special focus is placed on **circular** alternative proteins. Alternative ingredients were assessed on their quality, consistency, price, volume and growth potential.

**Limited accessibility of raw materials for feed millers**

High cost and limited fluctuating availability of commonly used raw materials such as soy and maize are key constraints for animal feed producers in Tanzania. These supply issues necessitate feed producers to identify and develop locally available alternative sources of their protein feed ingredients.

Tanzania has great potential for protein ingredients due to its abundant natural resources and climate. There are currently around 100 feed mills in Tanzania but an estimated 50 animal feed mills may meet minimum compliance of which 15-20 are seen as operating at professional and commercial levels. Poultry feeds are the most dominantly compound feed produced (approx. 95% of total), followed by dairy, pig and fish feeds. Total demand for animal feeds is estimated at 2.5 million MT with local production standing at just 800,000 (30% of demand). Despite the large supply-demand gap currently filled by imports, there is a high unutilized plant capacity with mills operating below 50% capacity, mainly attributable to poor supply of raw materials and high plant running costs.

Key protein feed ingredients such as soybean meal have become more expensive and less accessible for feed producers due to rising regional and global demand, decreased harvests and disrupted global supply chains. This drives the need for increasing local production, to offset the dependence on imports.

The supply of local raw materials to feed millers is furthermore constrained by poor promotion of the available materials in Tanzania. Production is mostly fragmented, and the logistics of the sector are poorly arranged which makes it difficult for millers to find a reliable supplier that can offer necessary quantities. Due to seasonality and other factors, these raw materials also have fluctuating qualities, making it difficult to produce feed of stable quality.

Sources: EKN (2020) Poultry Investment Guide Tanzania; FAO (2015) Tanzania White Meat; FAO (2019) Poultry sub sector.

# Objective

*The study aims to find promising alternative feed ingredients to reduce production costs and increase sustainability in the sector*

**Purpose**

The purpose of this study is to contribute to bringing down costs and improving the quality and circularity of animal feeds produced in Tanzania by providing insights into the nutritional, technical and commercial potential of alternative proteins for animal feed in Tanzania. The use of protein alternatives, including waste streams, will enable the feed sector to become fully circular.

**Objective**

The overall objective of this study is to provide insights into the technical, nutritional and commercial potential of alternative circular protein ingredients for animal feed in Tanzania, with the following long-term benefits:

- Develop insight in local alternative raw material supply & demand;
- Identify pathways for buyers to local sourcing of raw materials;
- Promote the use of alternative and circular feed ingredients and encourage feed millers to look beyond their usual raw materials;
- Decreased dependency on commodity import and currency exposure;
- Lower feed production costs and improve high-quality feed sales potential;
- Increased farm performance and profitability through the distribution of high-quality feeds;
- Increased local and regional sourcing;
- Promote investment in local value chains and promote circular economy;
- Increased alternative ingredient producer-feed miller collaborations;
- Scale-up of production of alternative protein ingredients;
- Identification of market opportunities for Dutch technologies and expertise to catalyze private sector investment.

**Geographical scope**

The study focuses on Tanzania.

# Executive summary

**Sector overview**

- The Tanzanian feed industry is key to a sustainable and competitive livestock industry. It has been projected in the Tanzania Livestock Master Plan that the deficit in red meat demand in the future will be covered by white meat which is expected to be produced from mainly poultry and fish (especially aquaculture). The intensification of production relies on a constant supply of quality feed. This is hampered by a lack of adequate high-quality protein sources. The high cost and scarcity of currently used protein sources make production uncompetitive and hampers the advancement of the industry. The search for alternative circular protein sources is necessary to expand the protein source base and reduce production costs.
- The Tanzania feed industry relies heavily on maize and soy producers. While there has been much progress in maize production in the country surpassing domestic demand, there is a long way to go for soy production to meet domestic demand. The poultry, pig and aquaculture stakeholders are experiencing high prices of feeds leading to high production costs. They have little room to increase the prices of their products as they operate in a highly competitive environment.
- There are a total of over 100 operation feed mills in the country (both formal and informal). Current efforts by the government to register all feed millers to comply with all regulations are hampered by the informal nature of the sector.

**Supply & trade**

- There is a growing export market for red meat as well as for live animals (cattle, goats, sheep). This export is very pronounced to countries in the Middle East. There is also both official and unofficial movement of animals to neighboring countries and substantial trade in animal feed resources to neighboring countries.
- With the harmonization of the East African Feed Standards underway, the production of sufficient animal feed ingredients in Tanzania offers opportunities for internal market as well as export to neighboring countries.
- The identification and development of alternative feed ingredients, especially protein sources, is a necessary step to capture the high local demand as well as the export market. Currently, some of the protein sources are difficult to source locally because of the high demand for export.

**Market and market linkages**

- Most feed millers process poultry feed and, to a lesser extent, pig feed. Sourcing raw materials is a bottleneck, as it is time-consuming, supply is inconsistent, and quality and prices fluctuate frequently. Feed milers are willing to invest time and money in High Protein Feed Ingredients (HPFI) production. HPFI is another term for alternative feed ingredients, including Black Soldier Fly larvae, cattle blood, and many more. Producers include individual farmers but can also be cooperatives. Training is needed for both producers and feed millers. Currently, there is a lot of mistrust in the sector, which is hampering development.
- Information on prices and availability is mostly accessed through personal networks and HPFI producers who actively approach feed millers.
- Feed millers are hesitant to use alternative ingredients as it can take considerable time and investments to convince farmers and consumers the alternative ingredient can offer the same or better quality.
- Acceptable prices of feed millers are determined in different ways depending on their technological advancements. Often, the price is either directly or indirectly compared to the price of soy and sardines (dagaa or omena) (fish meal). Feed millers estimate that the (digestible) protein in an alternative should be around 30% cheaper compared to the (digestible) protein of soy.

# Executive summary, continued

**Alternative feed ingredients**

- The costs of commercial feed are high and rising still. The high cost of raw materials is the main motivation for feed millers to look for alternative ingredients. The most promising alternatives include cattle blood meal, Black soldier fly, brewer's yeast and cashew nut reject meal.
- 85% of feed millers have not used HPFI, but they are willing to use these when available, as many of them do not know where to source these ingredients. Most feed millers who do have experience with HPFI have experienced poor results. Training and networking for both HPFI producers and feed millers are needed to inform all stakeholders about the opportunities. Training is also needed for HPFI producers to learn about quality standards within the industry.

**Cattle blood meal**

- Cattle blood, a by-product of the slaughtering of cows, is relatively well-known amongst feed millers. In pure form, it can be mixed in with feed at a level of 2%. An adequately processed blood meal contains roughly 83% crude protein.
- Cattle blood must be processed (boiled) and stored under the right conditions to prevent oxidation, bacteria growth, or dissolved amino acids. Its reputation has been damaged by inconsistent product quality, leading to mistrust within the sector. Improper handling by any stakeholder along the value chain can cause sand to enter the blood meal, thereby lowering the quality considerably.
- The opening of new abattoirs offer opportunities to produce more cattle blood meal. The government is actively supporting farmers to have their cattle slaughtered at formal government-owned abattoirs, free of cost to farmers so that hygiene issues in the field are addressed. This means more blood will be collected at one place and in a more controlled and hygienic environment than open fields.
- Training is needed for feed millers and processors to talk about quality demands and opportunities and to overcome issues with product quality and trust.

**Black Soldier Fly larvae (BSF)**

- The black soldier fly (BSF), Hermetia illucens, is a large Stratiomyidae fly (13-20 mm size). Black soldier flies are renowned as being one of the most efficient waste Raw materials supplier 7s of the insect world, making BSF ideally suited for food production due to its rapid production cycle and high protein concentration in its maggots. The protein content BSF ranges from 37 to 63% of dry matter, while lipid content also varies from 7 to 39%, principally depending on the rearing substrates and environment. BSF is recently regulated by the Tanzania Bureau of Standards, meaning there are standards within the sector and the export opportunity is open.
- At present, production is small and experimental, with only a few producers in Tanzania. They are currently producing in open areas, keeping the prices low (TZS 2,000/kg) but the quality is unstable. Exploring the opportunities for production in controlled environments (with regulated humidity and temperatures) will increase the quality and reliability of the product. Experiments and research are needed to determine the cost price under controlled conditions.
- Training is needed for producers about the quality standards of the feed milling industry. Matchmaking and networking are needed for feed millers to learn about the opportunities of the product.

# Executive summary, continued

Brewer's yeast

- Brewer's yeast is the dried by-product of beer production. It is made from malted barley or other cereals, which are fermented in the brewing process to extract sugar. After some time, the remainder of the barley and cereal are discarded as brewer's waste. This brewer's waste is a liquid that can be dried into brewers' yeast or dry yeast. It takes approximately 10 liters of brewer's waste to make 1 kilo of dried product. It is considered a suitable source of protein for animals with an estimated crude protein of 40-55%. Brewer's yeast is produced by mainly two beer companies (Tanzania Breweries Limited and Serengeti Breweries Limited in Dar es Salaam). The Tanzania Bureau of Standard does not regulate brewer's yeast.
- Although not used in large quantities, the product is in demand among feed millers. The prices are low (TZS 800/kg). However, the production is currently still low, with only two breweries processing the liquid by-product into dried brewer's yeast. Drying the brewer's waste into brewer's yeast is capital-intensive.
- A feasibility study is needed to determine the economic feasibility of drying brewer's waste.
- Brewers show limited interest in selling the brewer's waste, but the exact reasons for their limited interest must be further investigated. A study business case must be developed to adequately map all the costs related to the product and its potential.

Cashew nut reject meal

- Cashew nut reject meal is produced while processing cashew nuts for human consumption. It is widely used due to its high protein and energy level. It consists mainly of broken pieces of cashew nut and some unpeeled cashew nuts, with an estimated composition with a minimum of 25% protein and 40% oil. There are potentially two products, cashew nut reject meal and cashew oil which can also be used in feed production. The potential lies in the government's priority to promote the crop countrywide and current industrialization drive. At present, cashew nut reject meal is not regulated by the Tanzania Bureau of Standards. Cashew processors are often small scale and difficult to find making it difficult to source.
- Although the potential is very large for this crop, it is difficult to source for feed millers. There are mostly small-scale processors of cashews, and they are scattered throughout the country. Due to the temperature, the harvest time for the cashews is between 3-6 months a year, making the product difficult to source year-round.
- Separating the oil from the rest of the cashew nut will increase the value significantly while opening more options for feed formulation.
- The economic feasibility of oil extraction (expelling) should be studied.

# Executive summary, continued

## Current constraints

**1. Limited information about using alternative ingredients**

- 1.1 Uncertainty about selection of ingredients.
- 1.2 Uncertainty about usage (processing requirements, inclusion rates, etc.).
- 1.3 Lack of trust & network.
- 1.4 Lack of communication.

**2. Limited availability of alternative ingredients meeting the criteria**

- 2.1 High prices and lack of large-scale producers.
- 2.2 Lack of local quality control and objective trials.

## Solutions

**1. Training & networking**

- 1.1 Research & study: Fully establish the potential of alternative ingredients.
- 1.2 Awareness campaign: Alternative feed ingredients are found easily and are processed using best practices.
- 1.3 Networking facilitation: Producers and feed millers explore opportunities, discuss business and trust each other.
- 1.4 Professional training facilities: Better practices, increased innovation and more trust within the sector.

**2. Demonstration & trials**

- 2.1 Improved technology and R&D: Trials, R&D, technology and financing allow for proof of concept. Production is scaled up.
- 2.2 Small-batch trials and harmonized standardization: Quality is guaranteed and innovation advanced.

# Approach & methods

# Approach

The study has been performed between September 2021 and March 2022.

| Phase | Scope/activity |
|---|---|
| **Phase I**<br>**Assessment and selection** | High-level assessment of 29 alternative feed protein ingredients with the highest potential for feed production.<br>• Method: desk research (literature study), expert knowledge and validation interviews.<br>• Deliverable: Overview of top 29 protein feed ingredients with the highest potential in terms of nutrition, commercialization, scale-up, production/ technical. |
| **Phase II**<br>**Analysis** | In-depth analysis of top 4 selected alternative protein ingredients.<br>• Method: Desk research (existing studies, review of Tanzanian and international information) and interviews with feed millers and experts.<br>• Deliverable: Detailed assessment of the top-4 most promising alternative protein sources for (poultry) feed production in Tanzania. |
| **Phase III**<br>**Matchmaking** | Overview of the most promising ingredient producers.<br>• Method: Interviews with sector stakeholders, experts, private sector players, and governmental bodies.<br>• Deliverable: The ingredient producers of the top-4 most promising alternatives are invited to the Evaluation Workshop to network with feed millers. The event is attended by ingredient producing companies and feed millers as well as public sector stakeholders and associations. |
| **Phase IV**<br>**Development opportunities** | Assessment of development opportunities of top-4 protein ingredients, including involvement of Dutch public and private sector.<br>• Deliverable: Roadmap for alternative protein sources in the Tanzanian poultry feed value chains. |
| **Phase V**<br>**Reporting** | Reporting all results in final report<br>• Deliverable: Final report, including:<br>o Matrix summarizing characteristics of selected protein ingredients;<br>o Roadmap for the development of alternative protein ingredients production;<br>o Recommendations for the embedding of knowledge and knowledge exchange;<br>o Mapping of opportunities for Dutch technology and expertise. |

# Methods

Each alternative protein is rated on the following criteria (see matrix on the right) based on literature study and expert interviews. A score is assigned to each of the ingredients for each of the criteria. The following criteria are included (sample):

- Familiarity amongst feed millers in Tanzania
  Many feed millers use raw materials they know and are familiar with. When alternative ingredients are completely unfamiliar to farmers, it might be more difficult to inform them of its usage.

- Competition with human consumption
  Alternative ingredients which compete with food are likely to have higher prices. Furthermore, it is considered less sustainable than products which would otherwise be wasted. Pigeon pea and rapeseed are examples of products which can also be used directly as human food.

- Ease of handling / storage and stability
  Some raw materials, especially those of animal origin, can be challenging to store; deterioration must be prevented. The ease of handling, transport, and storage, is an important factor determining the chance of success and the ease of use of the alternative ingredients.

- Processing requirements of raw materials
  Some products require more processing steps than others, meaning the costs of processing will likely be higher.

The ingredients are scored based on their total number of points. To ensure the point system allows for a realistic assessment of the local context of Tanzania, local experts have assessed the scores and assisted in determining the four most attractive alternative proteins.

| Technical potential | | Nutritional potential | Commercial potential | |
|---|---|---|---|---|
| Sustainability factors | Production factors | Nutritional composition & availability | Supply factors | Price factors |
| Familiarity amongst feed millers in Tanzania (low/high) | Ease of handling / storage and stability (low/high) | Metabolizable Energy (cutoff is 2,500 kcal/kg) | Availability in Tanzania (low/high) | Scalability potential (qualitative estimation) |
| Circular (low/high) | Processing requirements of raw materials (low/high) | Crude protein (cutoff value is 35%) | Variability / consistency in product quantity (low/high) | Price per kg product (TZS) if available |
| Environmental impact (e.g., carbon footprint, water usage, biodiversity loss, land use, etc.) (low/high) | Effect on pellet quality / mash structure (feed milling equipment and final feed product, including palatability) (low/high) | Lysine and protein quality (cutoff is 4% lysine) | Annual production (in MT) | Price per kg protein (TZS) if available |
| Competition with other sectors and/or human consumption (low/high) | Effect on final consumer product quality (texture, flavor, etc.) (meat, egg, milk) (low/high) | Methionine and protein quality (cutoff is 2% methionine) | Potential risks (qualified) | Processing costs per kg product and suitability for local feed milling equipment (TZS) |
| | Rules and regulations (legal/not legal) | Digestibility (including anti-nutritional factors) (low/high) | | Potential risks (low/high) |
| | | Hazards and food safety (low/high) | | Ease and costs of logistics (low/high) |
| | | Variability / consistency in product quality (low/high) | | Number of (large-scale) suppliers (nr) |
| | | | | Discounts* (yes/no) |

Source: Hamid et al., 2015.
*Product composition reducing the need for additional ingredients during feed milling

# Results

# 1. High-level assessment of most promising alternatives

# Longlist of potential alternatives

*Several feeds of animal origin, plant (by-)products and forage plants have been identified as potential alternatives*

Based on desk research and expert information, the following ingredients have been longlisted as potential alternatives. The rating is based on alphabetical order. Continued next slide.

| Number | Alternative protein | Category | Information source |
|---|---|---|---|
| 1 | Baobab seed meal | Plant products/by-products | Insights by Professor Lekule and the Transcend team |
| 2 | Black soldier fly larvae (BSF) | Feeds of animal origin | WUR Insects for Africa |
| 3 | Brewery yeast | Plant products/by-products | Utilization of spent brewer's yeast as a protein substitute for fish meal in diets of growing pigs (researchgate.net) |
| 4 | Carabid beetle | Feeds of animal origin | Commercialisation of Alternative Livestock Feeds Could Save Fish Stocks in Lake Victoria \| African Journal of Tropical Hydrobiology and Fisheries (ajol.info) |
| 5 | Cashew nut reject emal | Plant products/by-products | Insights by Professor Lekule and the Transcend team |
| 6 | Castor oil meal | Plant products/by-products | Alternative protein sources for poultry feeds - All About Feed |
| 7 | Cattle blood meal | Feeds of animal origin | Insights by Professor Lekule and the Transcend team |
| 8 | Cockroaches | Feeds of animal origin | Commercialisation of Alternative Livestock Feeds Could Save Fish Stocks in Lake Victoria \| African Journal of Tropical Hydrobiology and Fisheries (ajol.info) |
| 9 | Common Housefly | Feeds of animal origin | WUR Insects for Africa |
| 10 | Common vetch seeds | Plant products/by-products | Alternative protein sources for poultry feeds - All About Feed |
| 11 | Crickets (field crickets, (Gryllus testaceus), dried) | Feeds of animal origin | Protein Alternatives - Planet of Plenty |
| 12 | Earthworm | Feeds of animal origin | Protein Alternatives - Planet of Plenty |
| 13 | Fish by-products | Feeds of animal origin | Insect and fish by-products as sustainable alternatives to conventional animal proteins in animal nutrition (tandfonline.com) |
| 14 | Grasshoppers (Locust) | Feeds of animal origin | Protein Alternatives - Planet of Plenty |
| 15 | Green fodder | Plant products/by-products | Alternative protein sources in the nutrition of farm animals (researchgate.net) |

# Longlist of potential alternatives, continued

*Several feeds of animal origin, plant (by-)products and forage plants have been identified as potential alternatives*

| Number | Alternative protein | Category | Information source |
|---|---|---|---|
| 16 | Hempseed cake | Plant products/by-products | Alternative protein sources for poultry feeds - All About Feed |
| 17 | House cricket (Acheta domesticus), fresh | Feeds of animal origin | WUR Insects for Africa |
| 18 | House maggot meal | Feeds of animal origin | Alternative protein sources for poultry feeds - All About Feed |
| 19 | Litter Beetle (lesser mealworm), dried | Feeds of animal origin | WUR Insects for Africa |
| 20 | Moringa leaves, dried | Plant products/by-products | Alternative protein sources in the nutrition of farm animals (researchgate.net) |
| 21 | Pigeon pea seed | Plant products/by-products | Alternative protein sources for poultry feeds - All About Feed |
| 22 | Potato, leaf protein concentrate | Plant products/by-products | Insights by Professor Lekule and the Transcend team |
| 23 | Poultry slaughter waste | Feeds of animal origin | Insects have the x-factor, poultry meal has potential for impact at scale; Opportunity study on circular proteins for aquafeed in Egypt. \| Nieuwsbericht \| Agroberichten Buitenland |
| 24 | Rapeseed, meal | Plant products/by-products | Alternative protein sources for poultry feeds - All About Feed |
| 25 | Seaweed/microalgae | Forage plants | Seaweeds (marine macroalgae) \| Feedipedia |
| 26 | Silkworm pupae from silk production | Feeds of animal origin | Alternative protein sources for poultry feeds - All About Feed |
| 27 | Sweet potato foliage | Plant products/by-products | Alternative protein sources for poultry feeds - All About Feed |
| 28 | Termite, dried | Feeds of animal origin | Commercialisation of Alternative Livestock Feeds Could Save Fish Stocks in Lake Victoria \| African Journal of Tropical Hydrobiology and Fisheries (ajol.info) |
| 29 | Yellow Mealworm | Feeds of animal origin | WUR Insects for Africa |

# Shortlist of most promising alternative ingredients

*Cattle blood, black soldier fly, brewery yeast and cashew meal are considered the top-4 most promising alternative feed ingredients*

Based on desk research, expert information and validation interviews, the alternative ingredients score the following. The rating is based on the total score. Based on this selection, the most promising High Protein Feed Ingredients (HPFI) are cattle blood meal, black soldier fly, brewer's yeast and cashew nut reject meal. The full matrix can be found in Annex I (Excel).

The top-4 has been selected based on their total score, as well as their future potential.

1. Cattle blood is expected to increase in availability due to the increasing number of abattoirs being opened in Tanzania.
2. For BSF, the technological developments are advancing rapidly with many funds going into BSF R&D globally.
3. Brewer's yeast is a product high in demand amongst feed millers.
4. Similar to cattle blood, the availability of cashew nut reject meal is expected to increase due to the increasing production and processing of cashew on Tanzanian soil.

| Number | Alternative protein | Category | Nutritional score | Technical score | Commercial score | Total score |
|---|---|---|---|---|---|---|
| 1 | Cattle blood meal | Feeds of animal origin | 16 | 37 | 42 | 95 |
| 2 | Black soldier fly larvae (BSF) | Feeds of animal origin | 15 | 32 | 42 | 89 |
| 3 | Brewery yeast, dehydrated | Plant products/by-products | 14 | 33 | 34 | 81 |
| 4 | Cashewnut reject meal | Plant products/by-products | 12 | 37 | 26 | 75 |
| 5 | Sweet potato foliage | Plant products/by-products | 11 | 26 | 32 | 69 |
| 6 | Castor oil meal | Plant products/by-products | 13 | 25 | 29 | 67 |
| 7 | Baobab seed meal | Plant products/by-products | 13 | 34 | 19 | 66 |
| 8 | Potato,Leaf protein concentrate | Plant products/by-products | 15 | 24 | 27 | 66 |
| 9 | Hempseed cake | Plant products/by-products | 13 | 27 | 20 | 60 |
| 10 | Rapeseed, meal | Plant products/by-products | 15 | 22 | 22 | 59 |

# 2. Feed millers demands

# Requirements of feed millers

*Feed millers are searching for cost reduction, while receiving constant quality, a long shelf life, and compliance with regulations*

The main reasons for feed millers to search for alternative ingredients are:

- The cost price of soy is increasing fast. Two years ago, the price was TZS 1,800/kg. Now the price is at TZS 2,300/kg. The harvests in Zambia and Malawi will be low in the coming years, and prices will increase even further. To keep the prices of feed affordable, low costs alternatives must become available.
- It becomes more challenging to find good ingredients. Import is often tricky, and local alternatives are unreliable in terms of quality.

For all feed millers, consistent quality and reasonable price are important. With different access to information and formulation software*, price demands can differ between feed millers. Feed millers have in common that they require raw materials with a moisture content below 12%.

The requirements from feed millers can be separated into three categories, as feed millers with advanced formulation technology have different demands than those using less advanced methods or no formulation software at all.

1. Feed millers which use advanced processing methods usually use formulation software to assess a potential new raw material. This software considers all nutritional aspects of the feed as well as the price. The formulation can change day-to-day depending on price fluctuations. These feed millers often use the cost of soy and sardines (dagaa/omena or fish meal) as a baseline. As a rough estimation, it can be assumed alternative proteins become competitive if their digestible protein levels are 30% cheaper than the baseline (soy and sardines).
2. In contrast to feed millers who are using advanced technology, feed millers using less advanced methods usually assess products based solely on their protein level and price. If the protein is cheaper than their current raw materials, they can add it to their formulation software. In this assessment, the feed millers take fewer nutritional components into account and are willing to use it if the protein source is about 30% cheaper than soy.
3. Feed millers without formulation software look at the protein level and go for the cheapest protein source.

| Feed miller | Requirement (MT / week) | Price willing to pay (TZS/kg) |
|---|---|---|
| Feed miller 1 | 200 | 1,000 |
| Feed miller 2 | 35 | 500 |
| Feed miller 3 | 137 | 200 |
| Feed miller 4* | Unknown | 200 |
| Feed miller 5* | 135 | 1,200 |
| Feed miller 6 | 70 | 1,100 |
| Feed miller 7* | Unknown | 1,000 |

*Experience with importing soy from Zambia and Malawi

* Formulation software is used to take the price and all nutritional aspects of many raw materials into account to calculate the cheapest composition of feed.

# Working with feedmillers

*Feed millers are willing to invest in a reliable supply of raw materials, but require training and more trust in their potential partners*

**Current communication**

Feed millers generally expect ingredient producers to reach out to them. They are interested in alternatives but rarely actively look for them. There is an informal network in which people exchange information. However, the network is limited, and many alternative ingredient producers are not participating.

**Quality standards**

Feed millers are interested in alternatives and working with producers to use alternative ingredients in feed production. For them, the biggest constraint is the lack of knowledge. They mention that often alternative ingredient producers do not know about the quality standards needed for animal feeds. Further, feed millers with limited resources state they don't know what to do with new ingredients and could use training themselves.

**Investments**

Feed millers are willing to invest time and money in developing alternative ingredients. However, mistrust is common within the sector as they often deal with severe quality issues. According to feed millers, something needs to restore trust before working together.

**Perception by farmers and the consumer**

Many feed millers are reluctant to use alternative raw materials due to the perception of farmers and consumers on eating insects. Previously, fish meal was used as one of the primary protein sources in feed. Due to quality issues, producers switched from fish meal to soy as a main protein source. The transition was successful, but it took a long time. It took feed millers time and investments to convince farmers to start buying feeds without fish meal. Further, it is known that people from certain ethnicities have objections to certain ingredients because of their religion or customs. For the top-4 ingredients selected in this study, this could potentially have consequences for cattle blood, as people from the Jewish community can object to its use. However, especially the smaller- to medium-scale feed millers seemed unconcerned, as the Jewish religion is not common in Tanzania.

| Feed miller | Maximum distance willing to travel (in hours) | Maximum transport costs willing to pay (TZS / kg) |
|---|---|---|
| Feed miller 1 | 9 | 100 |
| Feed miller 2 | 6 | 50-100 |
| Feed miller 3 | 6 | 50 |
| Feed miller 4 | 6 | 50-100 |
| Feed miller 5 | 9 | 50 |
| Feed miller 6 | 6 | 50-100 |
| Feed miller 7 | 5 | 50-100 |

# Tanzania Bureau of Standards (TBS)

*TBS is a governmental body developing standards for animal feed products to assure quality and promote export*

Tanzania Bureau of Standards

- The Tanzanian Bureau of Standards (TBS) was established in 1975, becoming operational in 1976. TBS is a statutory body of the government and is fully financed by the government. TBS is responsible for developing standards, quality control, and training.
- A committee within TBS develops and approves standards for each product commonly used as animal feed. This includes both feed ingredients and compounded feeds.
- Any feed ingredient producer or distributor may send a request to TBS for feeds with no standards yet developed. Samples will be taken for laboratory analysis, request will be tabled and once approved it will be sent for regional decision and harmonization.

Implications for international trading

- Currently, all standards are harmonized among East African countries. Therefore, once approved at the regional level, any product can be traded freely throughout the region. At present, there are no serious consequences of using a product which has no standard.
- However, compounded feeds must meet standards and ingredients sold commercially need to abide by standards if they are meant for import or export. Where ingredients do not meet the standard, one is encouraged to suspend production until the standard is attained.

TBS standards for alternative feed ingredients

- Of the four promising alternative feed ingredients, only cattle blood meal and BSF have received formal TBS standardization. Brewer's yeast and cashew nut reject meal have not received standardization.

TANZANIA BUREAU OF STANDARDS

The Name of Standards

# 3. In-depth analysis of most promising alternatives

# 1. Cattle blood meal

*Cattle blood meal is a slaughter by-product with a high protein content (83%), sold for EUR 0.4/kg*

Description

Cattle blood meal is a by-product of the slaughter process, produced by boiling and drying fresh cattle blood. One animal by-product can be used as a protein supplement in animal feed. As cattle blood meal is a by-product of slaughterhouse production, the scalability depends on the development of meat production in Tanzania. There are many abattoirs and slaughterhouses throughout Tanzania, making the product widely available.

Adequately processed blood meal contains roughly 83% crude protein. Cattle blood meal is a TBS-regulated product, making this product ready for commercialization.

Production process

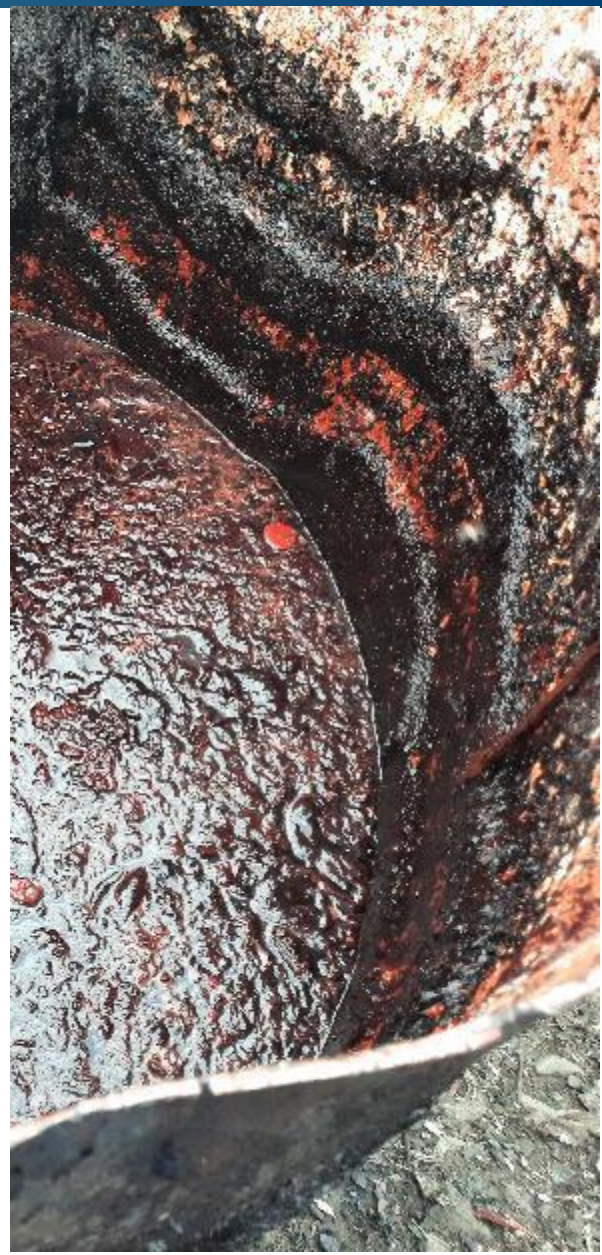
1. Collection of fresh blood: rendering the animal insensitive and bleeding through the jugular vein or severing the head (halal method) and collecting the raw blood in a container. In abattoirs, the cattle are slaughtered on concrete floors with gutters. The blood is caught in these gutters, often already coagulated and can be scooped out with buckets.
2. Boiling: boiling the blood in metallic or aluminum pots. Large metal containers are often used that can be held above a fire.
3. Drying. the cooked blood is placed on plastic sheets outside, and drying is usually done in the sun, so there are seasonal fluctuations.
4. Packaging: the cattle blood meal is packaged in bags and prepared for transport.

| Proximate composition | Cattle blood meal |
|---|---|
| Dry matter | 93.7% |
| Ash | 5.6% |
| Crude protein | 90.9% |
| Crude fat | 0.0% |
| Moisture | 6.3% |


*The Tanzania Bureau of Standards (TBS) is the national standards body for Tanzania established by the government.

# 1. Cattle blood meal, continued

*Most feed millers are familiar with the product, but the quality is inconsistent*



### Quality issues

There are several quality issues regarding the cattle blood:

1. Along the value chain, cattle blood is often **mixed with sand**. According to experts, sometimes up to 20% sand is mixed through the blood meal to increase the weight and improve the margin of the bloodmeal. The sand, however, reduces the product's nutritional value and can damage the feed milling equipment. Due to this contaminated feed being sold in the market, millers can be hesitant using bloodmeal and mistrust potential suppliers.
2. Bloodmeal must be processed (boiled) and stored correctly. If not, several issues can occur, including:
    a) If the bloodmeal is not stored correctly, chemical reactions create toxic compounds. Once processed into the feeds, these compounds will negatively affect the health and growth of the animal. Proper boiling and storage of the bloodmeal will avoid this **oxidation**.
    b) If bloodmeal is not correctly boiled, dried or stored, high amounts of **bacteria** can grow, leading to health risks for the animals and the consumers.
    a) If the bloodmeal is overcooked (not adequately cooked), the **amino acids will disintegrate**, lowering the bloodmeal quality.

In Europe, the use of cattle blood was associated with the mad cow disease (BSE-Bovine Spongiform Encephalopathy) outbreak of 1986-2001. Because of improper usage and not heating the product properly, the use of meat-and-bone meal was likely to carry the infecting agent to cows, causing a ban on using cattle blood in animal feed in Europe from 2000-2005. The ban was lifted, although some feed millers remain hesitant of using the product because of negative associations in the past. All the same, since the early 2000's, feed millers have gained extensive knowledge and experience on using the product safely and are currently mostly using the product for pet food and other applications.

### Price

The price estimates range from TZS 922 to 1,153 (EUR 0.35-0.4) per kg. The average price is TZS 1,044 (EUR 0.4) per kg. It is estimated the cost would vary throughout the year, with price fluctuations related to seasons. It is easy to dry and transport blood meal during the dry season, making it readily available, and the price goes down. During the wet season, drying and transporting blood is more difficult, and the subsequent shortage creates an increase in price.

# 1. Cattle blood meal, continued

*Cattle blood is a widely available product and meets TBS standards*

### Familiarity and experience

Most feed millers are familiar with cattle blood meal, and they consider blood meal to be readily available at a reasonable price. It is also sometimes used for human consumption, further increasing familiarity.

### Market description

In 2020, the total number of cattle and buffaloes slaughtered in Tanzania was 3.33 million. Each animal produces about 10 kg of blood with dry matter content of 20%. If only 30% of the blood could be collected and appropriately processed, there would be a potential production of roughly 2,000 tonnes of blood meal per year.

Recently the Tanzanian government decided to build more modern slaughterhouses to make the slaughter procedure more hygienic. Farmers can go to the slaughterhouses and slaughter their cattle there. The blood and other waste products can be saved. Farmers can choose to keep the blood or sell it to traders present at the slaughterhouses. Therefore, these new abattoirs can potentially be an opportunity to increase the production of hygienically processed bloodmeal.

The producers of cattle blood indicate the best places for meeting their clients (feed millers and livestock keepers) are farmer's meetings, surveys, as well as referrals and marketing and promotion (social networks like Facebook and Instagram, having a website or trade show). Usually, there is a direct arrangement between factories and manufacturers of the feed.

### Potential

There are TBS standards for cattle blood in Tanzania and its use is deemed safe to use if properly processed and stored. Inclusions of 2% or less are considered to be safe. In poultry feeds, especially, pure cattle blood must be limited to 2%, as the smell can encourage cannibalistic behavior in the birds.

# 1. Cattle blood meal, continued

*Interventions in technology, market linkages and financing are necessary*

### Valuable interventions

To tailor to the consumer demands in quality, producers foresee the following interventions to be meaningful:

- Knowledge exchange and awareness campaigns for producers. The production standards and quality risks are relatively unknown among producers.
- Education of feed millers about quality standards and inclusion rates, to avoid over usage.
- Encouraging processors to produce bloodmeal on a large scale to make it more accessible for large feed suppliers. This could be a business opportunity, especially with the new abattoirs being set up in Tanzania.
- Facilitating networking, forcing new connections and building trust. Many producers are hesitant to use cattle blood meal due to the polluted product with sand circulating the market.
- Improved processing and storage facilities.

Appropriate processing would create a high demand for the product in the country and outside the country with potentially high production.

### Circularity

As the cattle blood is a by-product, its use could be seen as circular. Some ethnic groups use cattle blood for direct (human) consumption. However, they mostly use their own cattle and not those from commercial slaughterhouses. Therefore, there seems to be no competition with immediate human consumption. Blood meal is relatively high in demand but does not reach its potential due to inconsistent supply and quality.

# 2. Black Soldier Fly larvae (BSF)

*BSF are an efficient protein producer, but they are currently only used in trials and are not formally regulated by TBS*

## Description

The black soldier fly (BSF), Hermetia illucens, is a large Stratiomyidae fly (13-20 mm size) found worldwide. Black soldier fly larvae are exceptional at converting waste into quality protein. Black soldier flies are renowned as being one of the most efficient waste Raw materials supplier 7s of the insect world, making BSF ideally suited for food production due to its rapid production cycle and high protein concentration in its maggots.

The protein content BSF ranges from 37 to 63% of dry matter. Lipid content varies from 7 to 39%, principally depending on the rearing substrates and environment. BSF is regulated by the Tanzania Bureau of Standards, meaning there are standards within the sector and the product could be used for export.

| Proximate composition | Black soldier fly |
|---|---|
| Dry matter | 94.9% |
| Ash | 0.0% |
| Crude protein | 28.3% |
| Crude fat | 40.0% |
| Moisture | 5.1% |

## Production process

Generally, BSF production is carried out in three steps:

1. The first step is the breeding phase which involves collecting the eggs of the Black Soldier Fly. The eggs are laid by mature Black Soldier Flies in special trays, making it easy to collect them. The eggs are generally collected every two days, after which they are transferred to special feeding containers in which they can grow for a few more days before entering the production phase.
2. The flies are placed on a plastic tray with organic waste for nine days in the production phase. During this time, they convert the organic waste into protein-rich body mass. After nine days, the larvae are harvested. If desirable, a small portion can remain for reproduction.
3. After harvesting, the larvae are dried in a mechanical dryer, after which the dry maggots can be grinded depending on the customers' wishes.


*The Tanzania Bureau of Standards (TBS) is the national standards body for Tanzania established by the government.

# 2. Black Soldier Fly larvae (BSF), continued

*High production costs and a complex value chain hamper production*

### Price

Feed miller Feed miller 2 is holding trials with BSF and indicated a sales price of TZS 507 / kg (EUR 0.19). This price is a reduced rate because they are currently executing a trial. Producer Raw materials supplier 7 Company indicated a sales price of TZS 2,250 / kg (EUR 0.86). However, the current production occurs in the open air, and as explained below, this has a significant effect on the quality. If a more constant rate is produced, the price will likely rise. More research is needed to know the cost of BSF on a large scale under controlled conditions. Feed millers indicate they are willing to pay an average of 700 TZS for BSF.

### Familiarity and experience

Most feed millers are not familiar with the product and/or cannot find availability of it in the market. However, respondents note the high availability of R&D and studies from other countries. Feed miller 2 is currently conducting a third trial with BSF. So far, all trials are promising. Other feed millers do not have any experience.

### Product quality

Production of BSF in Tanzania is experimental. Therefore, no significant industrial quality issues have been discovered. Producers of BSF mention that the final product quality can differ due to climatic conditions. Depending on the temperature and humidity, the protein content can differ significantly, making it hard to become a reliable raw material producer in current conditions. Producing BSF in a controlled environment will solve this issue; however, the equipment and electricity needed will likely increase the cost price. Further, due to the small scale of current production, it is unclear if a waste stream of a constant quality can sustain a large BSF production.

### Market description

BSF has not been adopted as a common feedstuff. There are a few producers producing them on a trial basis. Once the trials prove economic viability, they expect to attract investors for commercial production. The market is still in its early stage, and producers indicate that they need to learn about an optimal value chain, the necessities for large-scale production, and the demand from feed millers.

# 2. Black Soldier Fly larvae (BSF), continued

*Valuable interventions are more advanced technology and improved market linkages*

### Valuable interventions

To tailor to the consumer demands in quality, producers foresee the following interventions as most meaningful:

- Execute large-scale trials.
- Execute trials under controlled conditions, especially to determine the costs price.
- Bring together producers with feed millers to discuss standards and conditions.
- Research reliable waste streams for large scale BSF production.

### Sustainability

As BSF is currently produced on an experimental basis, it is only used in animal feeds on a trial basis. It will not compete directly with human consumption. The BSF could turn waste into raw materials, making it sustainable by replacing other protein sources.

### Circularity

Sustainability and circularity depend largely on the waste streams used to feed the BSF. If the feed used is not a waste stream the BSF can perhaps not be considered sustainable. If waste products are used, the process can be regarded as circular.

Image source: Muhammad Mahdi Karim

# 3. Brewer's yeast

*Brewer's yeast is a reasonably-priced by-product which is presently not regulated by the TBS*

| Proximate composition | Brewer's yeast |
|---|---|
| Dry matter | 87.4% |
| Ash | 8.1% |
| Crude protein | 35.4% |
| Crude fat | 1.6% |
| Crude fiber | 2.9% |
| Moisture | 12.6& |

## Description & production process

Brewer's yeast is produced in beer production from the malted barley or other cereals. These are fermented in the brewing process to extract sugar. After some time, the remainder of the barley and cereal are discarded as brewers waste. This brewers waste is a liquid that can be dried into brewers' yeast or dry yeast. It takes approximately 10 litres of brewer's waste to make 1 kilo of dried product. It is considered a suitable source of protein for animals with an estimated crude protein of 40-55%. Brewer's yeast is produced by mainly two beer companies: Tanzania Breweries Limited (TBL) and Serengeti Breweries Limited (SBL), both located in Dar es Salaam.

The Tanzania Bureau of Standards does not regulate brewer's yeast. There is not yet a request made to the TBS for the standardization of the product.

## Price

Prices average to TZS 500 / kg (EUR 0.23). One producer indicates selling for TZS 800 / kg (EUR 0.30). Compared to other proteins such as soy (TZS 2300, EUR 0.87 / kg), this price is relatively low. None of the respondents could explain this difference in price or why the price of brewer's yeast does not increase in times of scarcity in proteins. A potential explanation could be that the breweries do not give a lot of attention to the product as they are unaware of the potential. Their focus is on beer production, which may have higher margins at this time.


*The Tanzania Bureau of Standards (TBS) is the national standards body for Tanzania established by the government.

# 3. Brewer’s yeast, continued

*Inconsistent supply hampers large scale production of brewer’s yeast*

### Familiarity and experience

Most feed millers are not familiar with the product or do not know where to purchase it. The few millers that have experience with it are happy with the product itself but say it is difficult to get and the quantities are too small to use it more regularly or on a larger scale.

### Quality issues

Dryers and electricity are necessary to process the liquid by-product into brewer’s yeast, and not all breweries are willing to purchase this. As the processing cost for drying are relatively high, this causes a low demand. If not properly dried, quality issues would arise.

### Market description

Only two breweries in Tanzania are considered significant enough to potentially produce an interesting amount of brewer's yeast. Both brewers are currently not producing brewer's yeast. One does not have a dryer, while the other stopped because the processing costs were too high. One brewery indicated they could produce 49,000 litres of brewer’s waste per month, resulting in 4,900 kg brewers' yeast per month. Assuming the other brewery producers roughly the same amount, yeast comes to approximately 120 tonnes per year. Brewer's yeast is expected to be produced year-round without known fluctuations in quantity.

Brewer’s waste (not dried) can also be used. Some dairy and pig farmers have been known to use the unprocessed brewers waste to supplement dairy and pig feeds. There are no known effects of this other than only farmers living close to breweries can do this due to the high transport costs of the brewer's waste.

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# 3. Brewer’s yeast, continued

*With high potential for dairy, poultry and pig feed, technical support is needed to advance the market*

### Valuable interventions

To tailor to the consumer demands in quality, the following interventions are considered most meaningful:

- Conduct a study on the economic feasibility of drying brewers waste into brewer's yeast.
- Educate brewers on the potential to use waste in produce yeast.
- Develop a detailed business case on the possibilities of using brewers waste in animal feeds.
- Look into the options of using brewers waste (liquid form) as a feed supplement.

### Sustainability

The drying of brewer’s waste into brewer’s yeast requires energy, which could potentially cause damage to the environment.

### Circularity

Brewer's waste is a product that is now often discarded as waste. Turning this waste into brewer’s yeast and use in animal feeds makes it circular as the waste source is turned into another product.

# 4. Cashew nut reject meal

*Broken pieces of cashew have a high protein and energy level, although it not formally regulated*

## Description

Cashew nut rejects meal is produced while processing cashew nuts for human consumption. It is widely used due to its high protein and energy level. It consists mainly of broken pieces of cashew nut and some unpeeled cashew nuts, with an estimated composition with a minimum of 25% protein and 40% oil. There are potentially two products, cashew nut reject meal and cashew oil which can also be used in feed production. The potential lies in the government's priority to promote the crop countrywide and current industrialization drive.

At present, TBS does not regulate cashew nut reject meal. There is not yet a request made to the TBS for the standardization of the product.

## Production process

The cashew nuts are first selected based on their suitability for human consumption. Here the rotten or spotted cashews are removed. After this, they are roasted and peeled. During this process, rotten and spotted cashews are removed as well. Processing involves removing the outer cover of the nut. This is relatively simple and involves very rudimentary processing equipment. Most of the processors do most or all of the work manually.

## Price

Traders state the cashew reject meal is usually traded for prices ranging between TZS 525 / kg (EUR 0.20) and TZS 600 / kg (EUR 0.23). A cashew processor claims they sold cashew reject meal for TZS 8,000 / kg EUR 3.04 / kg. According to experts, separating the oil from the remainder of the cashew meal is possible and an interesting business opportunity. The oil would be worth around TZS 2,000 / kg (EUR 0.76), while the remainder of the cashew reject meal would be worth TZS 500 (EUR 0.19).

| Proximate composition | Cashew nut reject meal |
|---|---|
| Dry matter | 93.3% |
| Ash | 0.0% |
| Crude protein | 22.2% |
| Crude fat | 42.6% |
| Crude fiber | 6.2% |
| Moisture | 6.7% |

*The Tanzania Bureau of Standards (TBS) is the national standards body for Tanzania established by the government.

# 4. Cashew nut reject meal, continued

*Suppliers find clients through surveys, direct contact and events*

### Familiarity and experience

Most feed millers indicate not to be working with cashew nut reject meal or even being familiar with the product. The few that did try it used it because the price was lower compared to other protein sources.

### Quality issues

Cashew nut reject meal can be included in the feed, but there might be limitations to reaching the desired protein content due to the high fat and energy content. This fat reduces their shelf life to include it in animal feeds directly. Without processing, the cashew nut reject meal needs to be used within three weeks after harvest; otherwise, the reject meal will become rancid. It is possible to extract the fat and therefore create a high protein and low energy material for feed production while the oil can be used in animal feed (excellent energy source) or in other sectors, such as cosmetics. Removing the fat will increase the product's shelf life and allow for more options and higher inclusion rates in the formulation.

More research is needed into the costs of the expeller, or the minimal quantities needed to extract to become profitable. Many Tanzanian cashew processors struggle with their cash flow as cashew nuts are only produced for three to six months per year in Tanzania. In general, it seems likely that cashew nut producers are reluctant to invest in more equipment.

### Market description

Production of cashew nuts in Tanzania stood at 232,700 tons in 2019. Estimations by feed processor are that only 6% is processed in the country (13,692 tonnes of cashew). Assuming 5% is the reject meal, this means 685 tonnes of cashew nut reject meal are available in Tanzania. The challenge remains that many processors are producing on a small scale. Respondents state no overview with reliable information on how many producers there are and how much they produce. Sourcing, therefore, remains a big issue for feed millers and traders.

Image source: Feedipedia

# 4. Cashew nut reject meal, continued

*Improved technology and market linkages are amongst the necessary interventions*

### Valuable interventions

To tailor to the consumer demands in quality, producers foresee the following interventions as most meaningful:

- Research on costs and minimum quantities for the economic feasibility of expeller pressing cashew reject meal.
- Improving the network of cashew nut processors and connecting them to traders and the animal feed market.
- Education of feed millers about the possibilities and risks of the product.

### Sustainability

There are no known sustainability risks associated with using this cashew nut reject meal. A few producers have been known to sell the product occasionally to feed millers. However, it seems that the majority disregards the rejected meal as waste.

### Circularity

It is a waste product that otherwise would be discarded. The process can therefore be considered circular.

# 4. Overview of feed millers and ingredient producers

# Profiles of feed millers

*All feed millers use soy, with some venturing into alternatives such as BSF, brewer's yeast and cattle blood*

This study comes at a time where an increasing number of Tanzanians are engaging in commercial livestock and aquaculture production and are thus in need of high-quality protein ingredients. The following table provides a brief profile of feed millers in the market and their familiarity with alternative ingredients. Table continued on next slide.

| Category | Name | Production capacity in MT per year | Types of feed | Species | Protein source currently used | Prices (TZS/kg) | Prices (EUR/kg) | Familiarity with alternatives | |
|---|---|---|---|---|---|---|---|---|---|
| Feed mill | Feed miller 1 | 36,000 | Pellet & mash | Poultry (broiler, layer) | Soybean meal | 2,305 | 0.88 | None | Feed miller 1 is willing to use any alternative source of protein, provided it has good quality (protein content, low or no anti nutritional factors). Price is also important to them and should be 'reasonable'. Currently, Feed miller 1 uses shrimp as an alternative source of protein. The main constraint is availability, with prices quickly rising. |
| | | | | | Shrimp meal (uduvi) | 1,614 | 0.62 | | |
| | | | | | Sunflower meal | 576 | 0.22 | | |
| Feed mill | Feed miller 2 | 6,000 | Pellet & mash | Poultry (broiler, layer), pig | Soybean meal | 2,305 | 0.88 | Only BSF | Feed miller 2 is willing to use alternative source of protein. The main concern is the level of crude protein, adulteration and anti nutritional factors. Feed miller 2 is currently conducting a third trial with BSF. So far, all trials are good. Feed miller 2 is afraid to use fish by-product because of contamination of fish byproducts with other sea organisms and dust. |
| | | | | | Sunflower cake | 576 | 0.22 | | |
| | | | | | BSF (trial) | 507 | 0.19 | | |
| Feed mill | Feed miller 3 | 21,600 | Pellet & mash | Poultry (broiler, layer), pig, dairy cattle | Soybean meal | 2,305 | 0.88 | Brewer's yeast, cattle blood, poultry waste | The storage of brewer's yeast is slightly complicated, as Feed miller 3 buys it in wet form. The yeast is a waste-product from the brewery industry.<br>Feed miller 3 sometimes uses cattle blood, but with limitation in formula inclusion because they are afraid of biosecurity (disease transmission). Also, the quality of blood is not good as it is contaminated with sand.<br>Feed miller 3 never uses poultry slaughter by-product, as they fear poor biosecurity. |
| | | | | | Sunflower cake | 576 | 0.22 | | |
| | | | | | Fishmeal | 2,305 | 0.88 | | |
| | | | | | Brewery yeast | 599 | 0.23 | | |
| | | | | | Cattle blood | 922 | 0.35 | | |

# Profiles of feed millers, continued

*The experience with alternative protein sources is mixed, with many feed millers continuing to use soy and fishmeal*

This study comes at a time when an increasing number of Tanzanians are engaging in commercial livestock and aquaculture production and are thus in need of high-quality protein ingredients. The following table provides a brief profile of feed millers in the market and their familiarity with alternative ingredients. Not all the feed millers were approached, their names are still included for a potential follow-up.

| Category | Name | Production capacity in MT per year | Types of feed | Species | Protein source currently used | Prices (TZS/kg) | Prices (EUR/kg) | Familiarity with alternatives | |
|---|---|---|---|---|---|---|---|---|---|
| Feed mill | Feed miller 4 | Unknown | | Poultry, pig | | | | | |
| Feed mill | Feed miller 5 | 11,400 | Pelelt & mash | Poultry (broiler, layer), pig | Soybean meal | 2,305 | 0.88 | Cattle blood and fishmeal | They started using cattle blood and fish (sardines) as an alternative protein source.<br>For fish, the main challenge is that the protein level fluctuates from one consignment to another. Some suppliers are not reliable, as they adulterate the fish to increase weight. |
| | | | | | Cattle blood | 1,153 | 0.44 | | |
| | | | | | Fishmeal | 2,305 | 0.88 | | |
| Feed mill | Feed miller 6 | 12,000 | Pellet & mash | Poultry (broiler, layer) | Soybean meal | 2,305 | 0.88 | None | Fish (sardines) are the main source of protein. The main challenge is the quality of the product, as it is not constant (decomposed fish or high moisture, causing it to ferment easily).<br>Feed miller 6 is willing to try other alternative sources. Their main concern is needing a high protein level and looking for a reasonable price. |
| | | | | | Sunflower cake | 576 | 0.22 | | |
| | | | | | Fishmeal | 2,305 | 0.88 | | |
| Feed mill | Feed miller 8 | | | | | | | | |
| Feed mill | Feed miller 9 | | | | | | | | |
| Feed mill | Feed miller 7 | Unknown | | Poultry, pig | | | | | |
| Feed mill | Feed miller 10 | | | | | | | | |

# Feed millers' willingness to pay

*Feed millers are willing to pay the highest amount for BSF and the lowest for cashew nut reject meal*

The following figures are based on interviews. However, when interpreting these results, it is important to consider that feed millers indicated the lowest price they would be willing to pay as to gain a better negotiation position with the ingredient producers. Compared to market prices, these voiced willingness to pay figures do not adequately reflect market conform prices. These low estimates once more reflect the importance of increased collaboration, trust, and information sharing within the sector.

| Alternative source | Feed miller 1 | Feed miller 2 | Feed miller 3 | Feed miller 4 | Feed miller 5 | Feed miller 6 | Feed miller 7 | Average price willing to pay in TZS/kg | Average price willing to pay in EUR/kg |
|---|---|---|---|---|---|---|---|---|---|
| Cattle blood | 500 | 450 | 500 | 600 | 600 | 600 | 600 | 550 | 0.21 |
| Black Soldier Fly larvae (BSF) | 800 | 500 | 600 | 600 | 800 | 1,000 | 600 | 700 | 0.27 |
| Brewer's yeast | 200 | 300 | 200 | 250 | 200 | 500 | 200 | 264 | 0.10 |
| Cashew nut reject meal | 200 | 200 | 200 | 200 | 200 | 400 | 200 | 229 | 0.09 |

# Profiles of ingredient producers

*Prices range for the various alternatives, with BSF selling for the highest price (EUR 0.86/kg) and cashew for the lowest (EUR 0.20/kg)*

The following table provides a brief profile of ingredient producers in the market. Not all the producers were interviewed. Their names are included due to their relevance for a potential follow-up.

| Category | Name | Production capacity in MT per year | Protein source | Sales price (TZS/kg) | Sales price (EUR/kg) | Requires processing? | Production cost (TZS/kg) | Transport cost (TZS/kg) | Seasonal fluctiation? |
|---|---|---|---|---|---|---|---|---|---|
| Raw materials supplier | Raw materials supplier 1 | | | | | | | | |
| Raw materials supplier | Raw materials supplier 2 | Unknown | Cattle blood meal | 1,050 | 0.40 | Yes | 725 | 50-100 | Yes |
| | | Unknown | Cashew nut reject meal | | | | | | Yes |
| Raw materials supplier | Raw materials supplier 3 | | | | | | | | |
| Raw materials supplier | Raw materials supplier 4 | 1,500 | Cashew nut reject meal | 600 | 0.23 | Yes | Unknown | 50-100 | Yes |
| | | 364 | Cattle blood meal | | | | | | Yes |
| Raw materials supplier | Raw materials supplier 5 | | | | | | | | |
| Raw materials supplier | Raw materials supplier 6 | Unknown | Cattle blood meal | 1,050 | 0.40 | | | | |
| Raw materials supplier | Raw materials supplier 7 | 52 | Black Soldier Fly | 2,250 | 0.86 | Yes | 1,900 | 50-100 | Yes |
| Raw materials supplier | Raw materials supplier 8 | Unknown | Brewery yeast | 650 | 0.25 | Yes | Unknown | 50-100 | Yes |
| Raw materials supplier | Raw materials supplier 9 | 260 | Cashew nut meal reject | 525 | 0.20 | Yes | Unknown | 20-50 | Yes |
| Raw materials supplier | Raw materials supplier 10 | | | | | | | | |

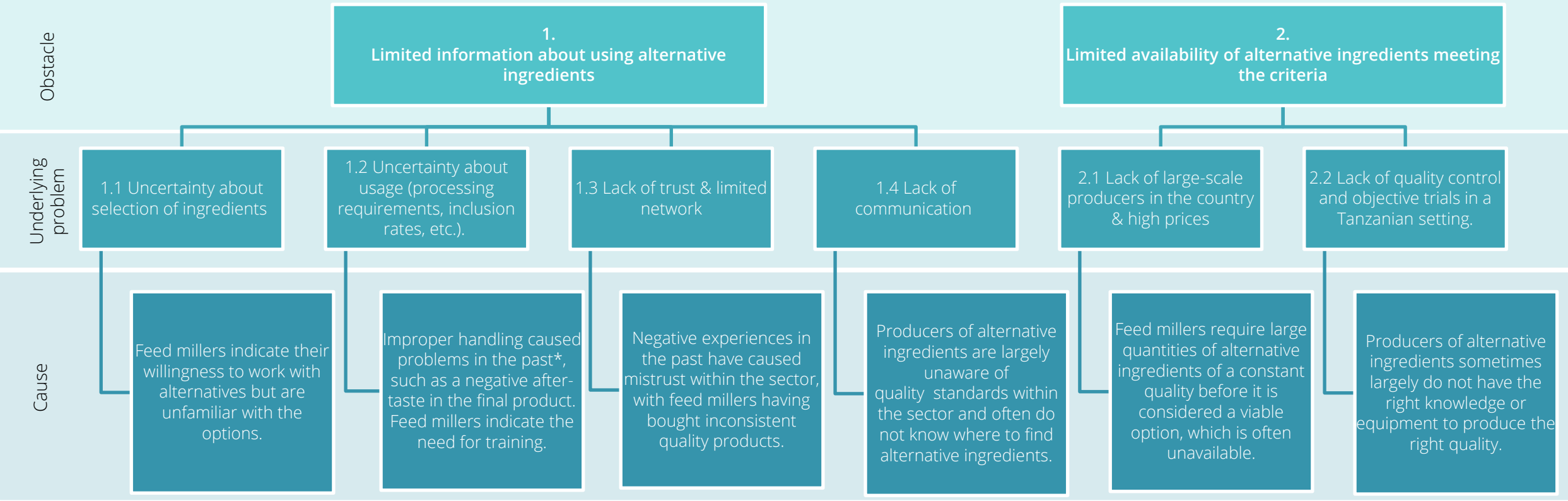
# Recommendations & development opportunities

# Roadmap for the development of alternative ingredients

*Limited information and limited availability are the major obstacles for large-scale usage of alternative ingredients*

**Current constraints in switching to alternative ingredients**

The Tanzanian feed sector is a relatively conservative sector. For example, it has taken ten years for the industry to incorporate soy into the feed (previously, this was predominantly in fish meal). It takes considerable time and effort to persuade feed millers to switch ingredients. Two major categories of obstacles have been identified, which feed millers face when switching to alternative ingredients:



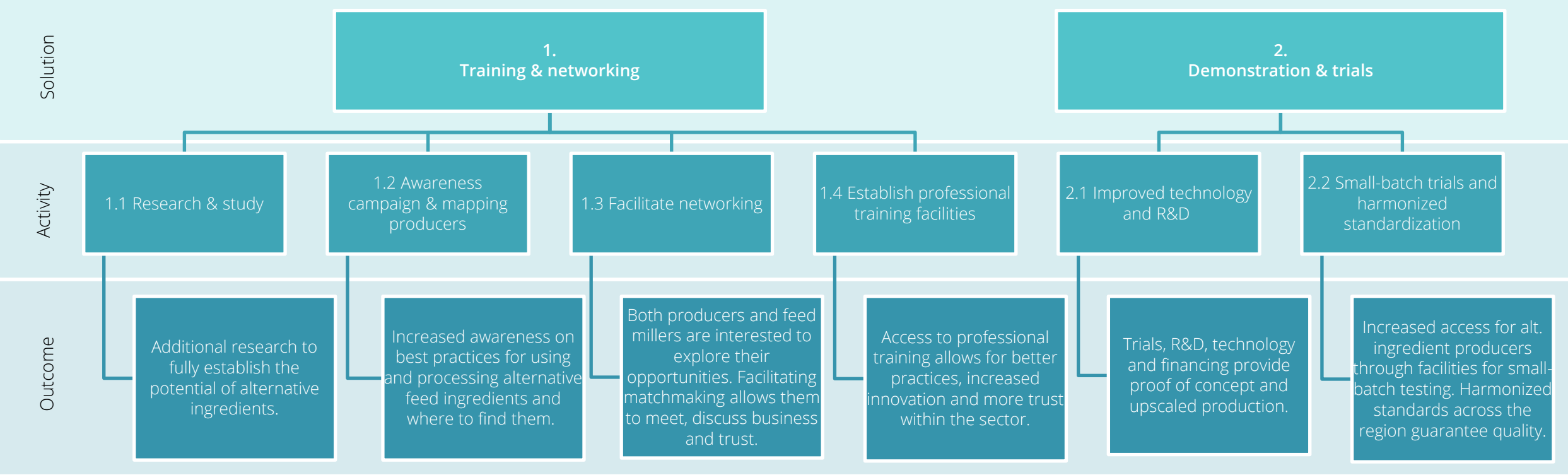

*This example occurred when many feed millers used too much (>7%) fish by-products in their feed, causing the consumer to notice the 'fishy aftertaste'. Although fish by-products would not cause this, improper practices and a higher use than the recommended inclusion rate have led to a negative image

# Roadmap for the development of alternative ingredients

*1) Facilitating training programs and networking and 2) setting up demonstrations and trials are essential for advancing the sector*

**Recommended solutions**

Two major interventions are required to advance the Tanzanian feed sector: 1) increased training and networking and 2) setting up demonstrations and trials.



# Recommendations for knowledge exchange

*Trials, demonstrations and trainings allow for increased collaboration within the sector*

**1) Training & networking**

- Encourage knowledge exchange through networking sessions

  Currently feed millers and alternative ingredient producers are not aware of each other's supply and demand and do not know how to find each other. By bringing the sector together, even without specific training, people can learn from each other, learn what they can do to improve their business and focus on building trust. If trust is restored feed millers could cooperate with the production and processing of raw materials more closely.

- Organize awareness campaigns about alternative ingredients

  As feed millers are often not aware of opportunities and constraints of alternative ingredients and ingredient producers do often not know about the quality standards of feed mills the sector is currently missing business opportunities. Organizing an awareness campaign can help the sector to become aware of the opportunities if it provides information relevant to the specific actor:

  - Ingredient producers: information about the requirements from feed millers, as well as best practices to scale-up production.
  - Feed millers: information about the available alternative ingredients, the possibilities and inclusion rates.
  - Farmers: information about the use of commercial feed, the advantages of alternative feed ingredients, and the lifting of any false prejudices towards alternative feed ingredients.

- Organize training programs

  Training is necessary to allow for the implementation of best practices, education, and improved food safety throughout the value chain. Professional and accessible training will not only allow for better practices with current stakeholders, but it will also allow for the attraction of new and young entrepreneurs. Offering training to young graduates or workers will help work towards a professional image of the sector and attract more young people to stay in or join the agri-food sector.

# Recommendations for the embedding of knowledge

*Research, trials, demonstrations and trainings allow for increased collaboration within the sector*

**2) Demonstration, trials and legislation**

- Construct a Centre of Excellence

  A reliable place is needed to bring people together and show them the potential of alternative ingredients. In the Centre of Excellence, controlled demonstrations and trials can be conducted. Best practices can be used here to prove the potential and take away any doubts within the sector. Continued research and development are required to develop business cases, allowing ingredient producers to scale-up production and optimize their commercial potential. In the Centre of Excellence, these research projects can be conducted while at the same time it can be used for the insemination of the results.

  In terms of species, it would be suitable if the demonstration facility could host several species of animals. At least, there must be facilities for broilers. Most commercial feed in Tanzania is used for broilers and given their relatively short production cycle, they are highly suitable for testing the effects of feed formulations.

  To ensure maximum usage under the local circumstances, the demonstration facility must allow for small batch-size testing. Usually, trials require large batch sizes, making it difficult for smaller-scale ingredient producers to access these places. Taking away the barrier of large batch size for testing allows for quicker testing and therefore advancement of the sector.

  A facility such as the one proposed requires CAPEX investments and operational management. Most likely, this would require investments from private sector players. In return for their investment, they would receive access to data of the trials, including the inclusion rates of various alternative ingredients, the optimal feed formulation, and processing requirements. Furthermore, these players would get a good overview of the feed millers and ingredient producers in the region.

- Consider a regional approach

  It is important to look beyond the Tanzanian borders. The East African feed sector experiences somewhat similar challenges, despite context-specific differences. Countries and localities can learn from one another and share the burden of investments. Local feed production allows for the best uptake amongst local species.

- Encourage harmonization of standards

  Currently, not all the alternative ingredients are regulated by the TBS. This lowers the options for usage in animal feeds and stops the possibility of export. Regulation of the ingredients will, therefore, make it easier for the sector to adopt new ingredients and open up more business opportunities.

- Continue the use of more common protein sources

  Although the alternative ingredient sector has plenty of opportunities, it is important to not forget ingredients already in use. For example, encouraging more soy production in Tanzania can help the sector as well.

# Short-term solutions

*Small-scale use of alternative ingredients, combined with improved connectedness within the sector, can help the uptake of alternative feed ingredients*

Constructing a Centre of Excellence or implementing extensive training programs takes time. However, this does not mean that the alternative ingredients produced at present cannot be used already. As the production scale of most of these alternative ingredients is relatively small compared to the common sources of protein (soy and maize), the alternatives are more suitable for small-scale production.

- The alternative ingredients provide an excellent nutrient source for various feeds. Even in small quantities, this could lighten the pressure on the currently used protein sources.
- To increase the size of production, training and increased collaboration within the sector is necessary. If the scale sufficiently increases, it can provide sizeable volumes for the livestock and aquafeed industry.
- Even though the poultry feed market is the most sizeable, the ingredients also offer opportunities for smaller sectors or feed mills. The smaller amounts of alternative ingredients can faster meet the demands of smaller sectors. Further, the price of niche markets is often slightly higher meaning that producers are more likely to invest in alternatives. For small-scale production, training and demonstration will also be needed.
- There is a great need for improved linkages, more connectivity, and improved trust between various actors within the sector, including:
    - Feed millers and ingredient producers: the current disconnect between feed millers and ingredient producers is harming business. Removing this can help increase the awareness of feed millers regarding the use of alternative ingredients and it can support ingredient producers in tailoring to the needs of the feed industry.
    - Farmers and feed producers: trust, awareness of best practices, and open communication are necessary to improve the current gap between feed producers and farmers.

# Cattle blood meal

*The negative perception of quality must be restored and handling of the product improved*

**Problems and constraints**
Cattle bloodmeal shows high potential among the alternative ingredients. The main challenge for commercialization is the fluctuating quality caused by poor processing, handling, and storage. Improving the quality, as well as rebuilding the trust between suppliers and feed millers, can make it a reliable feed ingredient.

**Next steps**
Training is needed for both feed millers and cattle bloodmeal producers to learn how to work with the product and explore the potential for the animal feed sector. Furthermore, it is recommended to explore the introduction of more advanced processing equipment which can help the Tanzanian sector to improve the quality of their blood meal.

**Potential implementation of Dutch solutions**
In the Netherlands, 8,000 tonnes of bloodmeal is produced annually. It is commonly used in pet food.

Knowledge sharing of this expertise could help the Tanzanian sector move forward. Some companies process cattle blood themselves and can share their knowledge and expertise. Furthermore, many companies can offer the equipment to process cattle blood in a professional way. This equipment can make the industry more efficient and can improve the quality of the cattle blood meal.

Different types of processing equipment can be used to process cattle blood. In Europe, three techniques are commonly used:
1. Batch dry rendering: cooking the blood in a jacketed cylindrical cooker that is indirectly heated by steam under high pressure.
2. Ring dry rendering: centrifuging the blood and drying with gas.
3. Spray dry rendering: the blood is sprayed in a hot chamber where it instantly turns to powder.

**Suggested support tools**
Exploring the construction of Centres of Excellence as well as training programmes could be facilitated by several support tools, including public private partnerships (PPP), SGDP, FVO, Impact Cluster or DHI, or several funding tools from the PSD toolkit.

# Black Soldier Fly larvae (BSF)

*Trials focused on large scale production under a controlled environment can show the potential in the feed industry*

**Problems and constraints**
Current BSF production is in Tanzania is small-scale and often on a trial basis. Because the production of BSF is outside (without a controlled environment), the quality of the products fluctuate. Limited availability and fluctuating quality make it difficult for feed millers to rely on BSF as an alternative ingredient.

**Next steps**
To discover the full potential of BSF in Tanzania, trials must be done to test and demonstrate the production of BSF under controlled and upscaled conditions. Most likely, producing in a controlled environment will ensure constant quality and quantity. Training is needed on how to achieve this in the most cost-efficient way.

**Potential implementation of Dutch solutions**
Various equipment can be used to control temperature and humidity in BSF production, although the exact specifications of the equipment depend on the location where BSF is produced. Suppliers and knowledge institutions can provide tailor-made advice for specific conditions.

The Netherlands has expertise to assist BSF producers, as the country is home to one of the largest BSF producers in Europe: a company that produces BSF on a large scale for animal feed. They have extensive experience with large-scale production and could share insights or technology. Furthermore, some public and private organisations are conducting research into optimizing production. Their research could provide insights that could be used to develop training programmes and to provide consulting to BSF producers. Some of these organisations have experience in the African continent.

Besides training, several dealers can offer the equipment needed for BSF production while providing remote support. The technology the Netherlands has to offer can help producers to ensure constant quality and increase their production.

**Suggested support tools**
Exploring the construction of Centres of Excellence as well as training programmes could be facilitated by several support tools, including PPP, SGDP, FVO, Impact Cluster or DHI, or several funding tools from the PSD toolkit.

# Cashew nut reject meal

*The full potential of cashew nut reject meal can be explored by developing a business case for expelling oil*

**Problems and constraints**

In Tanzania, the cashew processors are spread out geographically. They are mostly small-scale producers who are relatively unknown within the sector. It has been discovered that expelling fat out of cashew reject meal would greatly enhance the value of the product and facilitate use as a feed ingredient. However, without enough information available to develop a business case, it is difficult to understand the economic feasibility of using cashew nut reject meal for animal feed.

**Next steps**

To create an overview of the sector, it is necessary to map all the (small-scale) producers and estimate their production. As soon as this data is available, it is necessary to facilitate matchmaking between cashew producers and the feed milling industry to build trust and create more awareness of the potential.

**Potential implementation of Dutch solutions**

An important step to increase the value and suitability of cashew nut reject meal as an alternative ingredient is expelling the fat (oil) from the rest of the nut through an expeller. Companies in the Netherlands offer such high-quality expellers, meaning they can advise on what other equipment to use to complete the expelling line. Also, they can give realistic information on the power usage and the running costs so companies can estimate if the purchase is economically feasible. Tanzanian cashew processers can make use of high-quality Dutch technology to ensure a constant quality and production.

**Suggested support tools**

Exploring the construction of Centres of Excellence as well as training programmes could be facilitated by several support tools, including PPP, SGDP, FVO, Impact Cluster or DHI, or several funding tools from the PSD toolkit.

# Brewer’s yeast

*Increased awareness of the potential of the product and more efficient production allow for more widespread usage*

**Problems and constraints**

Beer producers have a relatively low interest in processing brewer’s waste into brewer’s yeast. Although feed millers show interest in purchasing brewer’s yeast, the high costs and relative difficulty of processing and drying the brewer’s waste into brewer’s yeast has limited brewer’s interest into the product. The availability of brewer's yeast is, therefore, relatively low, making it difficult for feed millers to rely on the product.

**Next steps**

There are two potential steps for increasing the production and uptake of brewer’s yeast.

1. To increase the production of brewer’s yeast, it is necessary to develop a business case for drying the brewer's waste. This can be shared with brewers, who have the possibility to increase their production.
2. Secondly, it is worth exploring the options for using brewer’s waste directly in feed (without drying). Although transport cost would be higher (brewer’s waste is ten times more volume than brewer’s yeast), it might be a relevant feed supplement for farmers living nearby the brewers.

**Potential implementation of Dutch solutions**

Mechanical dryers are necessary to process the brewer's waste into brewer’s yeast. There are several large Dutch brewers in the Netherlands, and several of them use their waste for the animal feed industry. Their expertise can help breweries to process the brewer's waste more efficiently. Further, the success stories of the Dutch brewers can help to convince Tanzanian brewers to start processing the brewer's waste into brewer's yeast.

**Suggested support tools**

Exploring the construction of Centres of Excellence as well as training programmes could be facilitated by several support tools, including PPP, SGDP, FVO, Impact Cluster or DHI, or several funding tools from the PSD toolkit.

# Annex

# Annex II: Detailed analysis of top-4 alternative ingredients

# Nutritional profile of the top-4 ingredients

*Cattle blood meal has the highest nutritional profile, although the difference is marginal*

| Alternative protein | Digestibility | Hazards & food safety | Consistancy in product quality | Metabolizable Energy Score | Crude Protein Score | Protein quality – Lysine | Protein quality – Methionine | Total nutritional score |
|---|---|---|---|---|---|---|---|---|
| Black Soldier Fly larvae (BSF) | 4 | Accepted | 4 | 2 | 2 | 2 | 1 | 15 |
| Brewer's yeast, dehydrated | 4 | Accepted | 4 | 1 | 2 | 2 | 1 | 14 |
| Cashew nut reject meal | 3 | Accepted | 3 | 2 | 2 | 1 | 1 | 12 |
| Cattle blood meal | 5 | Accepted | 4 | 2 | 2 | 2 | 1 | 16 |

*The metabolizable energy score of brewery yeast is relatively low, as the preferred ME content is above 2,500.
**The Lysine score of cashew nut reject meal is realtively low, as the preferred Lysine content is above 4%.

# Nutritional profile of the top-4 ingredients

*Cattle blood meal has the best nutritional profile, although the difference is marginal*

The table is in alphabetical order.

| Alternative protein | Metabolizable Energy (Kcal/Kg) | Crude Protein (%) | Lysine (%) | Methionine (%) | Digestibility | Hazards & food safety | Consistancy in product quality | ME Score | CP Score | Protein quality – Lysine | Protein quality – Methionine | Total nutritional score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Black Soldier Fly larvae (BSF) | 3,340 | 42.1 | 4 | 1 | 4 | Accepted | 4 | 2 | 2 | 2 | 1 | 15 |
| Brewer's yeast, dehydrated | 2,221* | 48.9 | 6.3 | 1.5 | 4 | Accepted | 4 | 1 | 2 | 2 | 1 | 14 |
| Cashew nut reject meal | 2,550 | 36.6 | 3.8** | 1.3 | 3 | Accepted | 3 | 2 | 2 | 1 | 1 | 12 |
| Cattle blood meal | 3,224 | 94.1 | 8.7 | 1.2 | 5 | Accepted | 4 | 2 | 2 | 2 | 1 | 16 |

*The metabolizable energy score of brewery yeast is relatively low, as the preferred ME content is above 2,500.
**The Lysine score of cashew nut reject meal is realtively low, as the preferred Lysine content is above 4%.

# Sustainability profile of the top-4 ingredients

*Brewer's yeast and cashew nut reject meal score the highest in terms of sustainability, as they are circular and do not compete with human consumption*

The table is in alphabetical order.

| Alternative protein | Familiarity amongst feed millers in Tanzania | | Considered circular | | Environmental impact | Competition with human consumption* | Subtotal: sustainability score |
|---|---|---|---|---|---|---|---|
| Black Soldier Fly larvae (BSF) | 4 | Feed millers using this product have a good understanding of the quality of this product and it has been widely discussed in seminars attended by feed millers. | 5 | BSF is produced from insects which feed off waste and are very efficient protein producers. This minimizes external inputs, reducing environmental impact, enhancing nutrient recycling. | 5 | 4 | 18 |
| Brewer's yeast, dehydrated | 5 | Due to its close features with brewer's waste which is very popular in pig feed, it is well known. | 5 | The high technology used in processing ensures efficient utilisation of this waste product. | 5 | 5 | 20 |
| Cashew nut reject meal | 5 | It is increasing in popularity as more cashew nuts are locally processed. | 5 | Its use may benefit the availability of resources adding to local inputs. | 5 | 5 | 20 |
| Cattle blood meal | 5 | It is very familiar to feed millers as in some places, it is also consumed by humans. | 5 | As this is a waste product, its use has some positive environmental impact reducing pollution. However, it can also be used for human consumption this usually does not apply for cattle at the slaughterhouse. | 5 | 4 | 19 |

*A high score on competition with human consumption means there is little to no competition between animal feed and human food.

# Production profile of the top-4 ingredients

*Cattle blood has the highest production profile, but cashew nut meal reject has the most technical potential*

The table is in alphabetical order.

| Alternative protein | Ease of handling | | Processing requirements of raw materials* | | Effect on pellet quality* | | Effect on final consumer product quality* | | Rules and regulations | Subtotal: prodution score | Total technical score |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Black Soldier Fly larvae (BSF) | 5 | Once processed the product is easy to handle and store. | 0 | BSF involves a very technical process, growing of larva, due to this delicate process it scores 0. | 4 | Easily mixed with other ingredients for mash and pellet making. | 5 | No negative effect | Accepted | 14 | 32 |
| Brewer's yeast, dehydrated | 5 | Product is dried and sold in dry form, so easy to store and requires no further processing. | 0 | High technology required by the brewery companies to process. | 3 | Having some starch helps gelatinization during palatalization and fiber helps pellet quality. | 5 | No negative effect. | Accepted | 13 | 33 |
| Cashew nut reject meal | 3 | Easy to handle but difficult to store because of high oil content resulting in rancidity if stored for a long time. | 5 | Produced in the processing of cashew nuts and requires no further processing. | 4 | Product has fat which will help pellet binding. | 5 | No negative effect. | Accepted | 17 | 37 |
| Cattle blood meal | 5 | When properly processed it is easy to handle and store. | 3 | Can be processed locally by boiling and drying. | 5 | No problem in pelleting. | 5 | No negative effect. | Accepted | 18 | 37 |

*A high score means there are few processing requirements or low effects on product quality

# Price profile of the top-4 ingredients

*BSF has the highest potential in terms of price, although this information is based on small-scale trials*

The table is in alphabetical order.

| Alternative protein | Scalability potential | | Price score per kg | Price score per kg crude protein | Potential risks** | | Ease and costs of logistics | | Number of suppliers | Discounts[a] | Subtotal: price score |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Black Soldier Fly larvae (BSF) | 3 | Due to the advanced processing requirements, it is not easy to get high amount of this product. | 2* | 3 | 4 | High protein content compared to other raw materials and good storage capacity. | 7 | BSF is light so it is bulky. Its bulkiness increases cost of transport per unit weight. | 4 | 3 | 26 |
| Brewer's yeast, dehydrated | 3 | Due to number of breweries, this raw material scores high in scalability. | 1 | 0 | 4 | No risks on storage or to consumer. | 7 | Brewery yeast is easy to transport but is available in a few major cities. | 0 | 1 | 16 |
| Cashew nut reject meal | 3 | Cashew is well-cultivated in many parts of the country. However, the amount produced is determined by cashew production. | 0 | 0 | 2 | Very rich in energy and good protein content. Risks in storage (rancidity) due to high oil content | 6 | Limited accessibility due to the few regions producing it. | 0 | 1 | 12 |
| Cattle blood meal | 5 | Raw blood is widely available in the country. Appropriate processing methods are necessary to produce high-quality product, but it can be scaled up widely. | 0 | 0 | 4 | It is well known to feed millers and has a high protein content. However, disease transmission is a risk. | 10 | Available throughout the country. It has good weight per unit volume (density) that makes it is easy to transport. | 3 | 2 | 24 |

*Trials show a price for BSF of a mere EUR 0.19/kg, which would make it a very attractive product. However, this is based on small-scale trials only.
**A high score on potential risks means there are very few to no risks to using the product in terms of supply.

a. Discount: product composition reducing the need for additional ingredients during feed milling

# Supply profile of the top-4 ingredients

*Overall, cattle blood and BSF show highest commercial potential*

The table is in alphabetical order.

| Alternative protein | Availability in Tanzania | Consistancy in product quantity | | Annual production | Potential risks* | Subtotal: supply score | Total commercial score |
|---|---|---|---|---|---|---|---|
| Black Soldier Fly larvae (BSF) | 3 | 5 | Produced through high-tech processing methods. | 3 | 5 | 13 | 42 |
| Brewer's yeast, dehydrated | 3 | 5 | Advanced technologies used in breweries. | 5 | 5 | 15 | 34 |
| Cashew nut reject meal | 2 | 5 | No consistency issues known. | 3 | 4 | 9 | 26 |
| Cattle blood meal | 4 | 4 | Currently low due to poor processing methods. | 5 | 5 | 14 | 42 |

*A high score on potential risks means there are very few to no risks to using the product in terms of supply.

# Annex III: Evaluation Workshop
January 21st, 2022

# Impressions


# Impressions


# Media coverage

The event was covered in the media.

- Newspaper: three newspaper articles were published in Tanzanian media.
- TV station: the event was covered in a mainstream news channel (see next slide), Tanzania Broadcasting Cooperation (TBC).
- Social media: TBC also covered the event on their Instagram and Instagram page.
- Larive, Lattice and Transcend used their social media channels to promote the event as well.

The Guardian

## Alternative protein feeds to replace soybeans, fish

FROM PAGE 1

regular food product while also needed for fish farming, therefore there is a gap for raw materials which affects the whole animal feed sector, he said.

The poultry and aquaculture industries employ about 4.5m people with Tanzania being among top producing countries of aquaculture and poultry products in Africa, he stated, underlining that the ministry would provide expertise on scaling the technology so that it trickles down to farmers.

Prof Lekule said the technology involves developing new local sourcing strategies and to improve self-sufficiency of feed resources, pointing out that the main raw materials used in the technology are fresh cattle blood, black soldier fly larvae, beer brewers' yeast and cashewnut rejects.

The report, 'Unlocking the potential of circular proteins in animal feeds' is funded by the Netherlands embassy working with a number of organizations, with ambassador Wiebe de Boer saying the Netherlands has a long history of working with Tanzanian institutions in developing poultry and aquaculture.

While soy is a popular mainstay in protein as a meat and milk alternative, the main part of soybeans produced in the United States and elsewhere is actually used for animal feeds.

In an agricultural economy that's highly focused on the environment, experts are calling for a look beyond traditional animal proteins used in livestock feed to more sustainable alternatives. This leads to insect farms and even single-cell proteins, with the future of feed additives in rapid evolution, the consultant added.

## 'Go for animal feed production'

By Louis Kolumbia
@Collouis1999
lkolumbia@tz.nationmedia.com

**Dar es Salaam.** Plans are afoot to mobilise local investors to start producing alternative animal feeds in order to address the challenge facing the country.

Livestock and Fisheries Development minister Mashimba Ndaki unveiled the plan during a stakeholders' meeting where four types of alternative animal feeds were introduced.

Mr Ndaki said the country had a high demand for feeds for fish produced through aquaculture and that alternative feeds could address the challenge once produced on a large scale.

"The problem is how the four types of feeds stated here would be produced in large quantities and meet business requirements," he said.

He said the government will provide expertise and conducive environment for both domestic and foreign investment to allow large scale production of alternative feeds.

"Local investors should know that the technology is simple and cheap. They should therefore engage in production of the animal feeds and benefit from the domestic market," he said.

He added: "The feeds could also be exported because they are exceptional and absent in other countries. Besides everything, they could be the cheapest if produced in large quantities."

Alternative animal feeds producing advisor Faustin Lekule named the four types of alternative animal feeds produced from dried blood; eggs of flies, by-products of beer production and tiny particles from cashews processing.

He said blood is collected from abattoirs, boiled and dried, noting that it consists of high protein content making it nutritious when mixed with chicken and fish feeds.

"The eggs of black soldier flies are kept until maturity, boiled and dried to make it a better animal feed.

"Usually the eggs are laid in a prepared and high hygiene environment to encourage the laying of more eggs," said Prof Lekule.

According to him, the third alternative animal feed comes from dried by-products of beer manufacturing, noting that most factories have developed modern mechanisms to dry and trade the by-products.

## Alternative protein feeds to replace soybeans, fish

**"While soy is a popular mainstay in protein as a meat and milk alternative, the main part of soybeans produced in the United States and elsewhere is actually used for animal feeds.**

# Media coverage

*Tanzanian media outlet TBC covered the event on the news and on Instagram*


YouTube link to TV news:
https://youtu.be/jEin1Sxai4w?t=1168


# Media coverage

*Larive International wrote an article on the study and the event, which was published on the website and social media channels*

- Article: Unlocking the Potential of Circular Proteins for Animal Feed in Tanzania | Larive International
- LinkedIn post: https://www.linkedin.com/posts/larive_unlocking-the-potential-of-circular-proteins-activity-6900098592917241856-Z0Sh

**Larive International**
2,648 followers
18m •

How to unlock the Potential of Circular Proteins for Animal Feed in Tanzania?

Access to affordable and quality animal feeds is the largest constraint to animal productivity in Tanzania. The feed industry relies on a narrow range of raw materials, which poses a risk, as the costs of these raw materials are rising and the availability is decreasing. As the feed sector is an essential part of the livestock industry, these fluctuations could jeopardize the production of poultry, cattle, piggery, and fish. The use of protein alternatives, including waste streams, has the potential to lower the feed costs in Tanzania and to enable the feed sector to become more circular and resilient.

On behalf of the **Netherlands Enterprise Agency (RVO)** and the **Embassy of the Netherlands in Tanzania**, **Larive International**, **Lattice Aquaculture Limited** and Transcend are executing a study to provide insights into the nutritional, technical and commercial potential of alternative protein ingredients for animal feed in Tanzania.

17-02-2022

## Unlocking the Potential of Circular Proteins for Animal Feed in Tanzania

Access to affordable and quality animal feeds is the largest constraint to animal productivity in Tanzania. The feed industry relies on a narrow range of raw materials, which poses a risk, as the costs of these raw materials are rising and the availability is decreasing. As the feed sector is an essential part of the livestock industry, these fluctuations could jeopardize the production of poultry, cattle, piggery, and fish. The use of protein alternatives, including waste streams, has the potential to lower the feed costs in Tanzania and to enable the feed sector to become more circular and resilient.

On behalf of the Netherlands Enterprise Agency and the Embassy of the Kingdom of the Netherlands in Dar es Salaam, Larive International, Lattice Aquaculture and Transcend are executing a study to provide insights into the nutritional, technical and commercial potential of alternative protein ingredients for animal feed in Tanzania. The project is currently ongoing and the full report is expected by March 2022.

*"This project is an example of the close cooperation between the Netherlands and Tanzania. Applying Dutch expertise appropriate in the Tanzanian local context can unlock the potential of the Tanzanian feed market in a more circular fashion."*

*– H.E. Ambassador Wiebe de Boer*

# Attendance list

| Organization | Category |
|---|---|
| Falcon | Feed mill |
| Interchick | Feed mill |
| Magito Stores | Feed mill |
| Lina | Feed mill |
| Joshi | Feed mill |
| Silverlands | Feed mill |
| G&B Animal Feed | Feed mill |
| Hill Animal Feed | Feed mill |
| BioBuu Ltd | Feed mill |
| Laurian Mtwali | Feed mill |
| Fransis | Producer/supplier |
| RECYCLER COMPANY LTD | Producer/supplier |
| Agrlife Ltd | Producer/supplier |
| Novfeed | Producer/supplier |
| TAFMA / Falcon | Association/foundation |
| World poultry Foundation/Mhega animal Feed | Association/foundation |

You are cordially invited to join the Evaluation Workshop

**'Opportunities in alternative circular protein for animal feeds'**

**Friday 21 January 2021**
9 AM – 1 PM Dar es Salaam
Hotel South Beach Resort - Kigamboni

**Animal feed sector in Tanzania**

Animal feeds are considered the largest constraint to animal productivity improvement by the Tanzanian government in its Agricultural Sector Development Program. The production of quality feeds in Tanzania and wider East Africa is severely constrained by the limited availability and high costs of raw materials. Therefore, feed manufacturers oftentimes use poor quality raw materials, resulting in lower quality feeds and suboptimal animal performance leading to mistrust among their customers.

**Alternative circular protein**

On behalf of the Netherlands Enterprise Agency and the Embassy of the Kingdom of the Netherlands in Dar es Salaam, a study was executed to provide insights into the nutritional, technical and commercial potential of alternative protein ingredients for animal feed in Tanzania. The use of protein alternatives, including waste streams, has the potential to lower the feed costs in Tanzania and to enable the feed sector to become more circular. The study was executed by Larive International, Lattice Aquaculture and Transcend.

**Evaluation Workshop**

On the 21st of January, we invite you to join us in discussing the potential of alternative feed ingredients. We share our intermediate findings and discuss the potential interventions with you. The event will be attended by public and private stakeholders, including feed millers and alternative ingredient suppliers. The event will be opened by our guests of honor, H.E. the Ambassador of the Kingdom of the Netherlands and H.E. the Minister of Livestock and Fisheries. The networking event offers the opportunity for you to get to know other stakeholders, share your experiences and stay up-to-date on the latest research.

**Program**

- Welcome and coffee
- Opening remarks by H.E. Ambassador Wiebe de Boer and the Minister of Livestock and Fisheries
- Presentation intermediate findings
- Validation and group discussion
- Coffee break
- Matchmaking session and networking
- Lunch (optional)

We welcome questions and discussion at the end of the session.

**Registration**

Please contact Florine Kremer (florine.kremer@larive.com) to confirm your attendance during the event. We look forward to welcoming you.

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# Attendance list, continued

| Organization | Category | Designation of attendee |
|---|---|---|
| Ministry of Livestock and Fisheries | Public sector | Minister of Livestock and Fisheries |
| EKN | Public sector | Ambassador |
| Ministry of Livestock and Fisheries | Public sector | Permanent Secretary of Fisheries |
| Ministry of Livestock and Fisheries | Public sector | Director of Aquaculture |
| Ministry of Livestock and Fisheries | Public sector | Director of grazing lands and Animal feed resources |
| Ministry of Livestock and Fisheries | Public sector | Personal assistant to the Minister |
| Ministry of Livestock and Fisheries | Public sector | Communication officer of the Minister |
| EKN | Public sector | Regional Agricultural Counsellor |
| EKN | Public sector | Agricultural Advisor 1 |
| EKN | Public sector | Agricultural Advisor 2 |
| EKN | Public sector | Agricultural Counsellor |
| Kigamboni Municipality | Public sector | District Commissioner |
| Kigamboni Municipality | Public sector | Mayor |

# Event programme

| Time | Description | Main speaker |
|---|---|---|
| 08:30 | Welcome | Victor Mwenda |
| 09:00 | Opening | Victor Mwenda |
| 09:10 | Opening remarks: Ambassador | His Excellency Mister Ambassador Wiebe de Boer |
| 09:20 | Official opening: Minister | Minister of Livestock and Fisheries Hon. Mashimba Mashauri Ndaki |
| 09:30 | Introduction Lattice-Larive team | Victor Mwenda |
| 09:32 | Presentation intermediate results | Victor Mwenda, Ivo van der Lee, Professor Lekule |
| 10:15 | Questions about presentation | Guests |
| 10:30 | Departure public stakeholders to the Big Fish farm | N/A |
| 10:32 | Coffee break | N/A |
| 10:45 | Discuss knowledge gaps | Victor Mwenda, Tim de Kruiff, Professor Lekule, Bruno Mmassy |
| 12:30 | Lunch and networking | Guests |
| 13:30 | Closing session | Victor Mwenda |

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