

Introduction to Circular Economy

May 17th, 2023

Patrick Webb

| Seta Tutundjian

| Omar Habboush



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WELCOME TO THE ZOOM WEBINAR

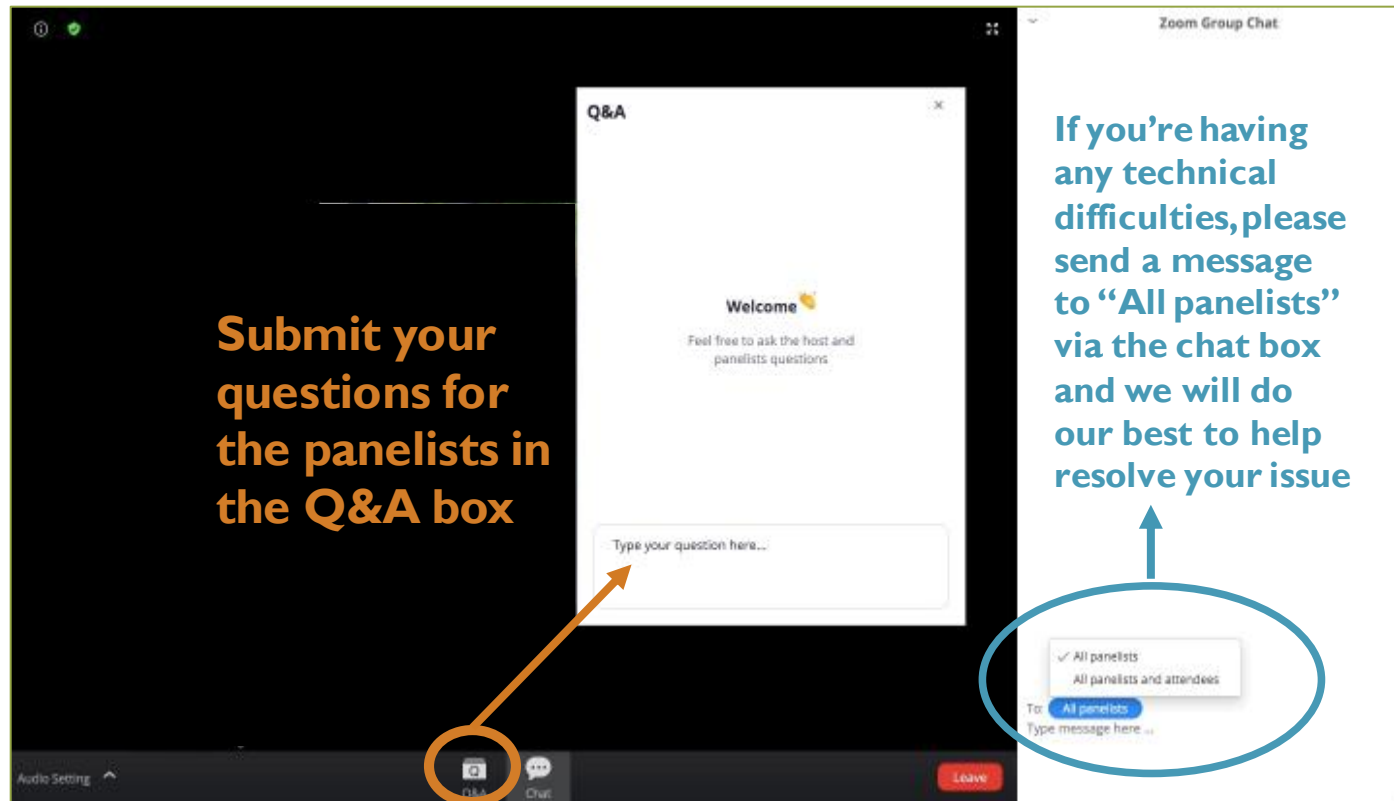
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Please use the chat box to introduce yourselves and share thoughts and comments by sending a message to “All panelists and attendees”



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Q&A AND CHAT



The image shows a Zoom interface with two panels. The left panel is the Q&A window, which has a 'Welcome' message and a text input field labeled 'Type your question here...'. An orange arrow points from the 'Q&A' icon in the Zoom bottom toolbar to this input field. The right panel is the Zoom Group Chat window, showing a dropdown menu for recipients with 'All panelists' selected. A blue circle highlights this dropdown, and a blue arrow points from it to the text on the right.

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The Food Systems for Nutrition Innovation Lab

Webinar Series with Thriving Solutions: Introduction to Circular Economy

Zoom Webinar | Wednesday, May 17th, 2023 | 7:00-8:15 AM (ET)



PATRICK WEBB

*Director,
Food Systems for Nutrition
Innovation Lab, Tufts University*



SETA TUTUNDJIAN

*Founder and Chief Executive Officer,
Thriving Solutions*



OMAR HABBOUSH

*Co-founder and Finance and
Business Strategy Officer,
Hivemind*



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Thriving Solutions
Reimagining our food systems to sustain our future

Tufts
UNIVERSITY

Gerald J. and Dorothy R.
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Circular Economy

Presented by: Seta Tutundjian

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May 17, 2023



LINEAR ECONOMY

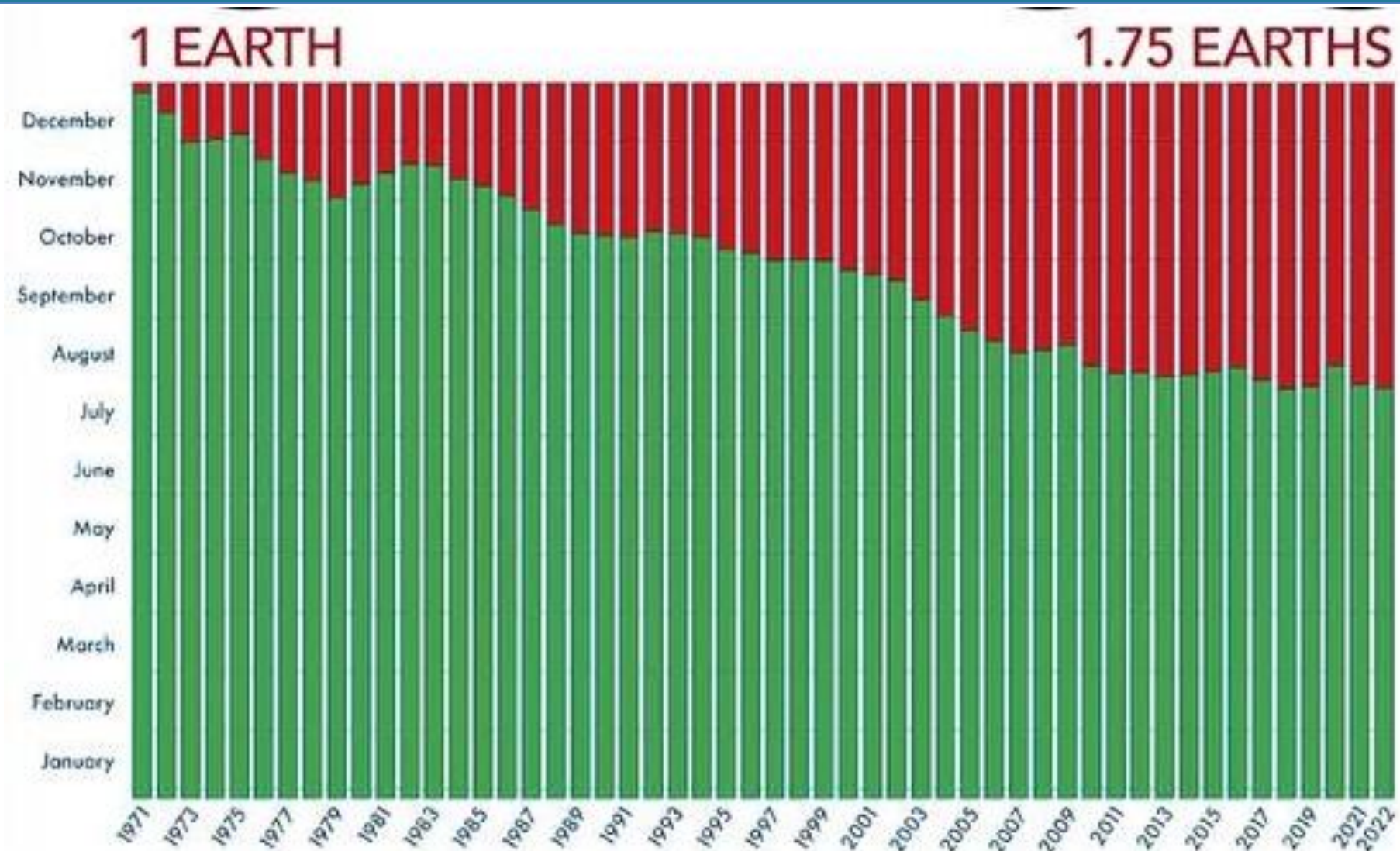
- We take material and resources from the earth, produce and discard a pile of waste.
- Linear operations:
 - *require endless supplies of resources (natural and financial).*
 - *increase waste,*
 - *accelerate pollution and GHG emissions,*



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- We need 1.75 planets to meet our consumption needs and absorb our waste.
- By 2030, we will need 2 planets.
- Earth Overshoot day in 2022, it fell on **28 July**

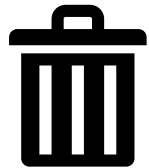


EXPRESS

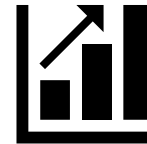
SOURCE: NATIONAL FOOTPRINTS AND BIOCAPACITY ACCOUNTS 2022 EDITION
DATAFOOTPRINTNETWORK.ORG

WASTE – A GLOBAL PROBLEM POLLUTING THE ENVIRONMENT AND AFFECTING HUMAN HEALTH

According to figures by the World Bank:



In 2020 the world generated **2.24 billion tonnes** of solid waste



By 2050 expected world generated solid waste is **3.88 billion tonnes**



Daily footprint of **0.79 kg** per person



90% of waste in Global South is unregulated or burnt



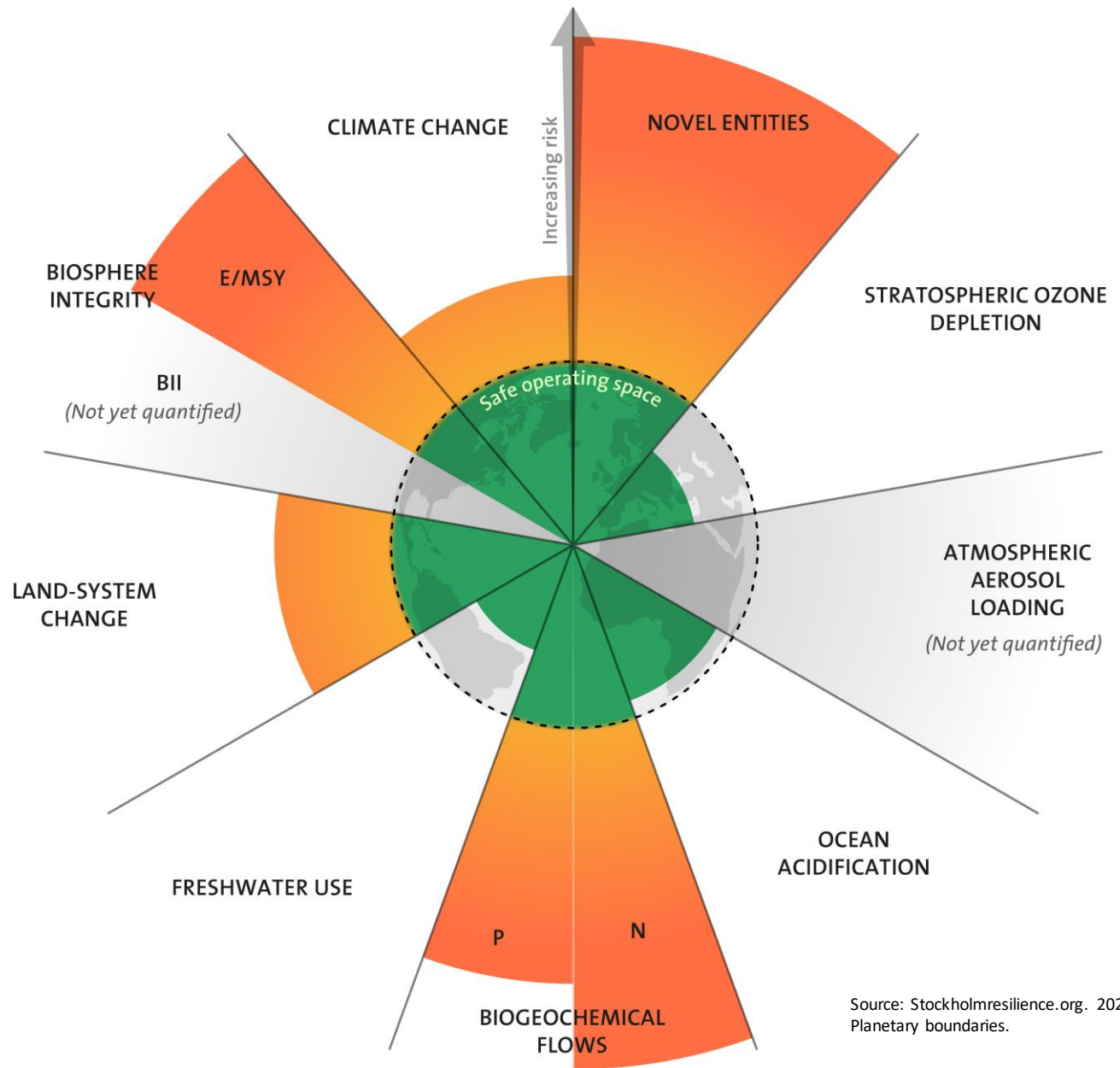
Landfills are filling up, as are natural ecosystems.

Greenhouse gases, chemical and biological pollutants are affecting critical planetary systems



PLANETARY BOUNDARIES

- **Planetary Emergency!**
- **9 systems** that regulate the state of the Earth.
- Green: Safe operating Zone;
Light Orange: Uncertainty
Red: Crisis/emergency
- Biochemical flows; Biosphere Integrity (biodiversity); Novel Entity.
- Land systems; climate change.



Source: Stockholmresilience.org. 2022. Planetary boundaries.

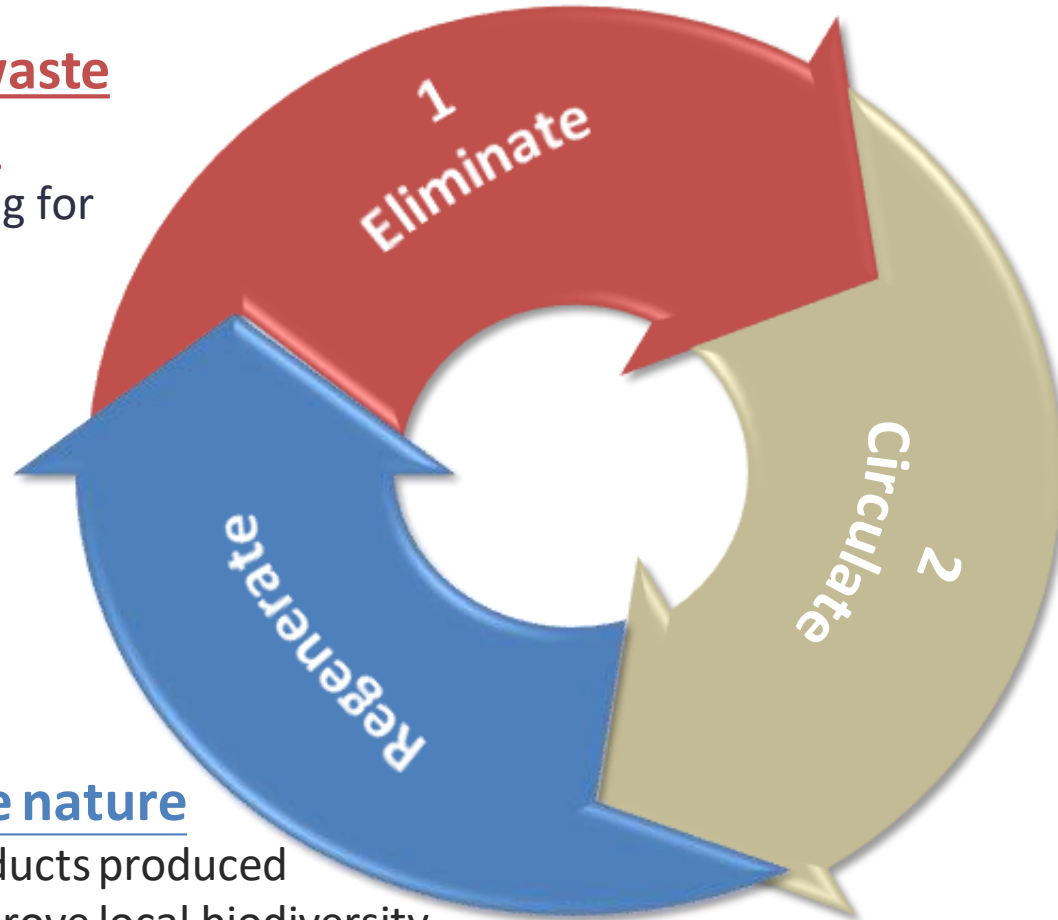
CIRCULAR ECONOMY

1. Eliminate waste and pollution

through designing for circularity.

3. Regenerate nature

by sourcing products produced in ways that improve local biodiversity, air and water quality.



2. Circulate materials and products

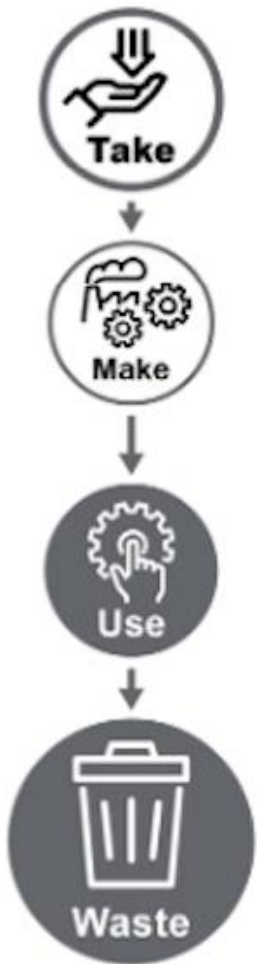
keeping them in use and prolonging their value.



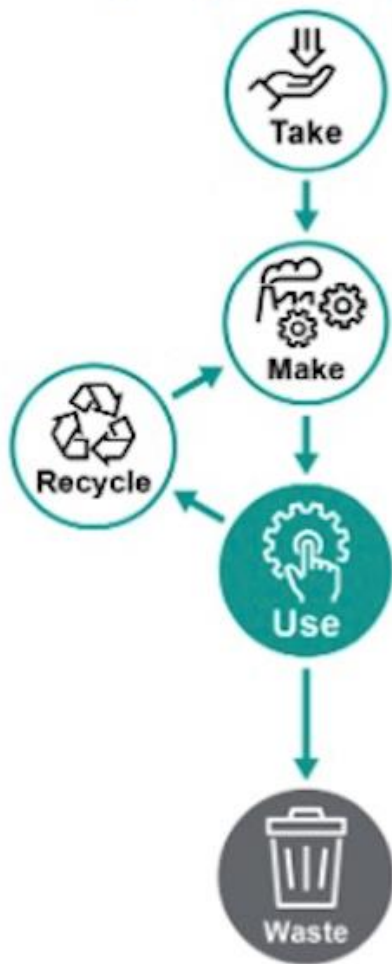
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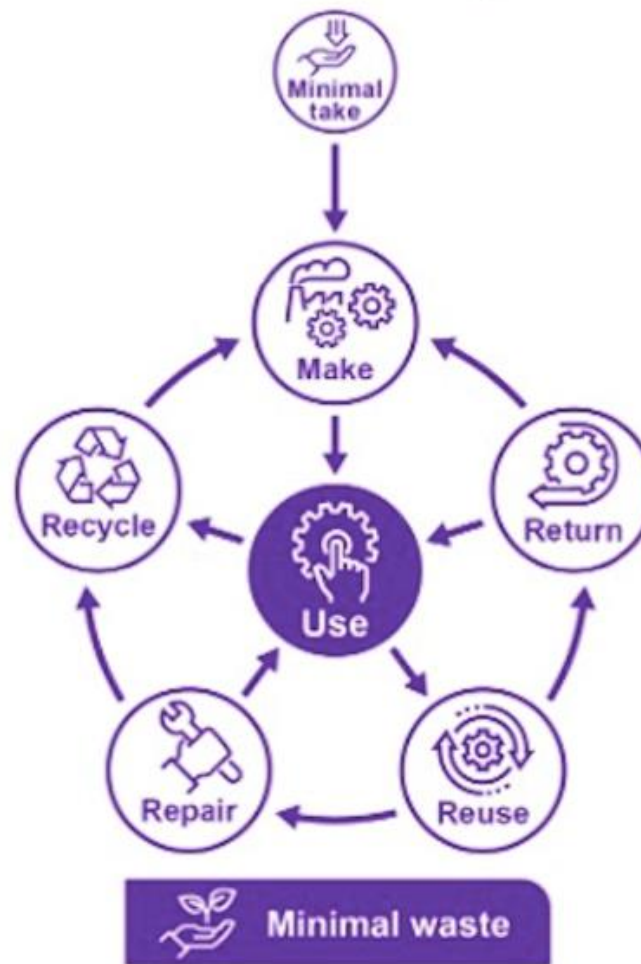
Linear Economy



Recycling Economy



Circular Economy



Source :
DXC Technology



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Priority 3
Useful application
of material

Incinerate
waste with
energy
recovery

Recover

Salvage
material
streams
with
highest
possible
value

Recycle

Reuse
product
but with
other
function

**Re-
purpose**

Make new
product
from
second-
hand
product

**Remanu-
facture**

Refurbish
product

Revive

Maintain
and repair
product

Repair

Use
product
again – as
second-
hand

Reuse

Reshape
product
considering
circularity
principles

Redesign

Decrease
raw
materials'
use

Reduce

Prevent
raw
materials'
use

Refuse

Priority 2
Extend lifespan of product and parts

Priority 1
Smarter product use
and manufacturing

10 Rs of circularity



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CIRCULAR FOOD ECONOMY



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WHAT IS FOOD?

- *Food is any substance (processed, semi-processed, or raw) intended for **human** consumption.*
- *It includes drink and any substance used in the manufacture, preparation or treatment of food.*
- *It **doesn't** include cosmetics, tobacco or substances used only as drugs.*

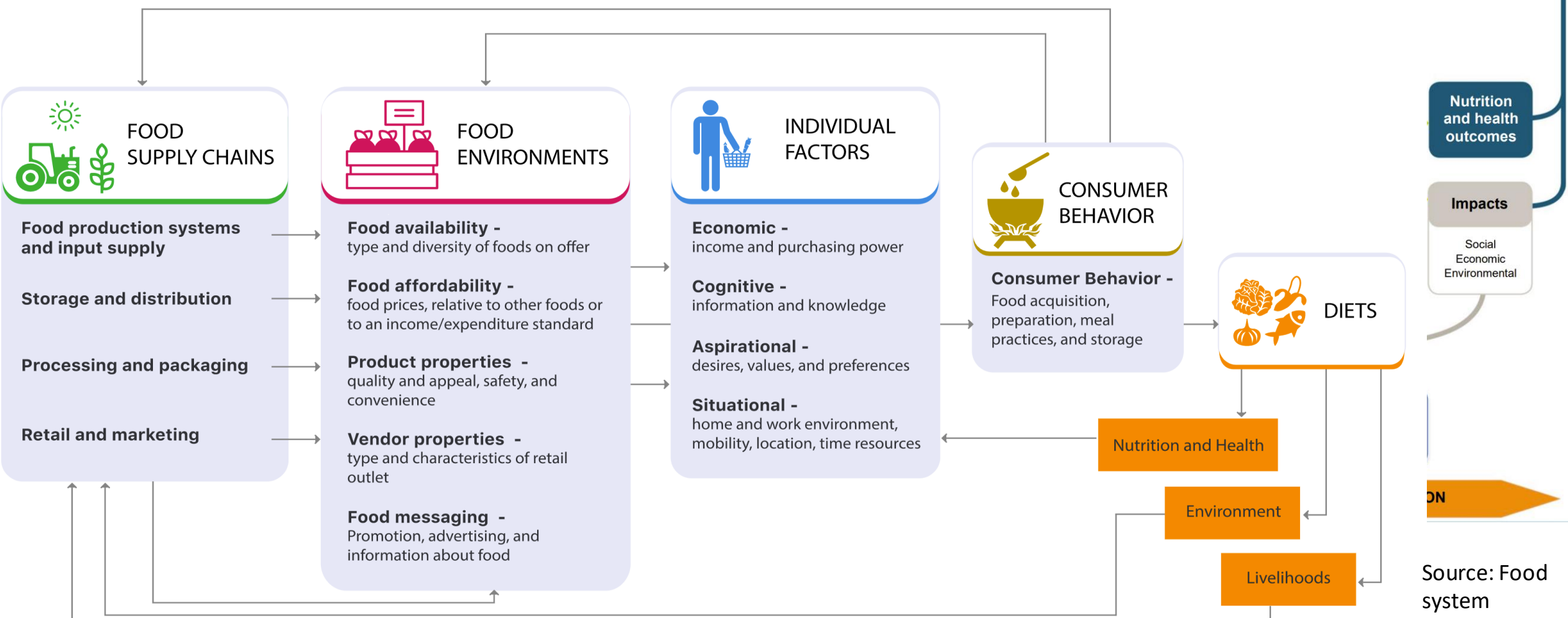
- Codex alimentarius commission, procedural Manual, 2013



FOOD SYSTEM



EXTERNAL DRIVERS



ADAPTED FROM: HLPE (2017). NUTRITION AND FOOD SYSTEMS. A REPORT BY THE HIGH LEVEL PANEL OF EXPERTS ON FOOD SECURITY AND NUTRITION OF THE COMMITTEE ON WORLD FOOD SECURITY, ROME, ITALY.

Source: Food system Dashboard

IMPLICATIONS OF CURRENT FOOD SYSTEMS



21–37%

of total global GHG Emitted



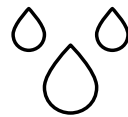
40%

Land use



25%

Soil
Degradation



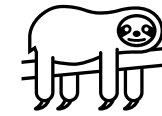
70%

Freshwater
use



80%

Deforestation



70%

Biodiversity
Loss



40%

Food loss
and waste

CIRCULAR FOOD ECONOMY MODEL



WHAT IS FOOD WASTE?



Food intended for human consumption that exits the food system.

When food exists the food system it is no longer available for human consumption and all resources used to produce it are lost.

Food “Loss and Waste” happens along the entire value chain



During or immediately after harvesting on the farm



Left in field during harvesting
Lack of buyer

After leaving the farm for handling, storage, and transport



Degraded by fungus or disease
Poor infrastructure

During industrial or domestic processing and/or packaging



Spilled during processing
Gaps in knowledge

During distribution to markets, including at wholesale and retail markets



Sorted out due to quality
Lack of buyer

In the home or business of the consumer, including restaurants and caterers



Purchased but not eaten
Poor forecasting

FOOD LOSS AND WASTE – A GLOBAL PROBLEM

40%
of food is lost or wasted
annually (2.5 billion tons)
14% is lost from post-harvest
to retail

1/4
of freshwater is
consumed by agriculture

28%
of cultivated land
(farmland size of China)

10%
of global GHG
emissions
(3rd emitter)

ECONOMIC COSTS OF FLW ≈ US\$ 1 TRILLION/YR.
ENVIRONMENTAL COSTS ≈ US\$ 700 BILLION/YR.

SOCIAL COSTS ≈ US\$ 900 BILLION/YR.

FOOD LOSS AND WASTE

- Global Issue with a Global Target



Food Systems Summit 2021

Food is Never Waste Coalition

Target

Halve food waste by 2030 and to reduce food losses by at least 25%.

SDG TARGET 12.3

BY 2030 HALVE per capita global food waste at the retail and consumer levels & **REDUCE** food losses along production and supply chains (including post-harvest losses)



Indicator 12.3.1: Global food loss index



Indicator 12.3.1: Global food waste index

PACKAGING

- Protects food from being damaged.
- Promotes health and safety along the supply chain.
- Prevents tampering of product.
- Extends shelf life therefore reduces spoilage.

Packaging increases consumer base.

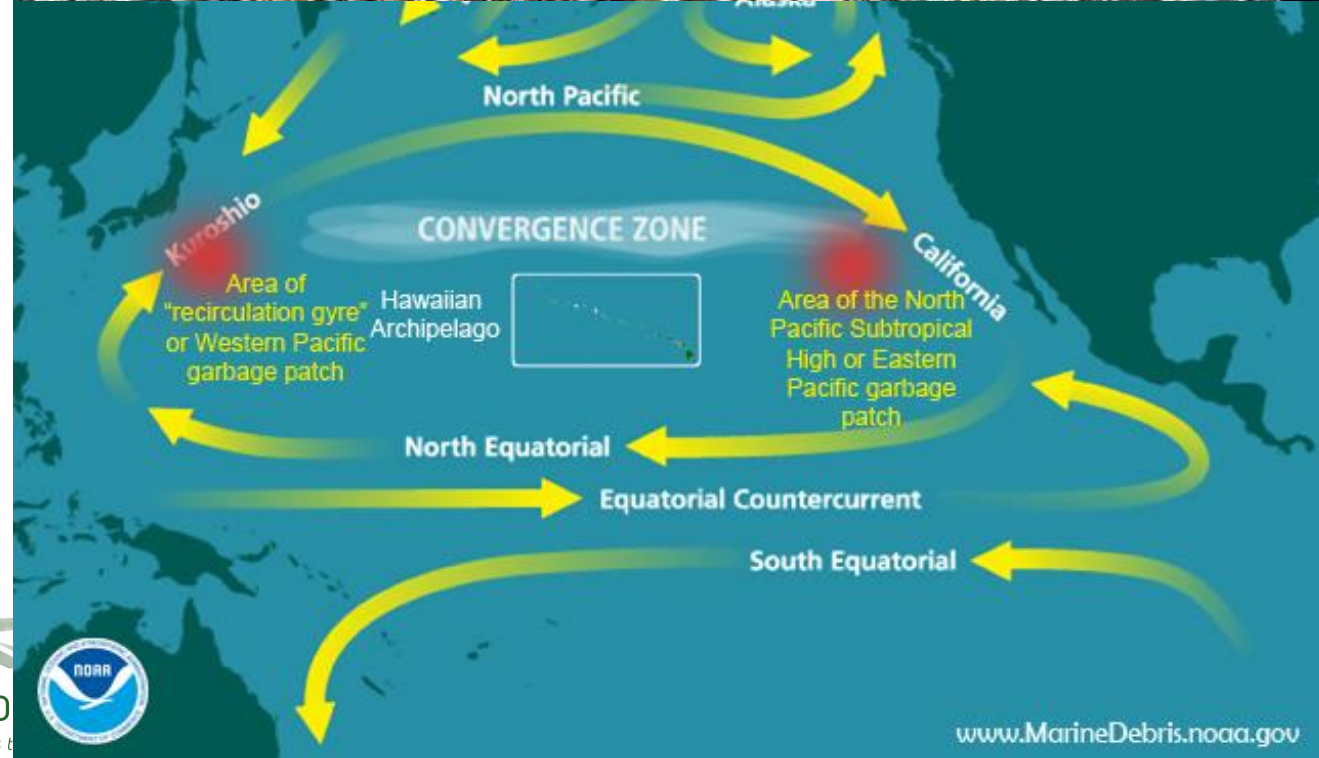
Packaging can have an environmental impact.

The most harmful packaging to the environment are Styrofoam and Plastics.



PLASTIC ISLAND

- **Great Pacific Garbage Patch:** a collection of marine debris in the North Pacific Ocean between Japan and the West Coast of the USA.
- It is 1.6 million square kilometers (3 times the size of France).
- It is estimated that 80% of the plastics come from land sources. 20% from boats.



Circular strategies for businesses:

- Packaging elimination
- Using sustainable packaging options
- Material circulation

Enabling Environment:

- Supporting policies and regulations that incentivize sustainable packaging.
- A working recycling system in place.
- Sustainable packaging available and attainable.
- Conscious customers.



SOURCING

Diverse

- Diverse ingredients for better nutrition, food security, resilience, sustainability, and more flavors.
- Promotes biodiversity

Lower impact

- Swap “convenient” ingredients with those with fewer negative environmental impacts.

Upcycled

- Transform inedible food byproducts to ingredients.

Regeneratively Produced

- e.g. Permaculture
- Suitable for local conditions.
- Creates healthier soils.
- Enhances biodiversity.

Source:
Ellen MacArthur Foundation



SOURCING

- We live on a narrow diet.
- 75% of global food comes from 12 plant and 5 animal species.
- 63% of our energy comes from 3 carbohydrates: Rice, Maize and Wheat.
- Industrial farming: mono-cultivations dependent on high inputs.





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HEALTHY AND NUTRITIOUS FOOD



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3 billion



828 million

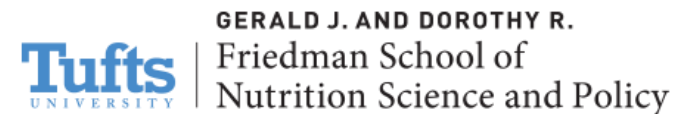


> 670 million Adults
120 million 5 – 19 yrs



1.9 billion Adults

Source:
FAO



BENEFITS OF A CIRCULAR

- Eliminates waste – *reduces our waste management costs.*
- Reduces need for extracting natural resources + production is done in wastes that regenerate nature - *enhances biodiversity, and ecosystem services.*
- Saves money.
- Creates opportunities for new businesses – *according to ILO transitions to a circular economy could create 6 million jobs.*
- Supports local communities.
- Improve access to Nutritious Foods
- Tackles Climate Change.



HOW CIRCULAR ARE WE?

“Global economy is only 7.2% circular.”

Circularity Gap Report 2023

WHAT MUST WE DO?

Pursue a systemic change to our production, consumption and waste management.

PERCENTAGE OF GLOBAL CIRCULAR ECONOMY BY YEAR



Source: Circularity Gap Reports

2018

2019

2020

2021

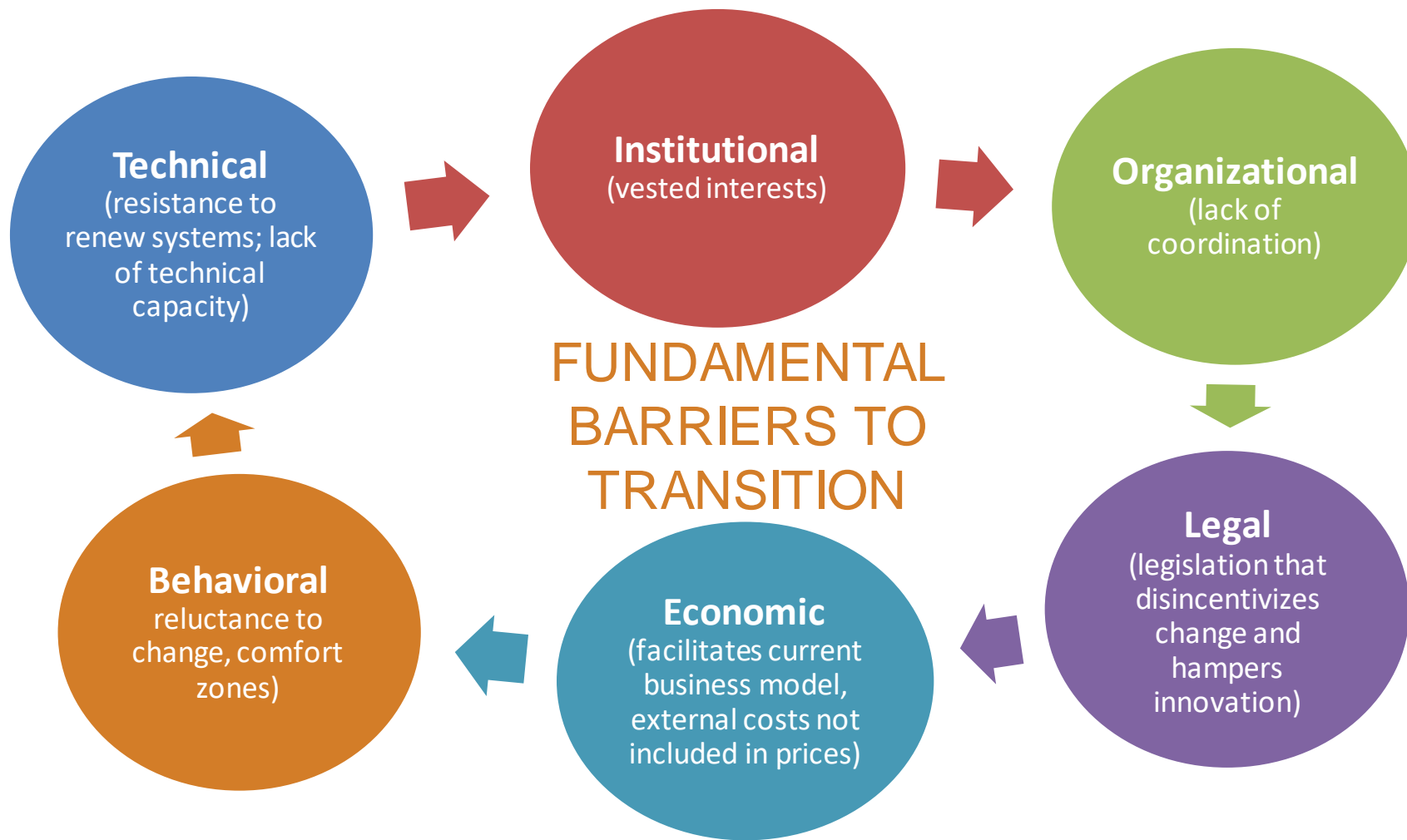
2022

2023



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Jacqueline Cramer 2020, How Network Governance Powers the Circular Economy, Amsterdam Economic Board



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ENABLING ENVIRONMENT



Policy Framework

National, regional, global regulatory framework facilitate the 10Rs of circularity. Phasing out of waste to landfills & incineration.



Investment, Finance, Funding

Investment and de-risking facility to accelerate investments in waste reduction and circular economy. Capitalize on existing finance mechanisms early on to avoid delays.



Awareness, Skill-base

Broad-base awareness (360°) across all society coupled with building skill-base to support the transition.



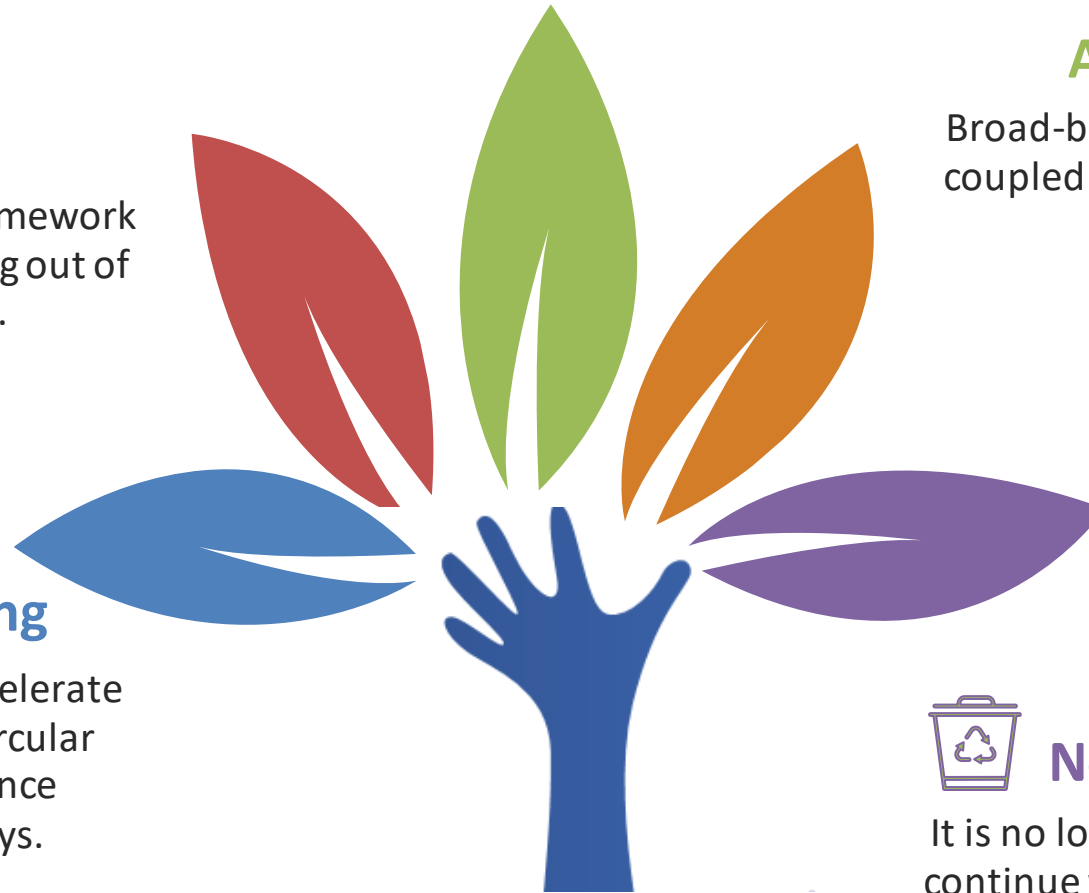
Public-Private Platforms

Collaboration between all public and private sector actors across the full value chain.



New Social Norms

It is no longer considered acceptable to continue with our wasteful linear model





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QUESTIONS?



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A Sustainable Path To Food Security

Fully Autonomous Black Soldier Fly Facility

17th May 2023
Omar Habboush

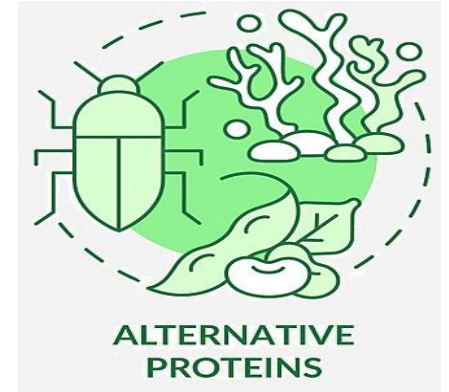
HIVEMIND
INDUSTRIES

EXECUTIVE SUMMARY

Hivemind Industries is building the facility in the UAE that will lead to organic waste being considered a value stream, putting an end to the devastating impact it has on our environment when it is sent to landfills to rot and pollute. Our Black Soldier Fly (BSF) larvae will recycle organic waste into:

- ◉ Certified organic fertiliser that is probiotic superfood for plants and will improve soil health, activate natural plant defences and accelerate plant growth.
- ◉ Create a sustainable & nutritious protein that can replace traditional feed sources in pet, pig, poultry, aquaculture diets and many other products.

We offer an integrated solution to reduce waste management cost and provide a more sustainable recovery while reducing greenhouse gases, tackling protein shortages, strengthening domestic supply chains and more.



“The alternative protein arena is wide open, and progress is happening fast. There is a real opportunity here for investors to make their moves early and become integral players in the future of food” (1)

Sources: (1) Alternative-Protein Market to Reach at Least \$290 Billion by 2035 | BCG | 2021.

THE PROBLEM

THE LINEAR ECONOMY OF WASTE

THE UN'S FERTILISER WARNING

A global fertiliser crunch is threatening to starve the planet (exasperated by The Russia-Ukraine Conflict) and resulted in prices rising exponentially in just over 24 months, which is set to continue

FOOD SECURITY

One-Third of food is wasted annually with over 70% ending up on landfills.

FUTURE OF FOOD

Food Insecurity is set to continue due to increased pricing and lack of availability with nearly 2.5 billion people do not have access to adequate food in 2022

LIVESTOCK FARMING

Traditional Livestock farming has a vast environmental footprint, representing 14.5% of all GHG emissions and accounting for 80% of all agricultural land use



USE

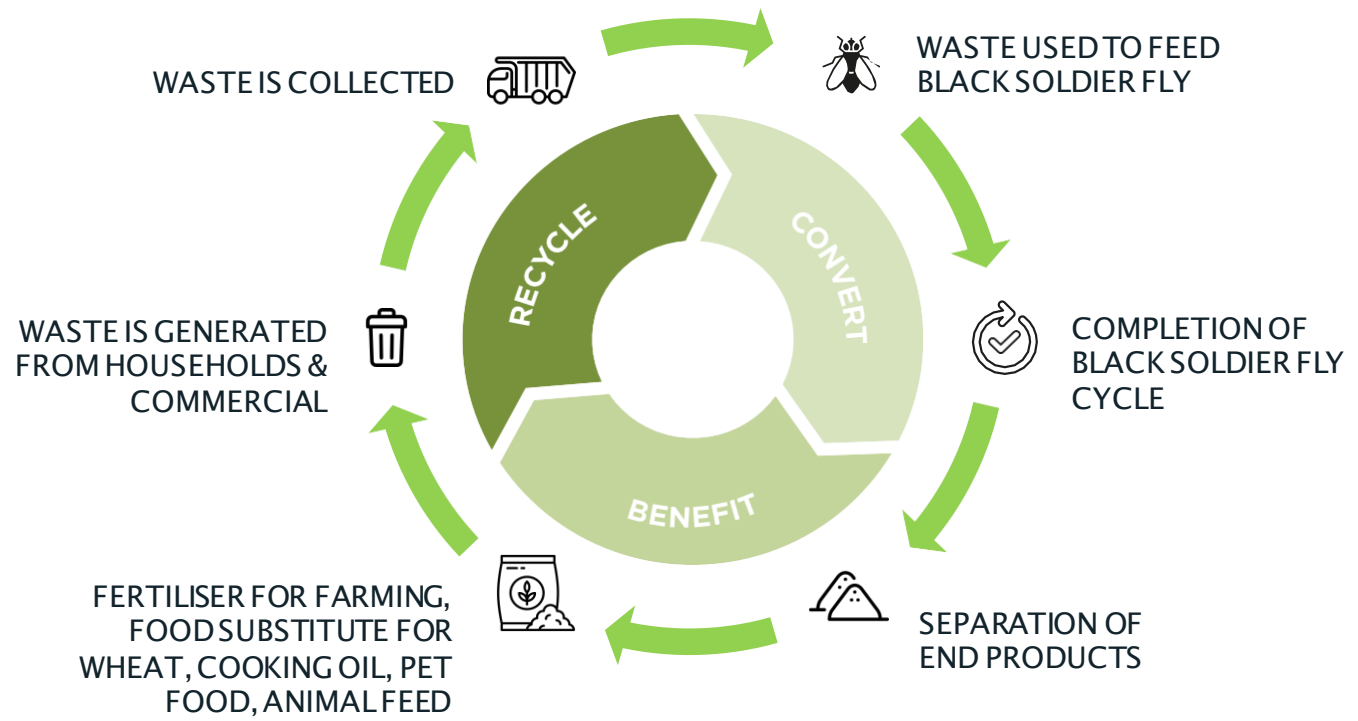
DISPOSE

WASTE

POLLUTE

THE SOLUTION

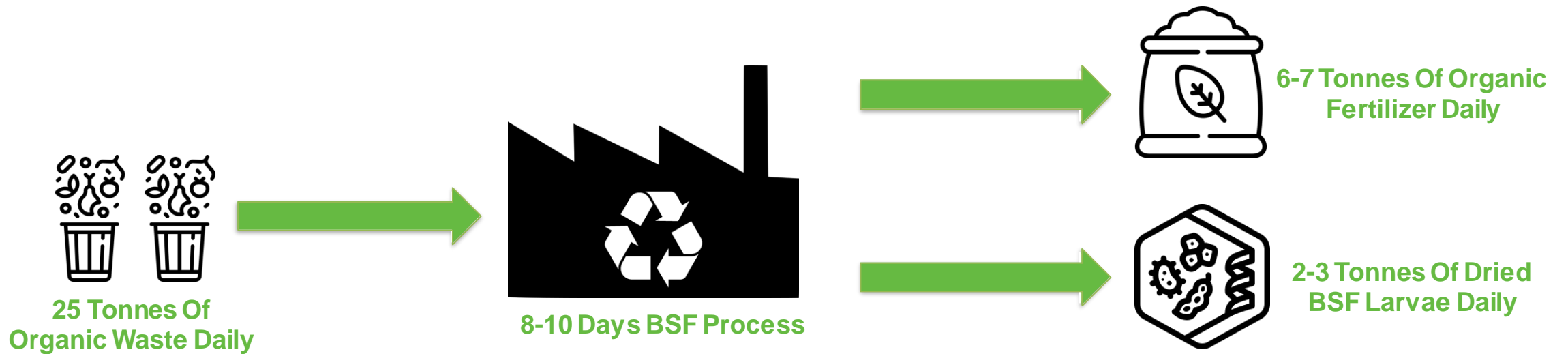
THE CIRCULAR ECONOMY OF WASTE



Hivemind utilizes organic food waste collected from restaurants, hotels, and domestic households that would otherwise be dumped in landfills and uses it as food for Black Soldier Flies.

Protein derived from these insects is then manufactured into various protein-rich products. This circular economy generates a positive impact on the environment and promotes recyclability.

HIVEMIND'S VISION



FORWARD THINKING TECHNOLOGY

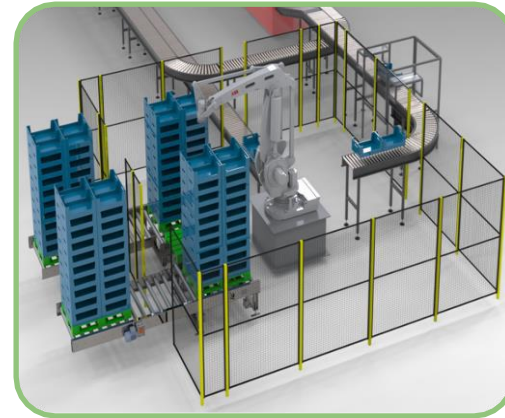
Feed Doser



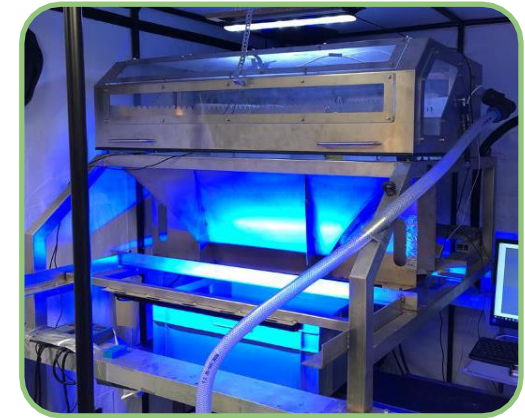
Fly Counter



Conveyance System

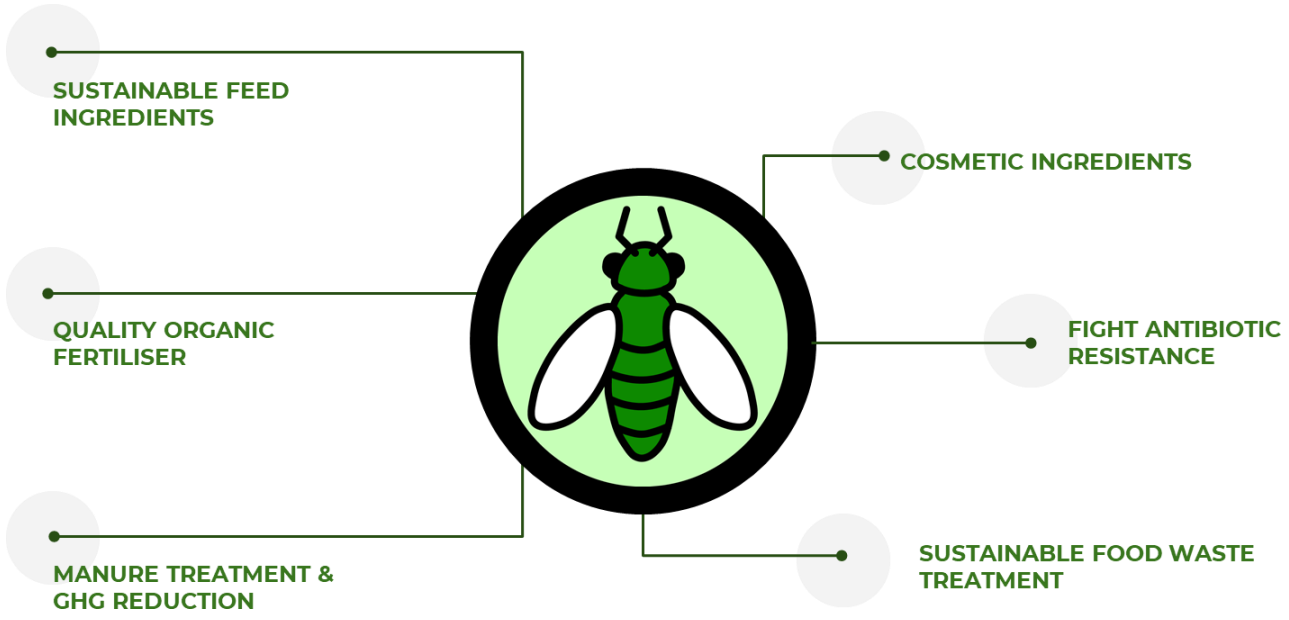


Neonate Counter



BLACK SOLIDER FLY

WHY IT MAKES SENSE



Greenhouse Gas Per 1kg of Protein (CO ₂ e)	140 g	1,900 g	3,700 g	13,300 g
Land Use Per 1kg of Protein (m ²)	0.5 m ²	18 m ²	24 m ²	164 m ²
Feed Conversion Ratio (Kg of Feed Per 1kg of Protein)	1.0 kg*	2.2 kg	5.0 kg	25.0 kg
Water Use Per 1kg of Protein (Litres)	1,000 L	3,500 L	3,900 L	15,500 L

**Not only is Feed required less, but this feed is fully organic waste rather than processed foods.*

BSF PROTEIN

THE SUSTAINABLE ALTERNATIVE



Characteristics	Black Soldier Fly	Mealworms	Crickets	Grasshoppers
Feeding Efficiency	High	Moderate	Moderate	Low
Growth Rate	Fast	Moderate	Fast	Fast
Environmental impact	Low	Moderate	High	High
Water Usage	Low	High	Moderate	Moderate
Land Usage	Low	Moderate	High	High
Nutritional Value For Animals	High	Moderate	High	High
Nutritional Value For Humans	High	Moderate	Moderate	Moderate

"Black soldier flies are a more sustainable and efficient source of protein than crickets and mealworms. They can be raised on a variety of organic waste materials. This makes them a more sustainable source of protein than crickets and mealworms, which are typically raised on feed that is derived from crops. Black soldier flies can also reach maturity in as little as 10 days, much faster than crickets and mealworms." Dr. David Zilberman, Professor of Agricultural and Resource Economics at the University of California, Berkeley

END PRODUCTS

LARVAE

1. PET FOOD (including specialised Pet Food)

BSF Larvae can be used in pet food in different forms, including dried larvae, insect meal and insect oil. This is because BSF are rich in protein, fat and other nutrients and are cheaper and safer than regular pet food. They are also increasingly used in Zoos, Private Animal Sanctuaries, Backyard Chickens

2. AQUACULTURE & LIVESTOCK FEED

The larvae of Black soldier flies are a sustainable and eco-friendly alternative to traditional protein sources such as soybean meal, fish meal, and other animal by-products, which can be expensive and environmentally unsustainable to produce.

BSF larvae in livestock and aquaculture feed is highly digestible. They can be easily broken down and absorbed by animals, resulting in better feed conversion and growth rates. Additionally, BSF larvae have been shown to improve the overall health and immunity of animals, which can help reduce the need for antibiotics and other medications.



FRASS

- **USE CASE:** organic fertilizer for soil enhancement
- **TARGET MARKETS:** Gardening companies for municipal gardens, malls, hotels, upmarket estates, farming and agriculture
- **OPPORTUNITY FOR VALUE-ADD** by semi-processing in adjacent facility, packaging (25kg) and marketing as organic fertilizer through garden shops or B-to-C online, leverage circular economy
- **VALUED AS POTTING SOIL** for indoor/vertical vegetable & berry farming operations ~ UAE growth market

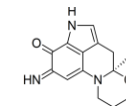
FUTURE



There are further The BSF contains antimicrobial peptides, which can be valuable in **medicine**.



Currently palm oil and coconut oil are often used in **cosmetics**. BSF oil could be applied as a replacement in those products



Melanin conducts electricity and can be used in **semiconductors, supercapacitors or batteries**

AN EVOLVING & FAVORABLE LEGISLATIVE LANDSCAPE

The global BSF legal framework varies widely between markets, but a few general trends can be discerned. On a simplified spectrum, developed markets such as the EU, the USA, and Canada are on one end, with a high degree of prescriptive legislation. On the other end developing markets, such as South Africa and Malaysia, tend to have looser frameworks.

“Legislation will not be a barrier for long.”
IPIFF | Rabobank | 2021

Characteristics	Livestock Feed	Organic Fertilisers	Pet Food	Technical Uses	Human Consumption	Technical Uses
European Union	Yes (In Some Forms)	Yes	Yes	Yes	No (Mealworms & Crickets Approved)	Yes
United States of America	Yes (For Most Livestock)	Yes	Yes (Only For Dog Food Currently)	Yes	No	Yes
United Kingdom	Yes	Yes	Yes	Yes	No	Yes
Japan	Yes	Yes	Yes	Yes	Yes	Yes
South Korea	Yes	Yes	Yes	Yes	Yes	Yes
South Africa	Yes	Yes	Yes	Yes	Yes	Yes

Less Stringent Feedstock Requirements



RAPIDLY GROWING MARKET

Market	Short Term (2022)	Long Term (2023)	CAGR	Required Volume
Pet Food	\$6.3bn	\$17.29bn	9.30%	250,000 Tonnes
Livestock & Aqua Feed	\$7.2bn	\$45bn	30.2%	700,000 Tonnes
Organic Frass	\$1.2bn	\$5.8bn	17.7%	200 Million Tonnes

Company	Funding Round	Date	Amount Raised (USD)
Enterra Feed	Series C	2023	\$200m
Protix	Series D	2022	\$100m
InnovaFeed	Series C	2022	\$240m
Ynsect	Series D	2022	\$400m
AgriProtein	Series C	2021	\$100m
Beta Hatch	Series A	2021	\$15m

"The black soldier fly market is a key part of the future of food, and is expected to play a major role in meeting the world's growing demand for protein."

JPMorgan Chase

"The black soldier fly is a potential source of affordable and nutritious protein for people living in poverty. It is a sustainable and environmentally friendly source of protein"

Bill & Melina Gates Foundation

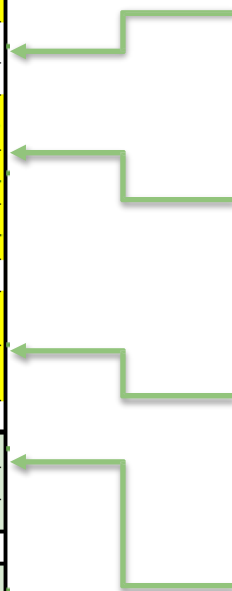
"The black soldier fly is a potential source of high-quality protein for animal feed and human consumption. The FAO is supporting research on the development of black soldier fly production systems and the use of black soldier fly products in animal feed and human food."

UN Food & Agriculture Organization



FINANCIAL OPPORTUNITY

Plant Capacity	
Wet feed into production (kg) / day	25,000
Final Product	Whole Dried Larvae
Feed Conversion Ratio	25%
Utilities	
Electricity (\$/kWh)	\$ 0.1416
Gas (\$/kWh)	\$ 0.0054
Water (\$/L)	\$ 0.0114
Product	
Whole Dried Larvae (\$/T)	\$ 2,950.00
Frass (\$/T)	\$ 590.00
CAPEX (\$)	
\$ 10,199,088.10	
IRR (%)	
19.99%	
Payback (Years)	
6	
Year 1 Revenue (\$/year)	
\$ 3,485,860	
Year 1 OPEX (\$/year)	
\$ 956,581	
Year 1 Gross Margin	
73%	



Profitability is highly dependent on the Feed Conversion Ratio. Through tests Hivemind have already completed we estimate it at 25%

Standard utility pricing can also be reduced through subsidies and partnerships with local municipalities and larger government entities

End products are a commodity and we have noted continually increasing pricing as Demand outstrips supply

Total CAPEX pricing includes all required planning, engineering and full technology CAPEX items

Thank You
Questions.

THANK YOU

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