Fish Health Management Workshop: North-South Dialogue on Capacity Building and Knowledge Transfer Approaches

19th – 24th Sept, 2022, Kisumu Hotel, Kenya

Addressing Global Food Security Challenges through Partnerships and Local Community Engagement

Circular Economy: Emerging innovations in the Aquaculture sector

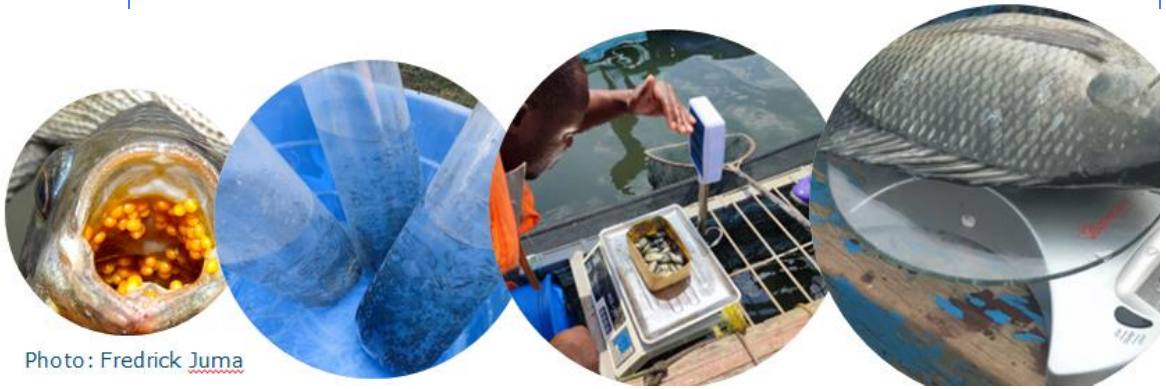


Photo: Fredrick Juma

Black soldier fly
(*Hermetia illucens*)

By: Mr.Fredrick Juma Ouma

C.E.O Hydro Victoria Fish Hatchery Farm Ltd,

Social Enterprise, BSF Commercialization Pilots

Port Victoria, Busia,Kenya

Use of Black Soldier Fly Larvae for Bioconversion of Organic Waste to Produce alternative Protein and Essential Amino Acids used as ingredients in Fish Feed Formulation (Catfish and Tilapia)

Immerging Trends & Drivers Key to Shape Future Aquaculture

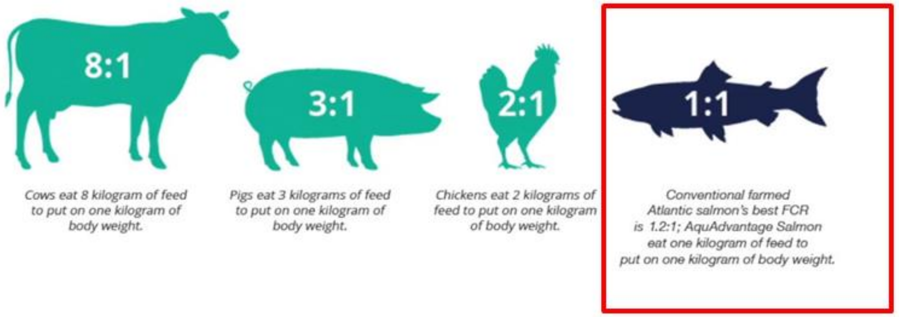
Driver 1 : Demographic & development

Driver 2 : Consumption Patterns

Driver 3 : Climate change & Environment

Driver 4 : Significant decline in Global Capture Fisheries

Driver 5 : Increased demand and cost of feeds for Aquaculture (2020-2022)



Trend 1: Africa need to increase food availability by at least 60 % by 2050

Trend 2: 40% of food produced by smallholder farmers in Africa is lost (Farm to Fork)

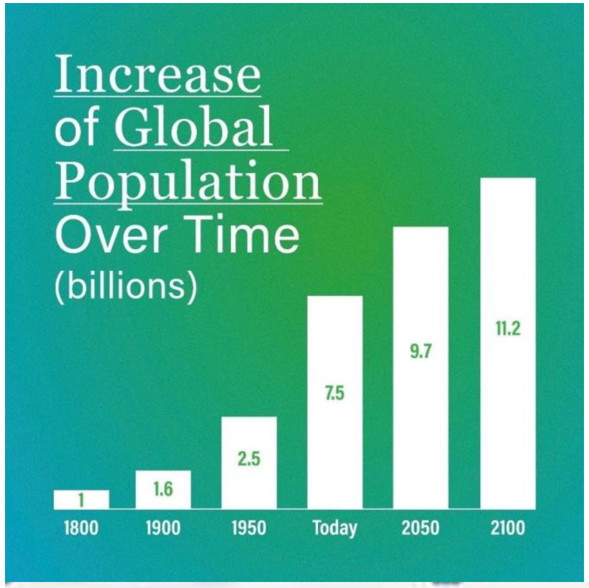
Trend 3: Food loss in Kenya is extrapolated to monetary loss of Ksh.72bn annually.

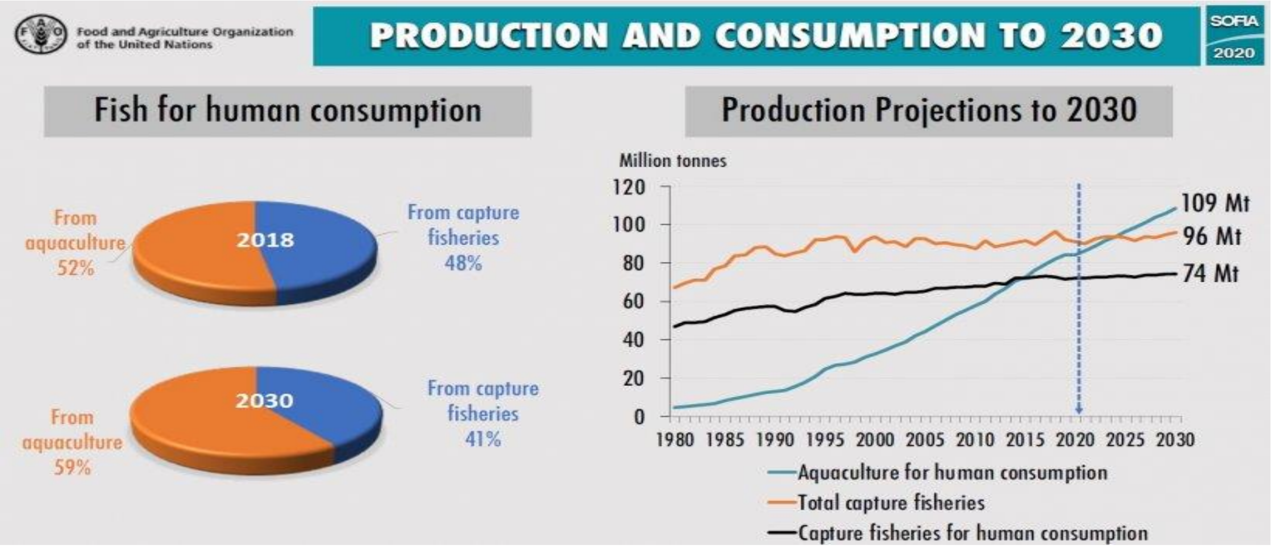
Mitigation: Sustainable & Inclusive Aquaculture for food production

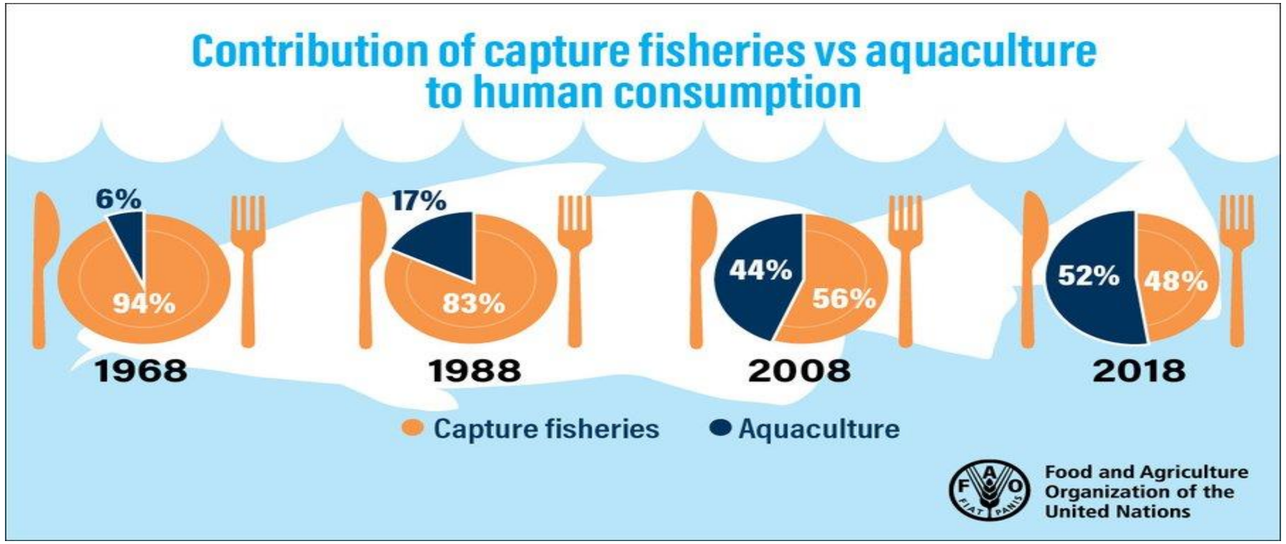
Source: FAO, UN

Global Reality Gaps (Consumption & Production in Aquaculture)

1. Inadequate Quality Feeds
2. Increased Demand for Quality Fingerlings
3. Environmental issues & Climate Change







In Kenya Per Capita Fish Consumption is at 4.6Kgs as of 2021 against global rates of 20.3Kgs

Our World of Finite Materials → Regenerative Agriculture

Rethink/Transform :Take →Make→ Waste (**Space,Time,Water,GHG)** Transition from **Fish & Soy Meal to BSFL**

Food Systems Thinking
(to changing our mindset on food)

5R Thinking in Production & Consumption (Avoid landfill & dumping)

Thinking like Bees:
Everything is food for something else and this calls for **Unique** collaboration.

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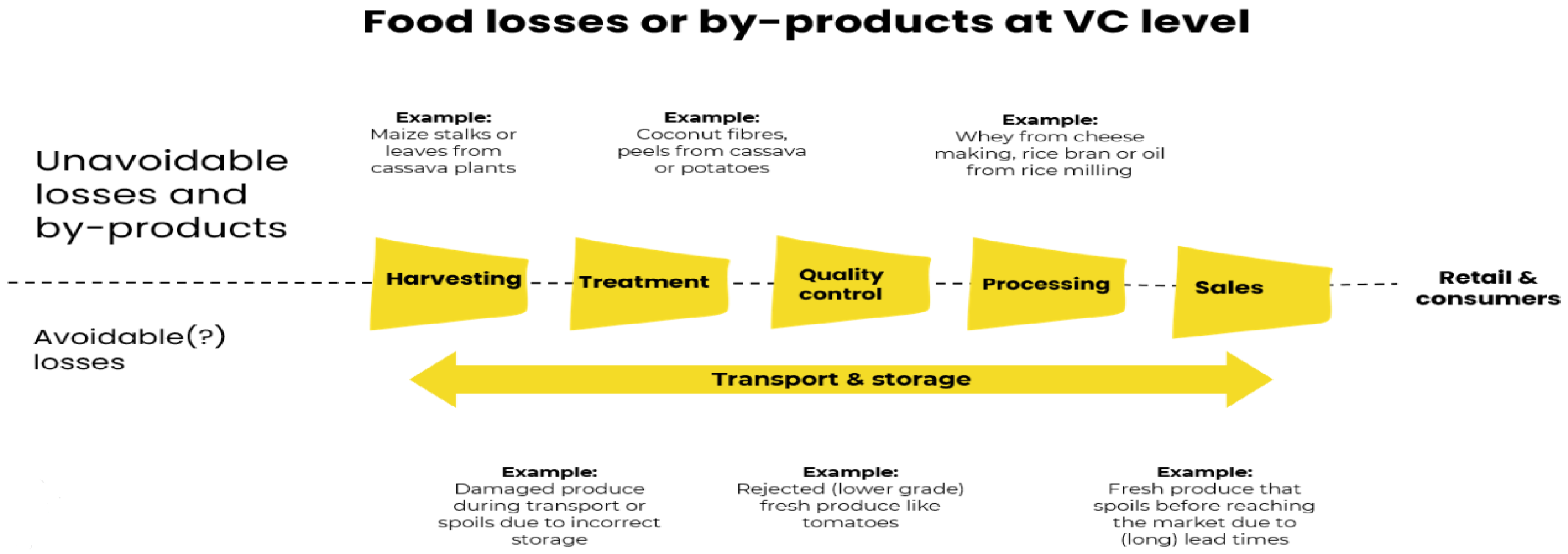
**BSFL -only animal protein with No Competition with human food

Insect based feeds as twin solution to Food losses & high demand for feeds to Aquaculture



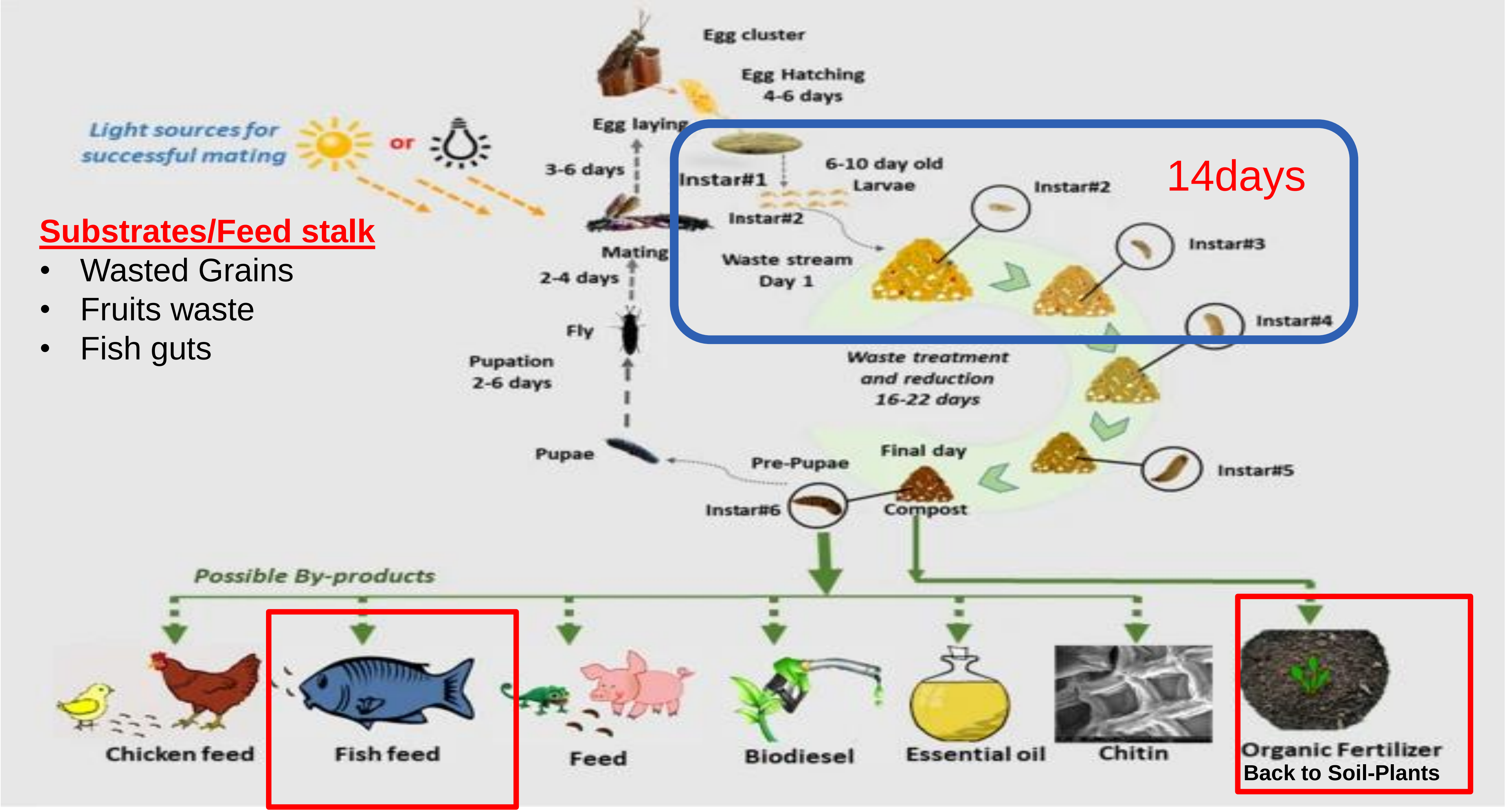
Nutrient Recovery Strategy: Closing the Loop of consumption & Improve recovery

BSFL affordability Strategy: Establish partnerships between Aquaculture Feed Processors & Waste Producers to break the barrier of transportation cost element

Potential of BSF Products & Feed stalk for Aquaculture

Substrates/Feed stalk

- Wasted Grains
- Fruits waste
- Fish guts



BSF & Its By products Benefits: Industrial level

Average composting time of BSF larvae is around 12– 15 days, BSFL adults aged 2 weeks have the lowest methane emission (Jayanegara et al. 2017).

BSF has a high nutritional content, such as quite high protein (40%–50%) and fat contents ranging 29%–32%, respectively (Bosch et al. 2019), has 9 essential amino acids,

Antibacterial studies in Korea showed that methanol extract from BSFL has antibiotic properties against gram-negative bacteria but is not effective against gram-positive bacteria (Kim et al. 2011)

Omega-3 and -6 fatty acids are present in BSF biomass for substrates, such as microalgae, seaweed, and fish offal (Surendra et al. 2020).

BSFL has functional molecules for food ingredient (Iaconisi et al. 2017).

Heavy metals & nonessential elements do not accumulate in BSFL EXCEPT in residues (Bohm et al. 2022).

BSF has potential to produce chitin polymers or polymer of glucosamine up to 7% of BSF biomass on dry matter basis (Surendra et al. 2020).

According to Leke-Aladekoba (2018), chitin from BSF has an antimicrobial activity against Staphylococcus aureus. Giving BSF meals to laying hens can also increase egg production and egg weight and adjust the composition of the gut microbiome, especially the chitin-degrading microbes that increase the production of short-chain fatty acids. Therefore, BSF feed can be used as an excellent prebiotic for the gut microbiota (Borrelli et al. 2017) and reduce the use of antibiotics.

BSF as Source of Beneficial enzyme, chitin, medium-chain fatty acid, and antimicrobial peptides:

BSF is also rich in lauric acid (36.74%), (Fitriana et al. 2022), used as an antimicrobial agent, especially against gram-positive bacteria, One of the stages in the life cycle of BSF is **prepupae,** which are rich in protein and fatty acids; the fat in prepupae can reach as much as 0.58 g C12: 0/100 mL, which is beneficial to suppress the growth of Lactobacilli and Streptococci (Spranghers et al. 2018). BSF can be used as a feed additive that can fight pathogenic bacteria including Streptococcus suis, E. coli, Clostridiumperfringens, Salmonella poona, and S. aureus and functions as an immunomodulator in livestock (Jackman et al. 2020; Widianingrum et al. 2019). Lauric acid also represses Listeria monocytogenes, which is a foodborne pathogen that can infect animal production (Çenesiz and Çiftci 2020), and can be converted into monolaurin that has antibacterial, antiviral, and antiprotozoal properties (Almeida et al. 2022).

The addition of lauric acid in the end also improves livestock productivity, such as feed efficiency, average daily gain, egg mass, and animal health in pig and poultry (Irawan et al. 2020; Elrod et al. 2019; Madeira et al. 2020). Lauric acid also improves productivity in beef and dairy cattle, including carcass percentage, IMF, and meat and milk quality (Nguyen et al. 2020; Wang et al. 2020a). Lauric acid from BSF is safe for cattle and can be used to fight against the adult nymphs or larvae of Rhipicephalus (Boophilus) microplus (dos Santos et al. 2020). As an antivirus, it can also retrain African swine fever virus, herpes simplex virus type I, and coronavirus (Jackman et al. 2020; Aldridge 2020). Lauric acid can also be used as an anticoccidial (Price et al. 2013). Other essential fatty acid in BSF larva oil are palmitic, linoleic, and oleic acid often used as emulsifiers, emollients, and stabilizers of cosmetic formulation (Almeida et al. 2022).

Antibacterial Peptides from BSF Continued:

Antimicrobial peptides from BSF: Moretta et al. (2020) identified AMPs in BSFL using bioinformatics and found that 57 putatively active peptides have the potential to be developed as antimicrobials, antifungals, anticancer, and antivirals. Four peptides with an average size of 4.2 kDa can fight Helicobacter pylori (Campylobacteria: Heliobacteria) and E. coli (Enterobacterial: Enterobacteriaceae) and thus can be employed as a substitute for antibiotics against bacteria with increasing resistance (Alvarez et al. 2019). Three AMPs from BSF, namely, hidefensin-1, hidiptericin-1, and hiCG13551, were cloned and transferred to E. coli to produce transgenic antimicrobials to fight entomopathogenic bacteria in Bombyx mori silkworm; hidefensin-1 and hidiptericin-1 successfully inhibited the growth of E. coli and Streptococcus pneumonia, and HiCG13551 suppressed the growth of E. coli and Streptococcus pneumonia (Xu et al. 2020).

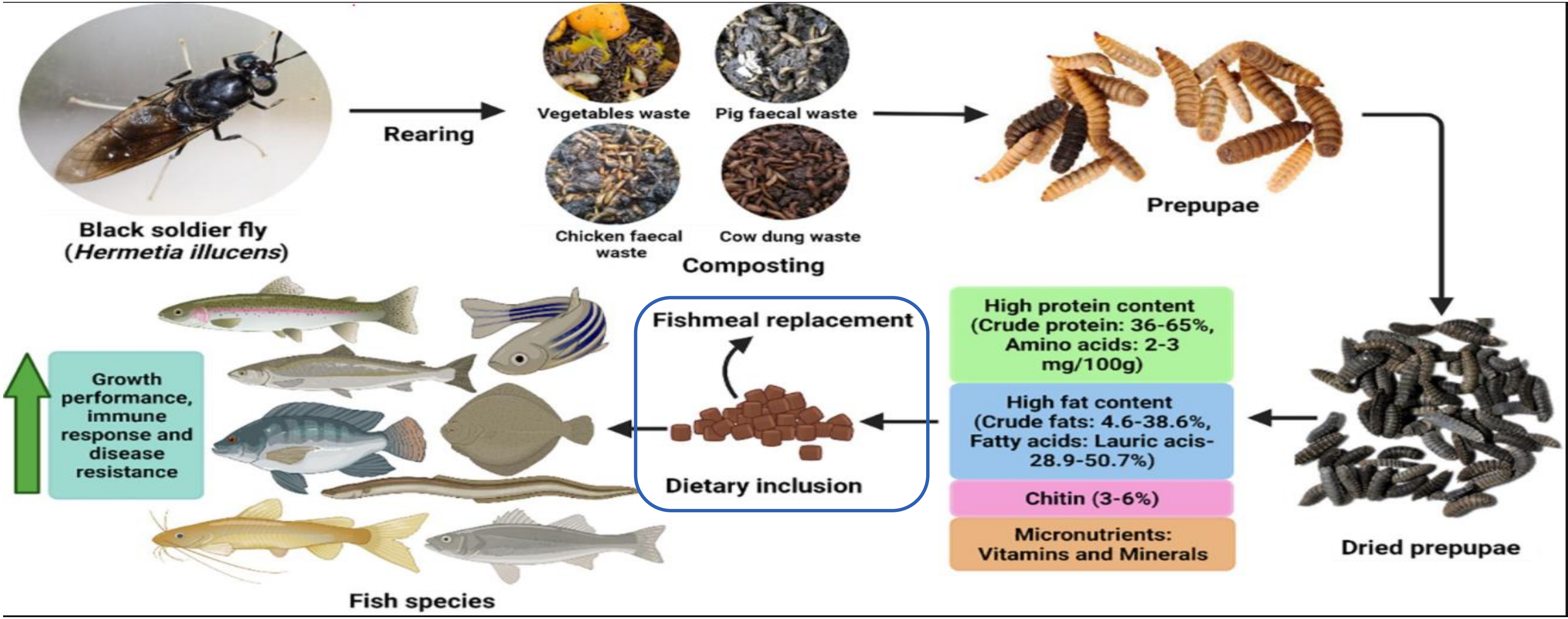
A study of AMPs in BSF confirmed that a new peptide (defensin-like peptide, DLP) could challenge gram-positive bacteria, including MSRA (Park et al. 2014). Another type of AMP is cecropin-like peptide 1, which can fight against gram-negative bacteria (Park and Yoe 2017). AMPs in BSFL are associated with more than 50 genes, 26 of which are classified as defensins. Therefore, attention must be paid to gut microbiota adaptation in livestock because the modification of feed given will modulate the gut microbiota population (Vogel et al. 2018). The antimicrobial peptides present in BSF biomass show potential use against fungi and viruses.

The use of BSF as a prebiotic and antimicrobial agent has been discovered recently, and the bioactive components of BSF were found to be enzymes, chitin, peptides, and polysaccharides. The bioactive content is a component that has potential to be developed in addition to BSF as a protein-rich feed source. The protein of BSFL can be hydrolyzed to produce antioxidant peptides for functional foods (Zhu et al. 2020), cosmetic industries, and pharmaceutical products (Almeida et al. 2022).

The BSF also secretes beneficial enzymes related to digestion, such as amylase, lipase, and protease, during metabolism. The proteases with high activity in the digestive tract of BSFL include leucine arylamidase, fi-galactosidase, fi-mannosidase, fi-fucosidase, and figalactosidase (Kim et al. 2021). Cellulase is another enzyme that is presumed to be produced by BSFL, especially in its digestive tract, due to the discovery of the novel CS10 cellulase gene in BSF, which is expected to be an excellent opportunity for cellulase enzyme producers in the industry (Lee et al. 2014). Several studies also reported cellulase and ligninase enzyme activity, such as corncob fermentation with BSFL to reduce lignin by 2% and cow manure processing using BSFL to reduce hemicellulose level by 5% and cellulose content by 17% (Li et al. 2015; Gold et al. 2018).

BSF can reduce virus survival (Lalander et al. 2015).

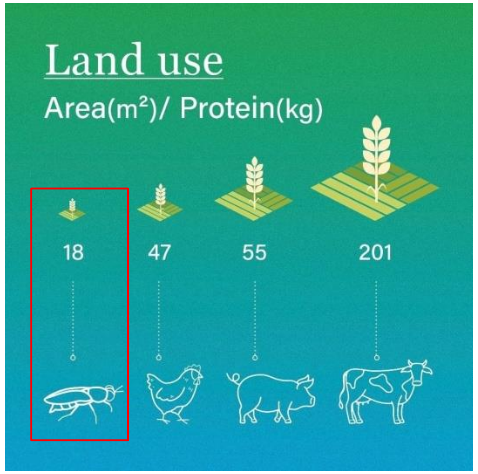
Black Soldier Fly: (*Hermetia illucens* L.) larvae meal in aquafeeds

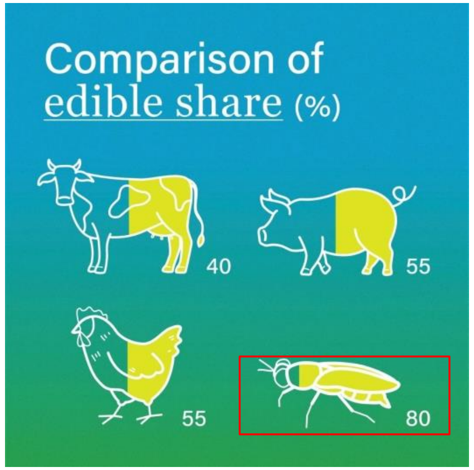


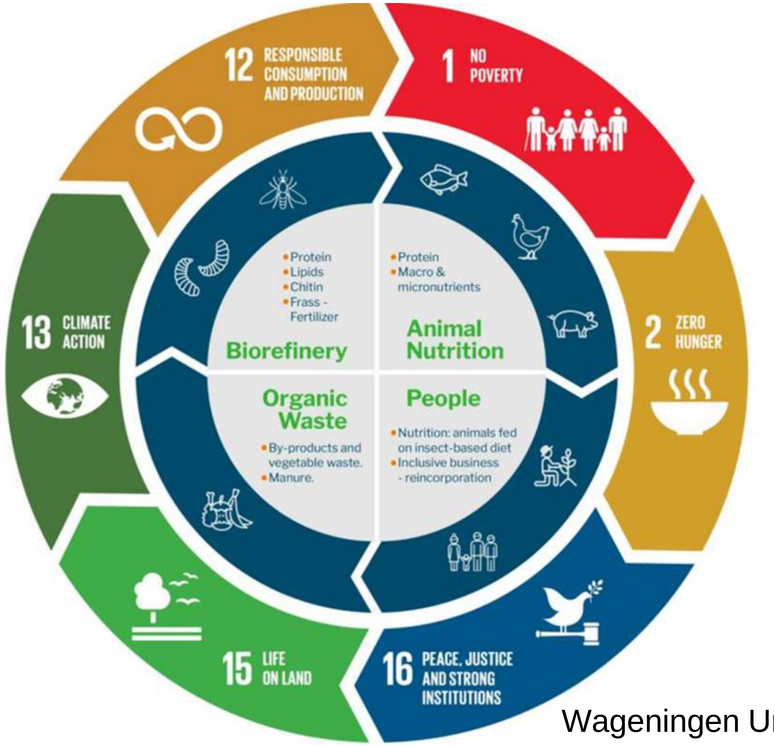
Research →BSFL on fish: Growth, Weight, FCR, Feed Intake, Digestibility, Survival (immunity/Resistance to pathogens/diseases)

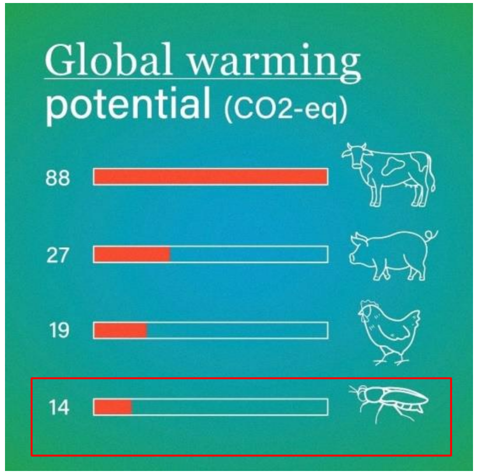
Sustainable Aquaculture needs BSFL

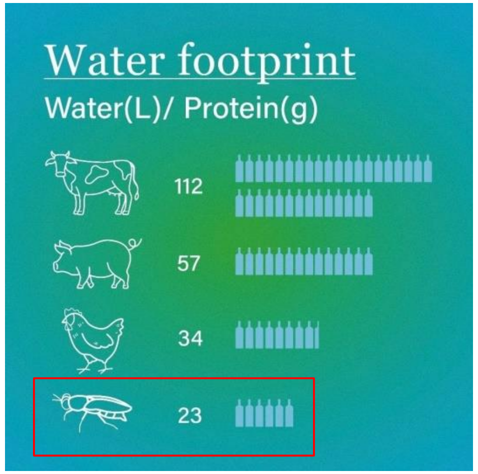
F.A.O Report 2022





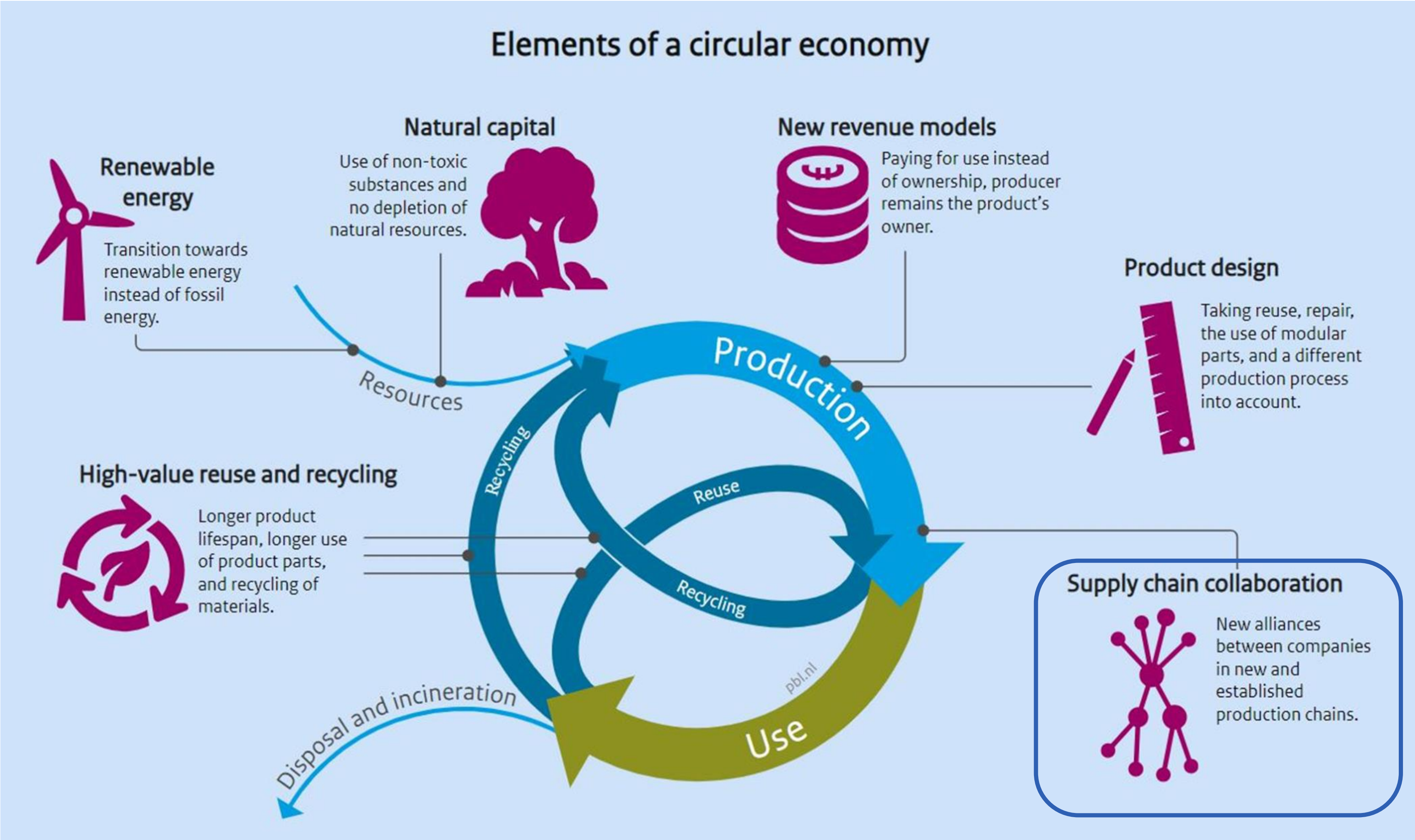






Wageningen University & Research

Unique Collaboration: Hydro Victoria & Partners



2 Ton/Hr Capacity feed Plant
for (fish/poultry/pig)

Collaborators:

- World Bank/KCSAP
- Maseno University
- K.M.F.R.I

In-Pipeline for Circularity

- Victory Fish Farm
- Blue sky fruit Co. (10 factories- Ghana, Egypt, S.Africa, Benin, Brazil,U.K)
- Rice Cooperative Societies

Local BSF Production@HYDRO







Research Area:

- Focus on effectively and safely enhancing the cultivation and processing of BSF and its applications as a functional and nutritional food (eg. Substrates selection)
- Industrial or commercialization of BSF and its products
- Many more opportunities

THANK YOU ALL