Black Soldier Flies:
Introduction & Landscape

Fertilizer & Air Emissions Regs
07 February 2023

Welcome: Before we get started

Welcome

Introduction to Black Soldier Flies

Air emissions licensing session + Q&A

Fertilizer regulations session + Q&A

The
Food System
Problems

The Food System: Four Big Problems

Production

Resource intensive
Resource inefficient
Few monocrop reliant
Degrades nature
Diverse habitat loss
Zoonotic disease
Antibiotic resistance

+

Supply Chain

Geopolitical shocks
Fertilizer supply/cost
Fuel for logistics
Protein sources
Zoonotic diseases

+

Climate

Energy inputs
Transport miles
Livestock rearing
Synthetic fertilizer
Landfill gas

+

Food Waste

Disposal overheads
Disposal security
Landfill airspace
Regulatory risk
Dry recyclables impact

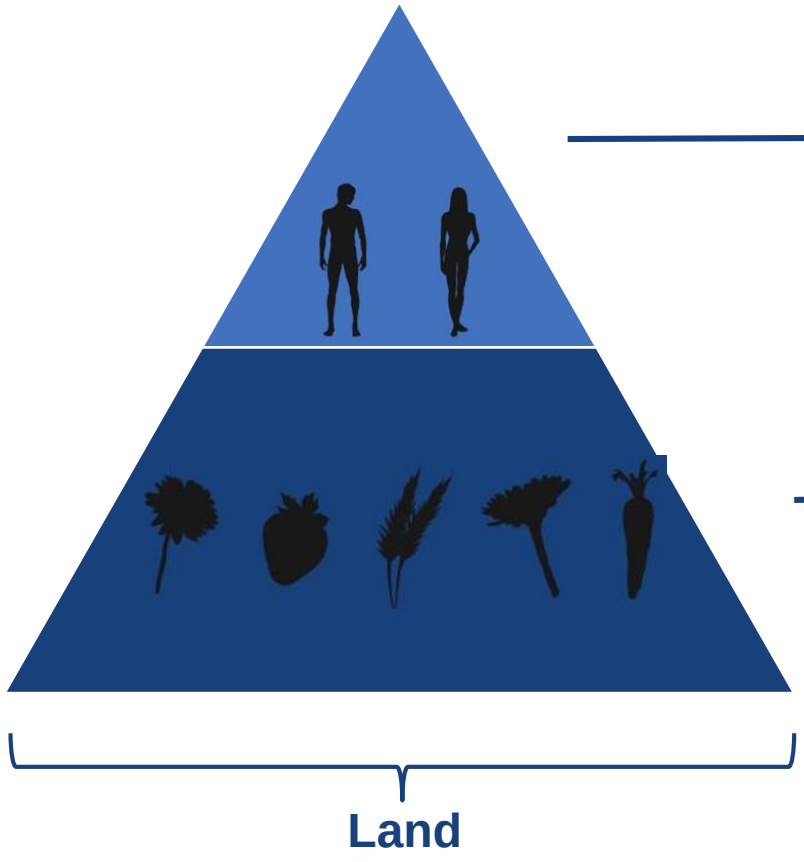
Food + Feed Security Risk

Waste Management Risk

Livestock Amplified

The Food System: Four Big Problems … Livestock Amplified

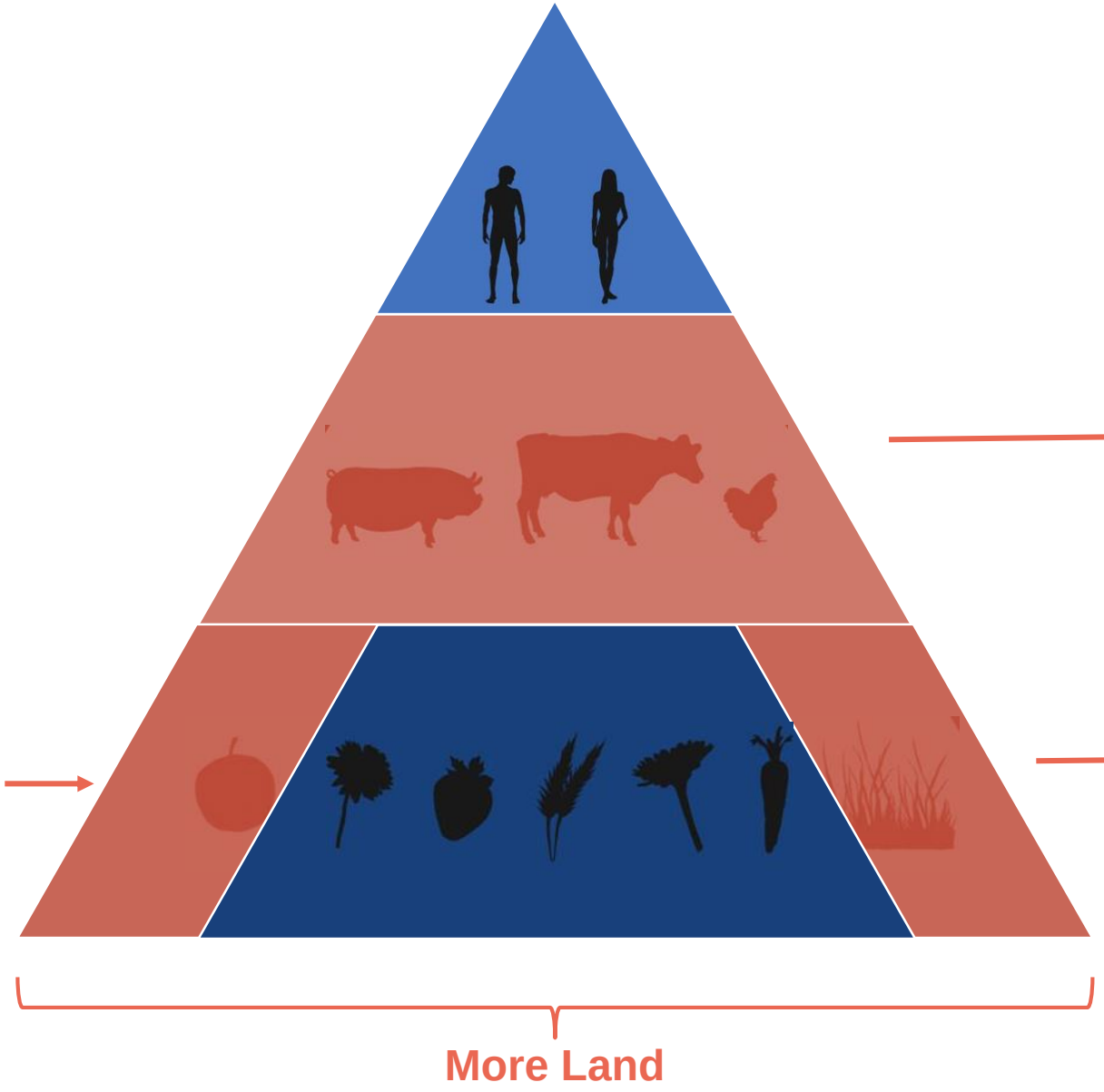
- Food
- Fertilizer (imported)
- Fuel (imported)
- Water (scarce)
- Energy (you know)



- Solid Waste
- Landfill

- Solid Waste
- GHG

The Food System: Four Big Problems … Livestock Amplified



- More Solid Waste
- More GHG

- More Solid Waste
- More GHG

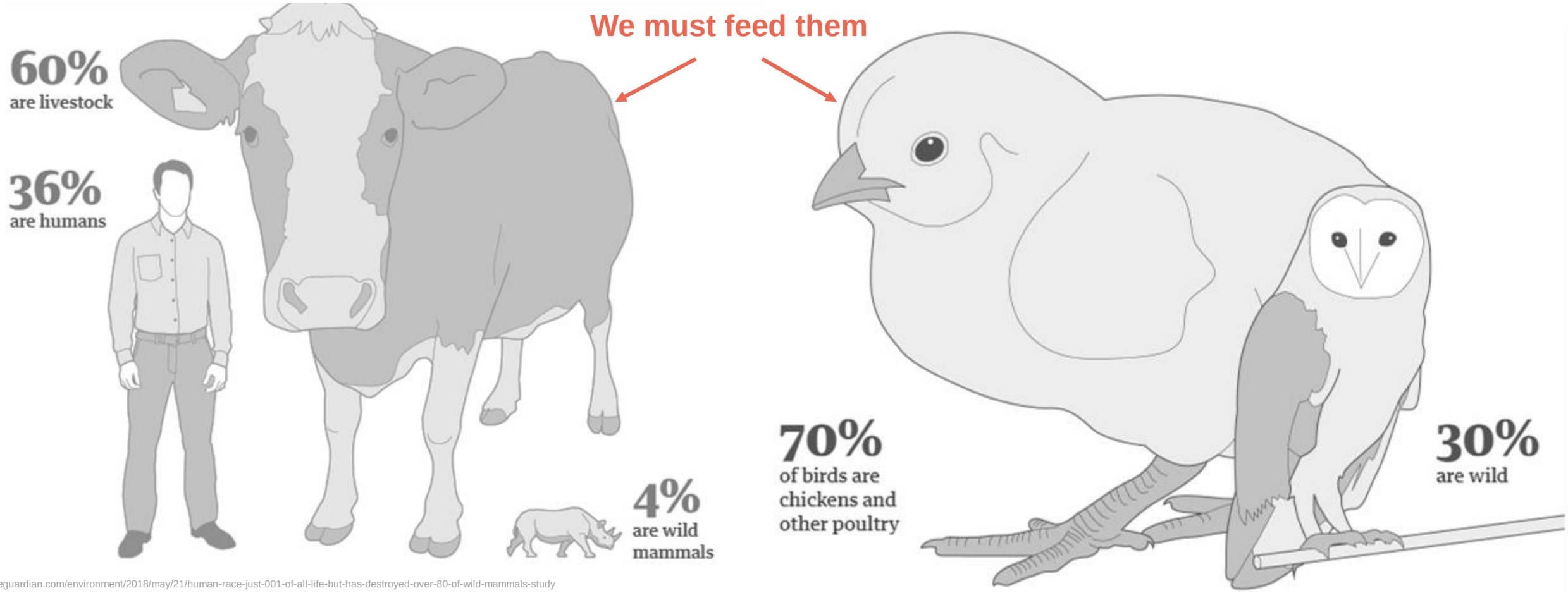
- More Fertilizer
- More Fuel
- More Water
- More Energy

More Land

The Food System: Four Big Problems … Livestock Amplified

80 Billion livestock Slaughtered each year

We must feed them



www.theguardian.com/environment/2018/may/21/human-race-just-001-of-all-life-but-has-destroyed-over-80-of-wild-mammals-study

The Food System: Four Big Problems … Livestock Amplified

Livestock convert plants and other raw materials, into products for human use.

Demand for animal-based products expected to rise. Meat & dairy expected to increase 327% + 270% respectively in Sub-Saharan Africa by 2050 alone.

To feed demand, vast quantities of feed are needed, notably protein, such as soy and fishmeal, to fuel animal growth.

To supply vast amounts of feed requires enormous amounts of input resources.

The extraction of these resources are inherently linear, highly inefficient, and unsustainable.

The ecological, social, and economic shortfalls of such a food system are well documented and undeniable.

This exposes cities, and their citizens, to stresses and shocks related to:

- Food security
- Climate change
- Waste management

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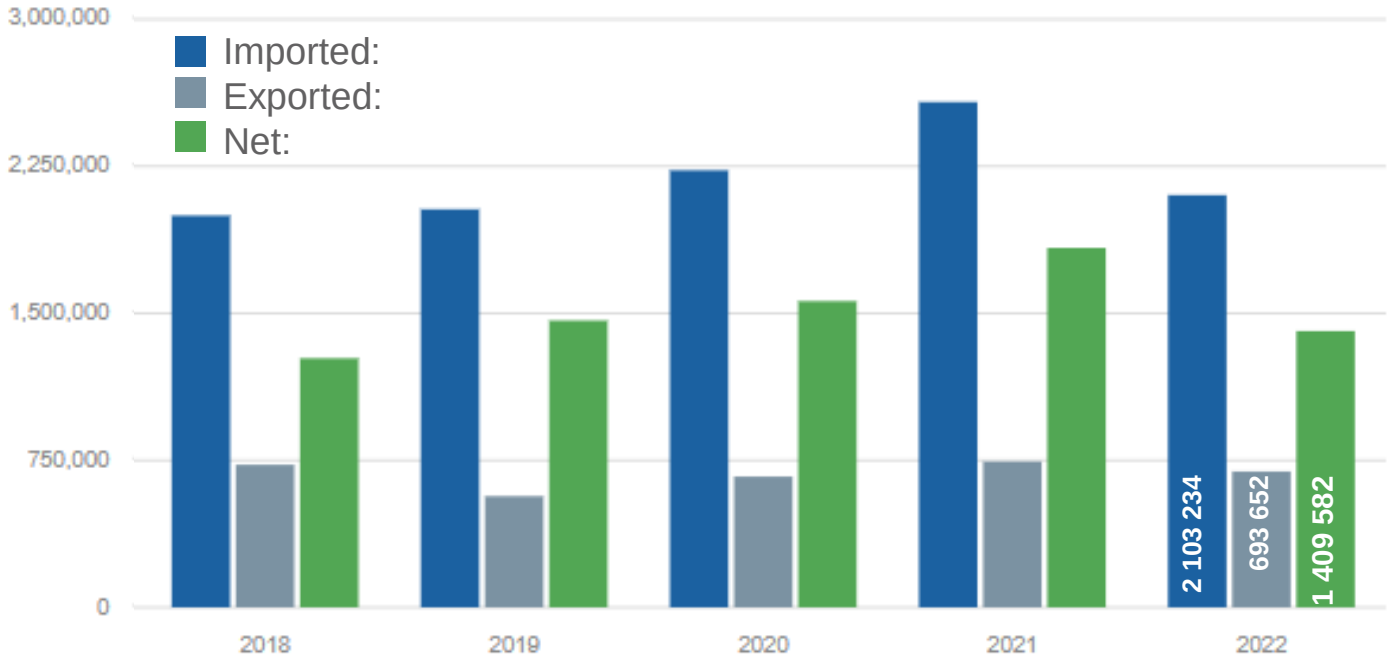
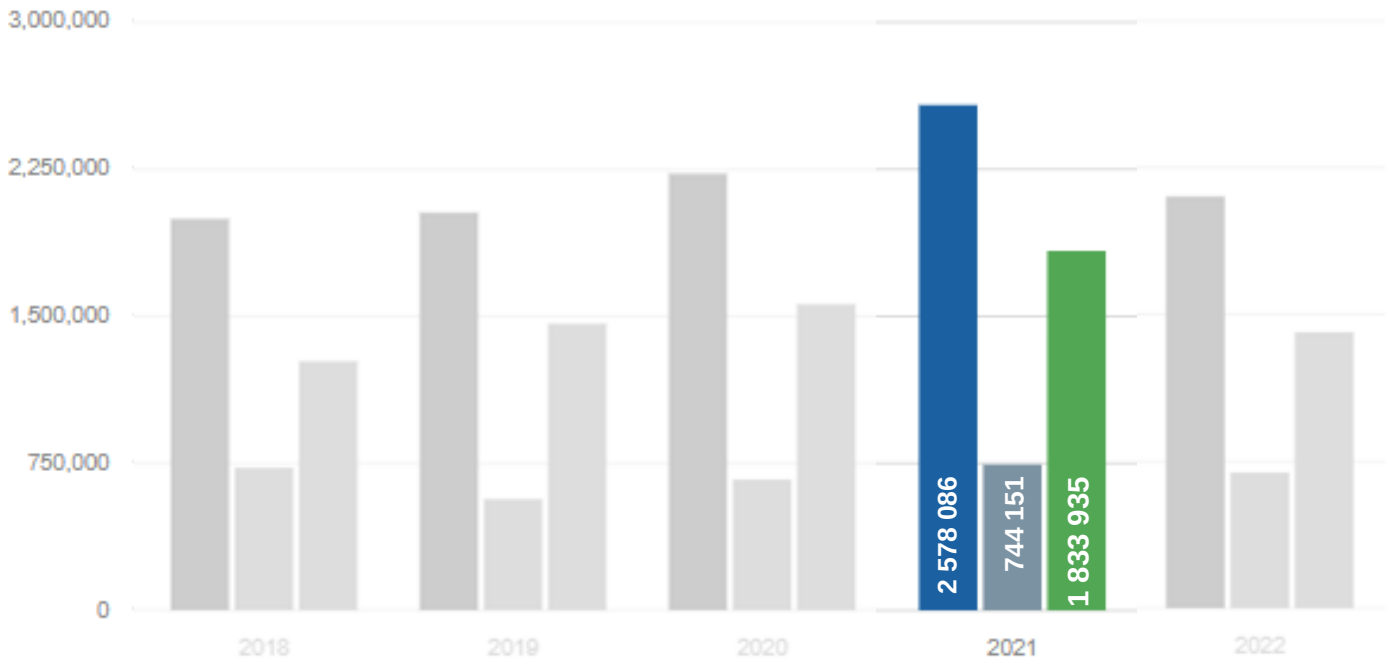
Supply Chain Risk

Supply Chain Risk: Fertilizer ... South Africa is a net importer



Source: http://www.fertasastats.co.za

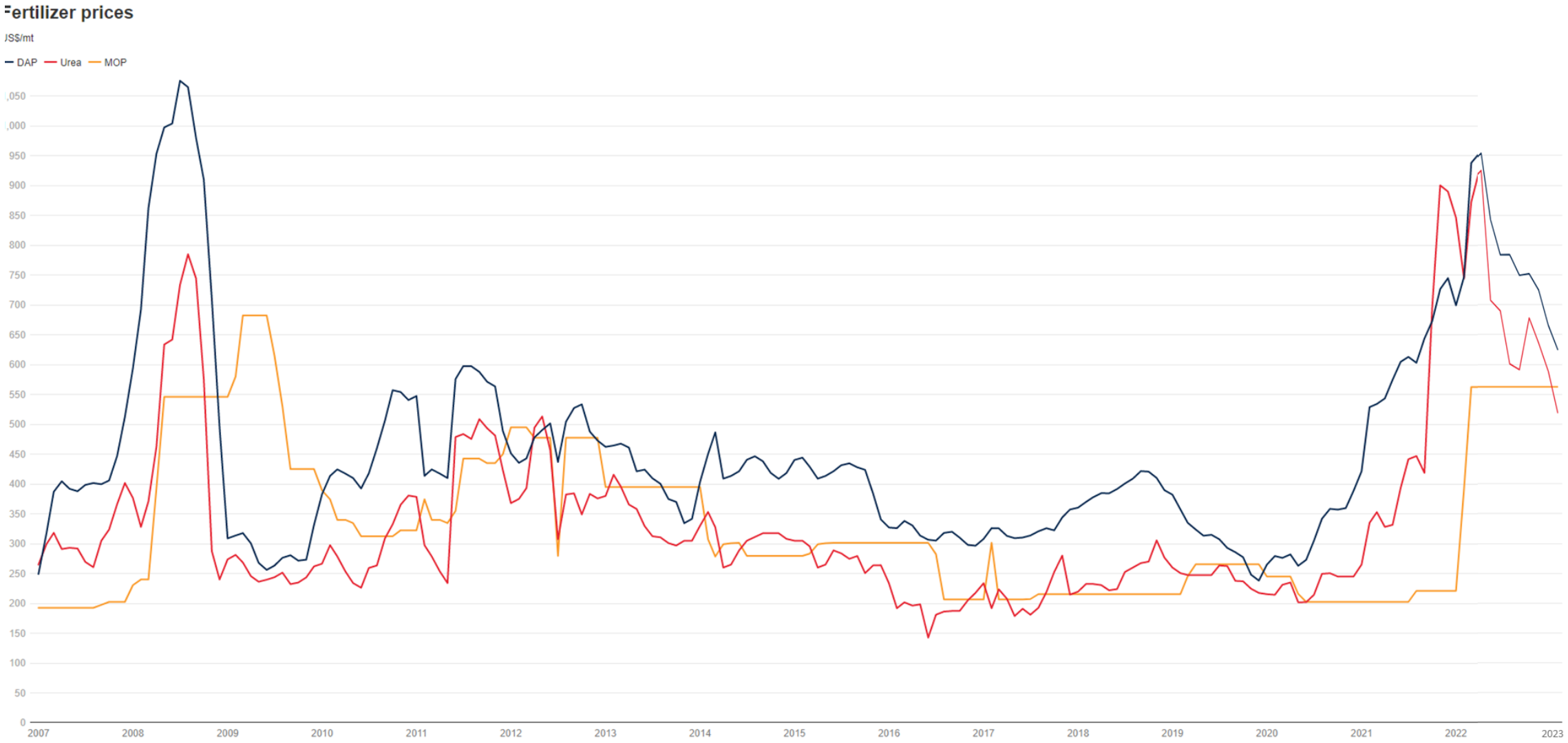
Supply Chain Risk: Fertilizer ... South Africa is a net importer



Fertilizer usage 2021 RSA						%
	N	P	K	NPK	Physical	
Crop	Metric tons					
Maize	277 650	54975	23045	355 670	1184380	53,66
Sunflower	7 100	4373	1964	13 437	44745	2,03
Soybeans	8 060	5720	5352	19 132	63709	2,89
Wheat	16 200	8492	2241	26 933	89687	4,06
Barley	3 959	1654	548	6 161	20516	0,93
Canola	1 110	704	123	1 937	6450	0,29
Groundnuts	401	220	0	621	2066	0,09
Sorghum	2 382	634	359	3 374	11237	0,51
Dry Beans	775	396	86	1 256	4184	0,19
Tobacco	186	308	399	893	2973	0,13
Cotton	540	145	37	723	2406	0,11
Citrus	4 960	955	3088	9 002	29978	1,36
Subtr fruits/nuts	9 000	1254	9960	20 214	67313	3,05
Vines	8 000	2508	3187	13 695	45605	2,07
Deciduous fruit	6 050	3828	3789	13 667	45511	2,06
Vegetables	16 150	6644	9462	32 256	107412	4,87
Potatoes	8 670	3590	5080	17 340	57742	2,62
Sugarcane	35 236	9592	42279	87 107	290068	13,14
Lucerne	1 950	4400	2590	8 940	29769	1,35
Other pastures	21 000	7040	2440	30 480	101499	4,60
TOTAL	429 377	117432	116028	662 838	2207249	100,00

Source: http://www.fertasastats.co.za

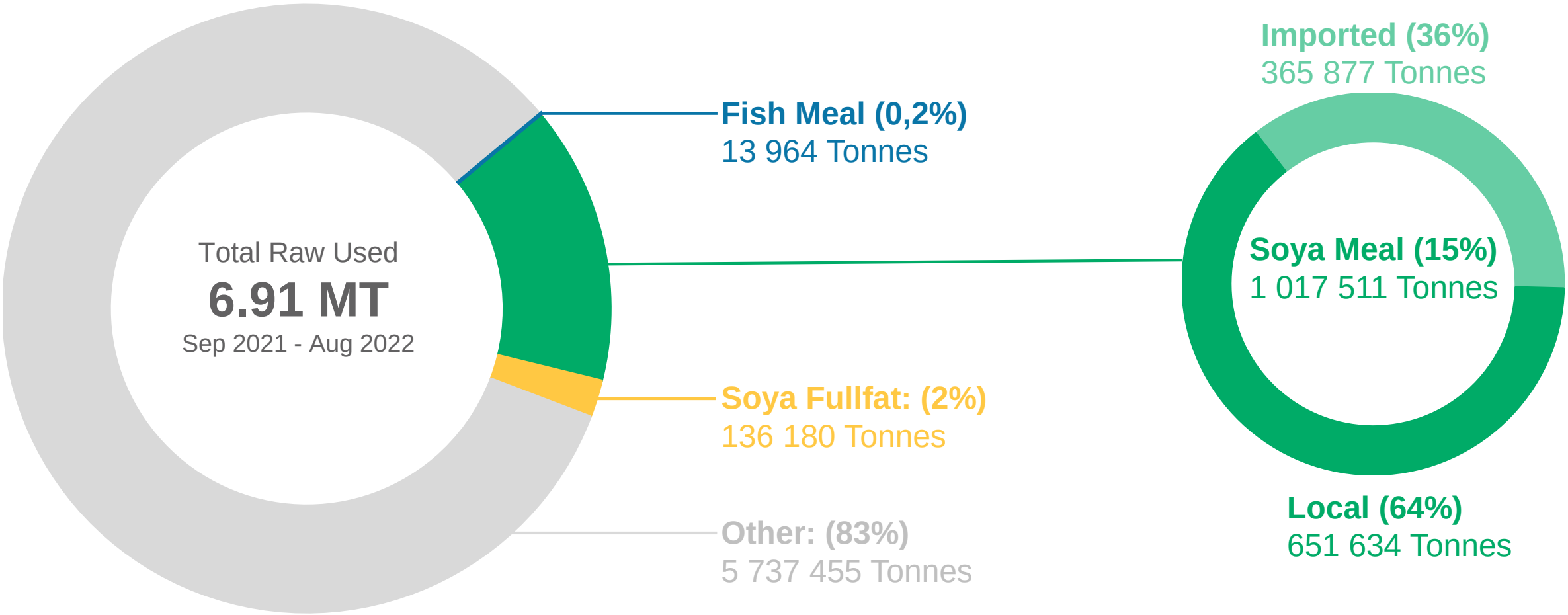
Supply Chain Risk: Fertilizer ... The price is volatile



Note: DAP = diammonium phosphate. MOP = muriate of potash. mt = metric ton. Last observation is December 2022.

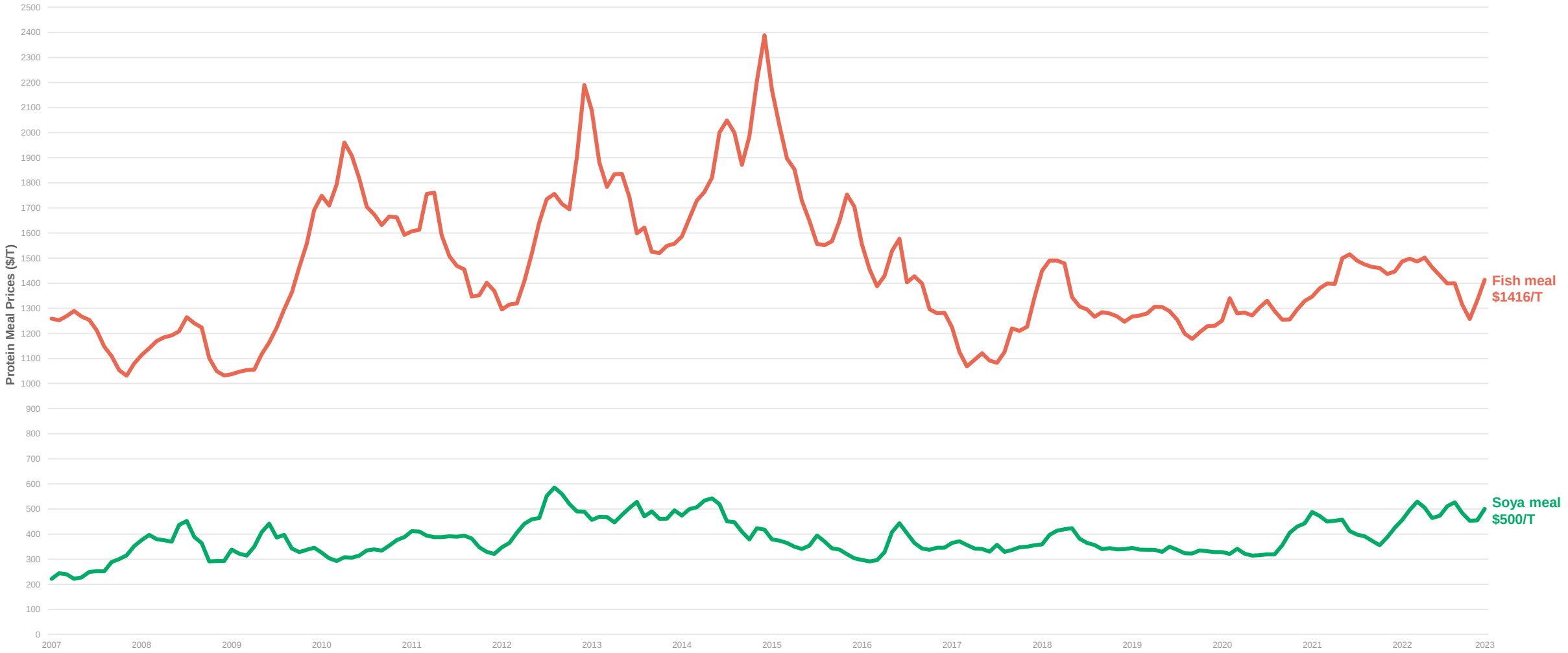
Source: https://blogs.worldbank.org/opendata/fertilizer-prices-ease-affordability-and-availability-issues-linger

Supply Chain Risk: Protein … South Africa imports a lot for feed



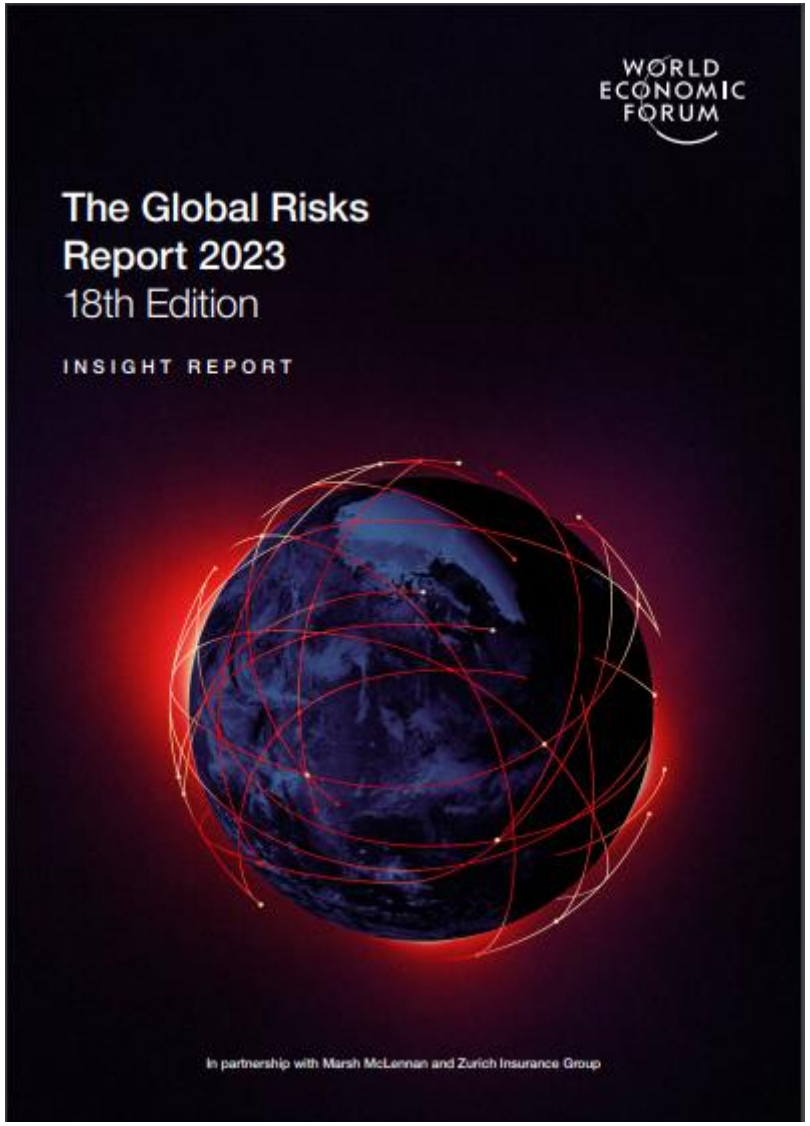
Source: AFMA

Supply Chain Risk: Protein … Prices are volatile too



Source: https://blogs.worldbank.org/opendata/fertilizer-prices-ease-affordability-and-availability-issues-linger

Supply Chain Risk: Global Risks … Top 10 Crises



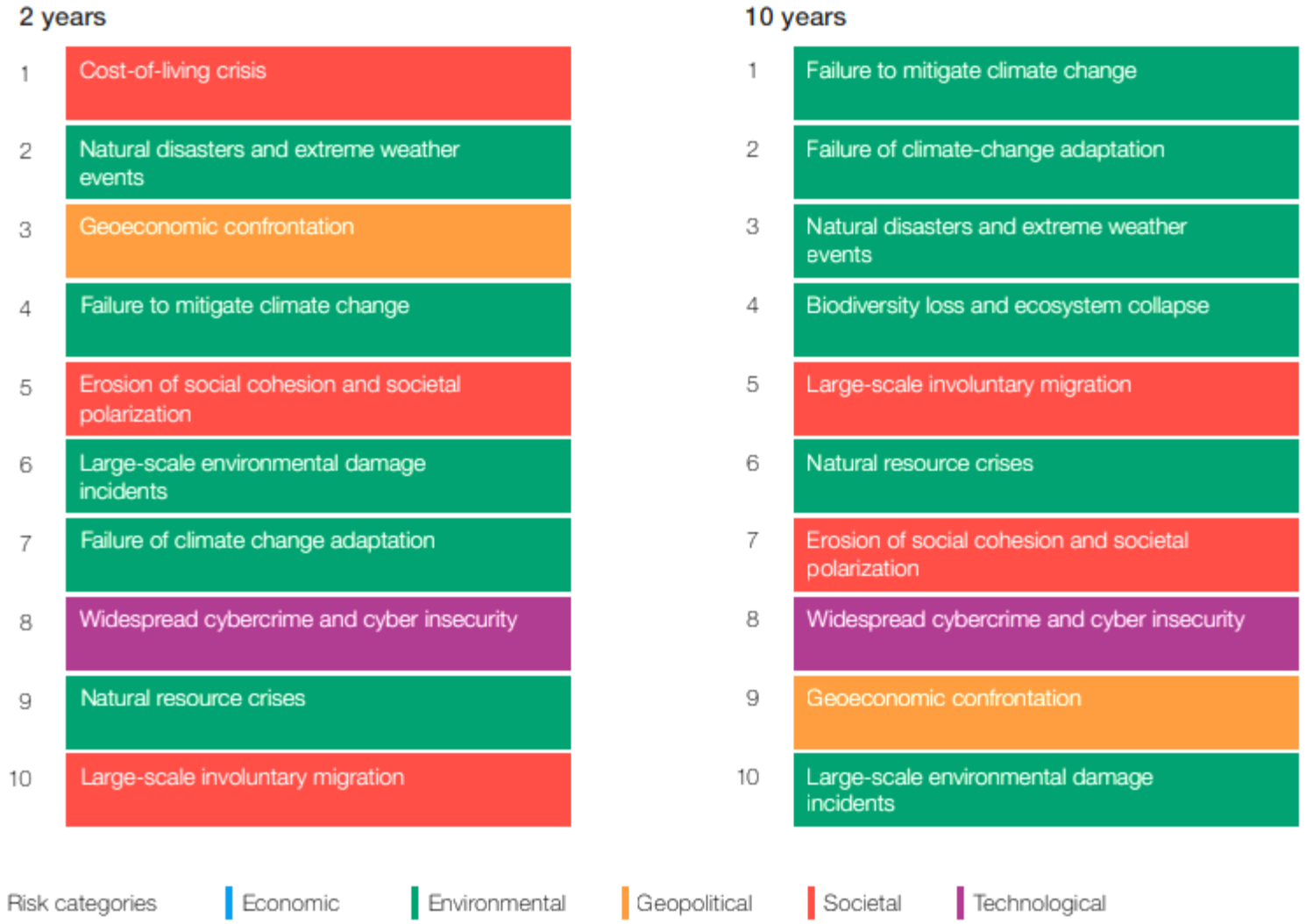
	2 years	10 years
1	Cost-of-living crisis	Failure to mitigate climate change
2	Natural disasters and extreme weather events	Failure of climate-change adaptation
3	Geoeconomic confrontation	Natural disasters and extreme weather events
4	Failure to mitigate climate change	Biodiversity loss and ecosystem collapse
5	Erosion of social cohesion and societal polarization	Large-scale involuntary migration
6	Large-scale environmental damage incidents	Natural resource crises
7	Failure of climate change adaptation	Erosion of social cohesion and societal polarization
8	Widespread cybercrime and cyber insecurity	Widespread cybercrime and cyber insecurity
9	Natural resource crises	Geoeconomic confrontation
10	Large-scale involuntary migration	Large-scale environmental damage incidents

Risk categories: Economic | Environmental | Geopolitical | Societal | Technological

https://www3.weforum.org/docs/WEF_Global_Risks_Report_2023.pdf

Supply Chain Risk: Global Risks … Decade of Polyrises

- Decade of Polycrises and turmoil.
- Top 5 long term risks = environmental
- Geo-economics confrontation is short and long term risk
- SA top five are socio-economic risks
- But SA reliant on imports (fuel, fertiliser, protein), & ecosystem goods & services
- Result in immense pressure of food related supply chains
- Translates to job losses, cost of living, and food insecurity



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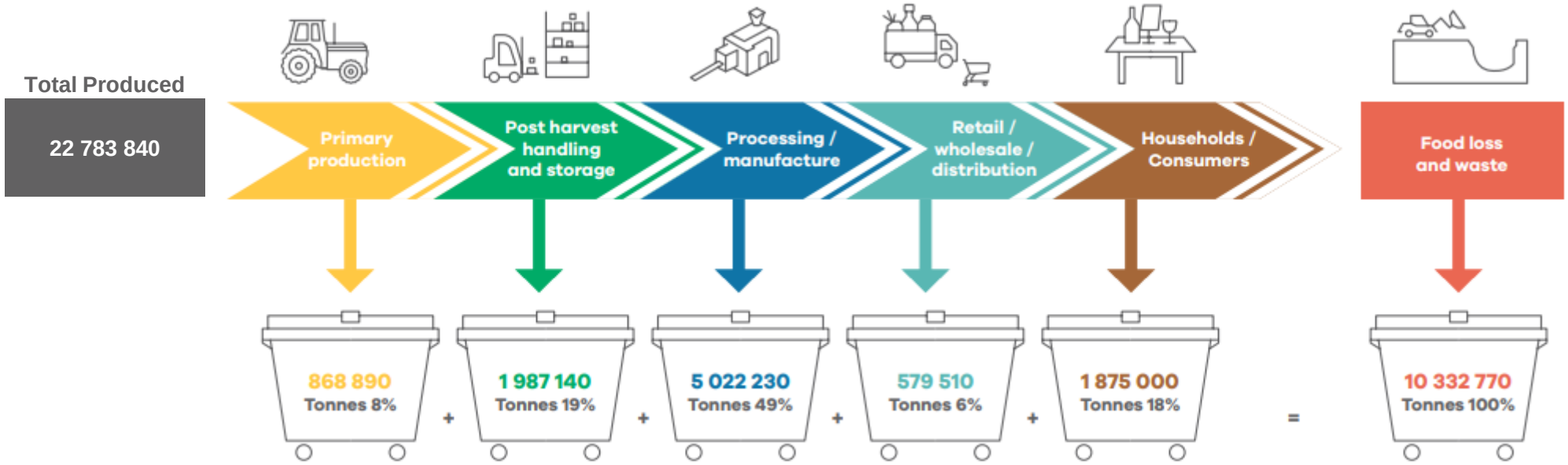
Waste Problem

Waste Problem: It’s also Linear … it is very wasteful



https://wasteroadmap.co.za/wp-content/uploads/2021/06/17-CSIR-Final_Briefing-Note_Food-waste.pdf

Waste Problem: It’s also Linear … it is very wasteful

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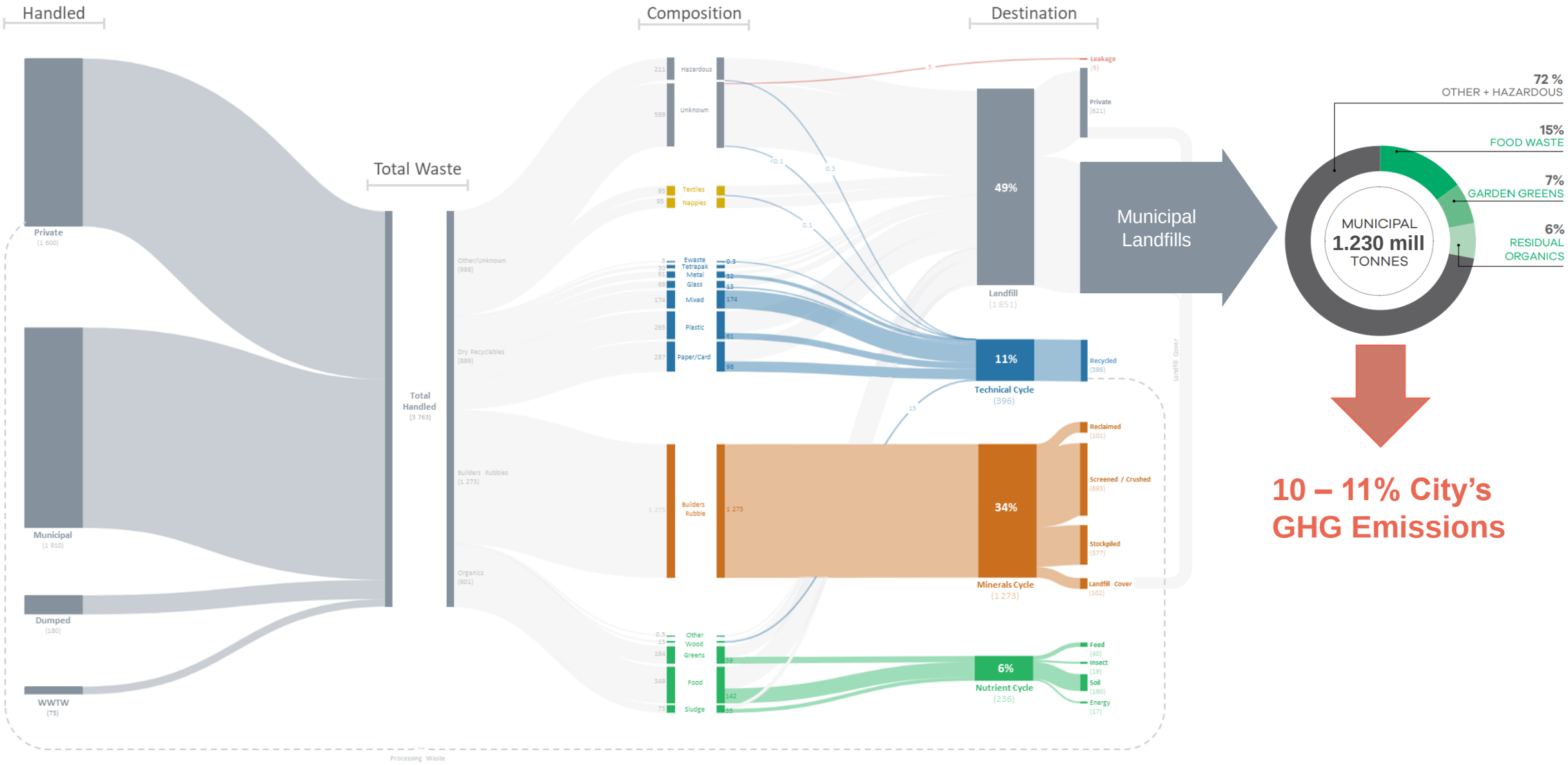
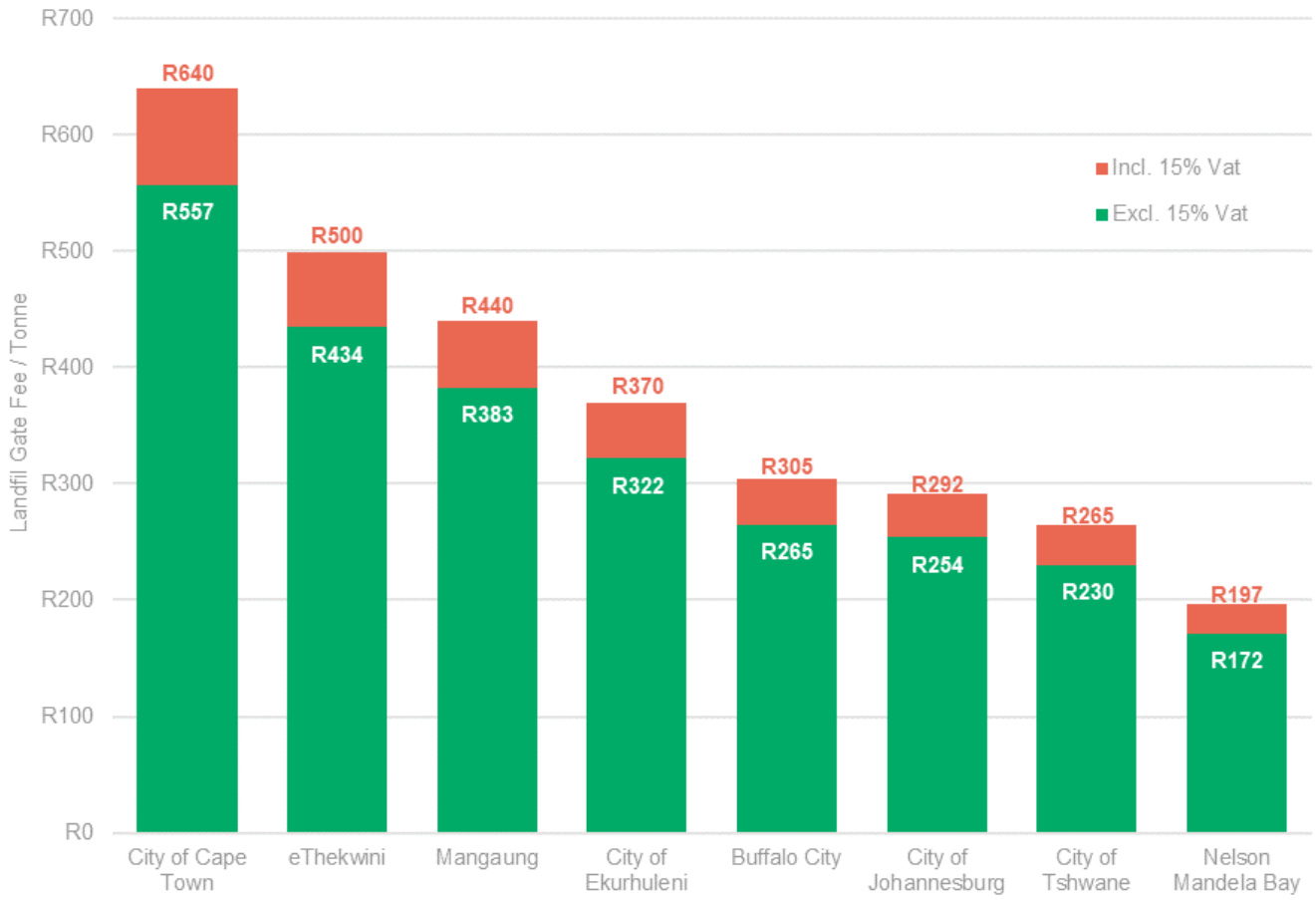
Waste Problem: It's also Linear … it is very wasteful … CPT 2019

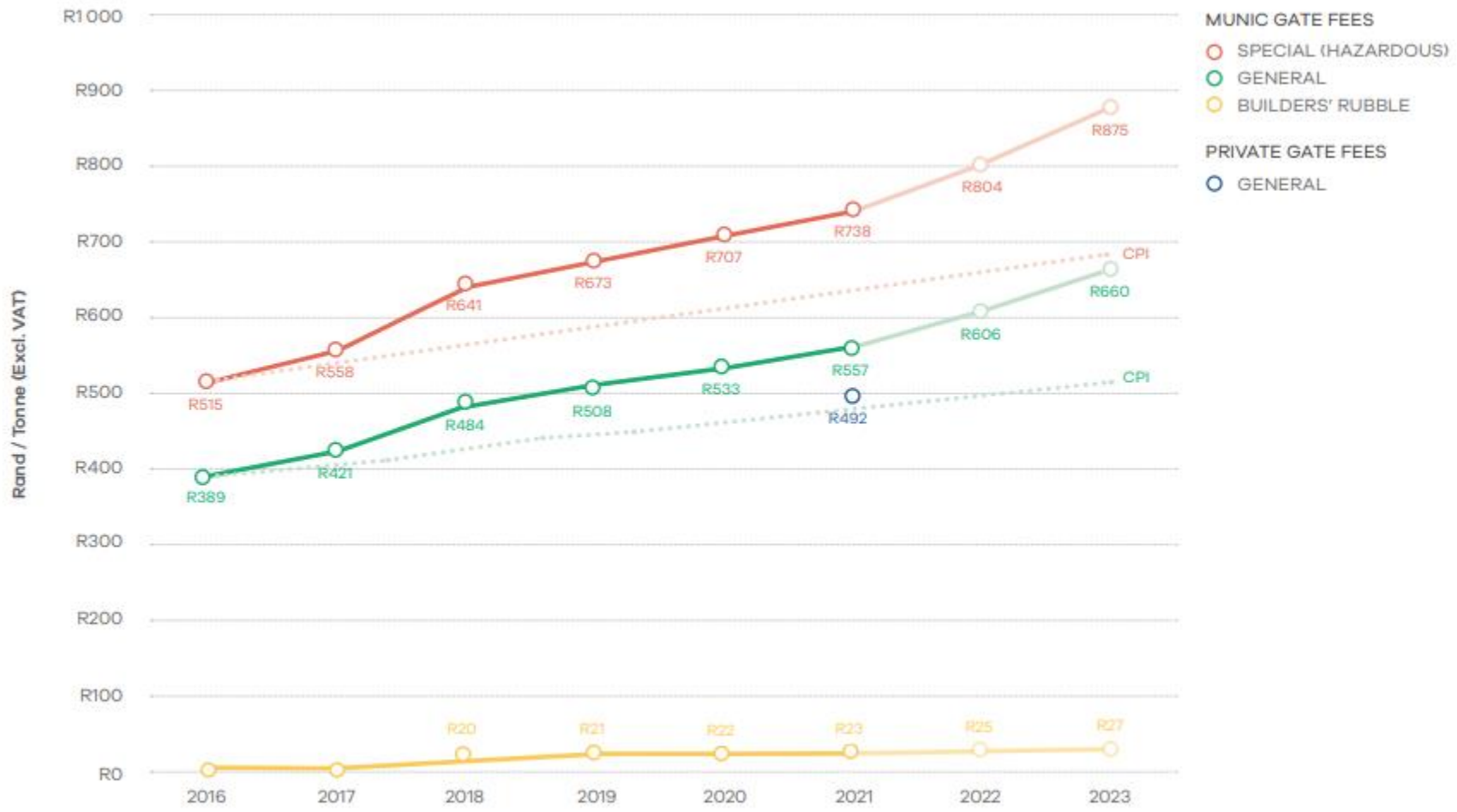


10 – 11% City's GHG Emissions

Waste Problem: It's also Linear … it is costly … 2021/22



Waste Problem: It's also Linear … it is costly … 2021/22



Food Waste: It’s also Linear … it’s a regulatory nightmare

Western Cape Organic Waste Landfill Restriction 2022 + 2027

+

National Waste Management Strategy Targets

+

Municipal Landfill Airspace Security

+

National & City Level Climate Mitigation Targets

What's Needed

What's Needed: We need a food supply chain that is:

We need feed / food that is:

- Price competitive with existing feedstocks
- Uses less resources (water, electricity, materials)
- Requires less land so that other activities
- Less reliant on imports and supports local
- Promotes urban jobs for rural livelihoods
- More resilient during times of crisis
- A stable price, even during times of volatility
- Promotes healthy livestock and pets
- Tackles a national waste crisis, notably urban organics
- Promotes climate mitigation and adaptation
- Enhances soil security for the long term to grow more feed

One Solution
Ticking Many Boxes

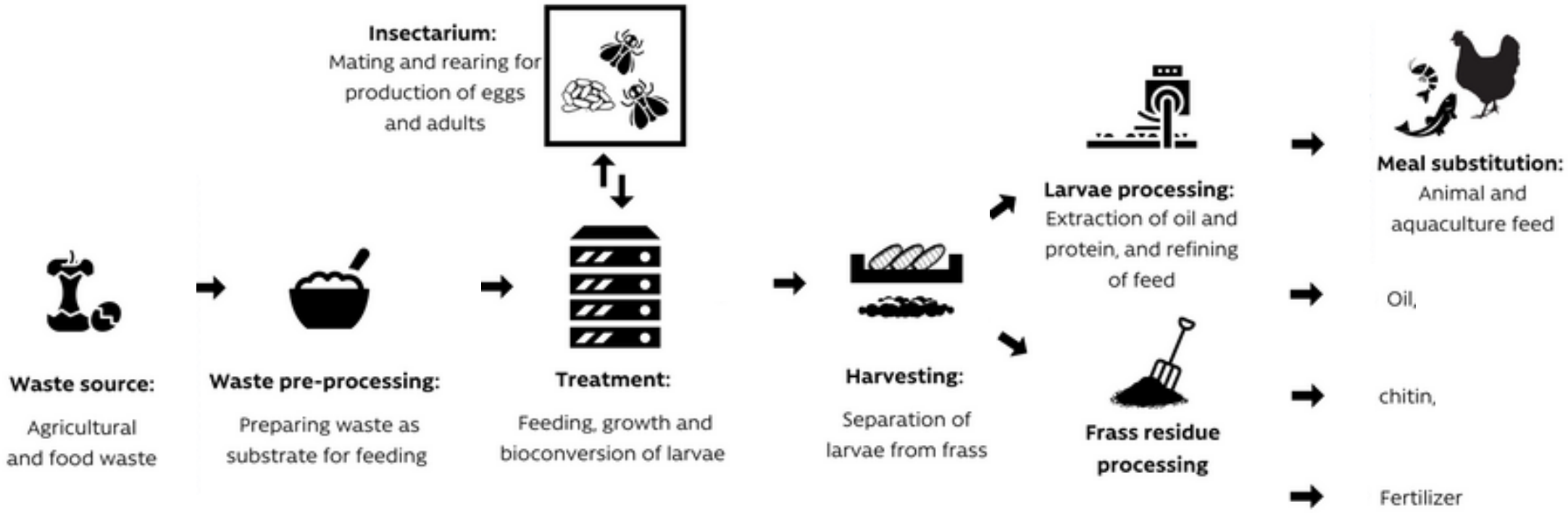
A Solution: The Humble Black Soldier Fly

- The Black Soldier Fly (Hermetia illucens) is a wasp like fly.
- Adult is shy and largely avoids human interactions.
- Adults do not have mouthparts and thus do not seek out food.
- The purpose of the adult is to locate mates and lay eggs.
- They are not associated with transmitting diseases.
- Only in the larvae form do they consume food.
- The larvae digests and converts feed extremely efficiently.
- Humans are able to process the larvae into various high value products
- They have evolved to break down problematic bacteria and emit odours that repel pests.
- The excrement is rich in nutrients and can be used as an organic fertiliser.
- BSF is regarded as sanitary solution to food waste and a source of sustainable protein.

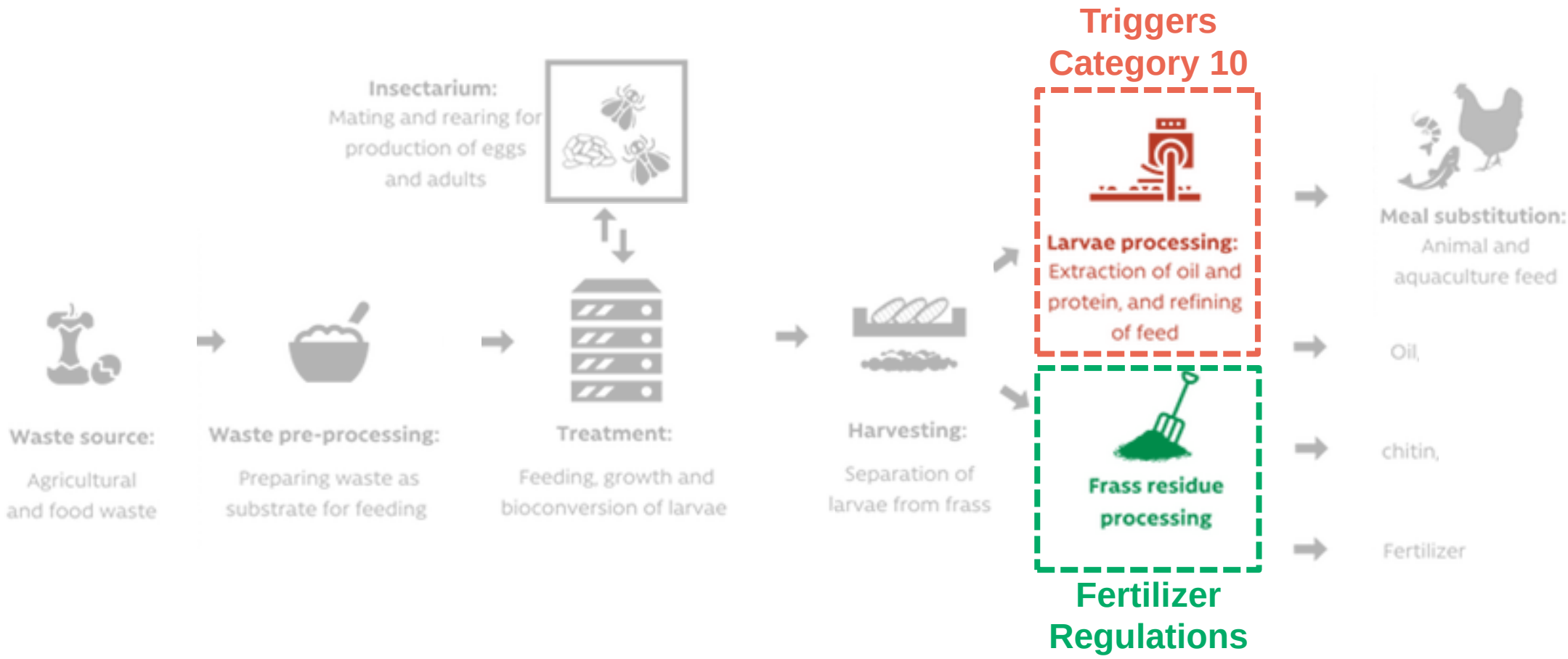
A Solution: The Humble Black Soldier Fly … It's not a house Fly

The Process

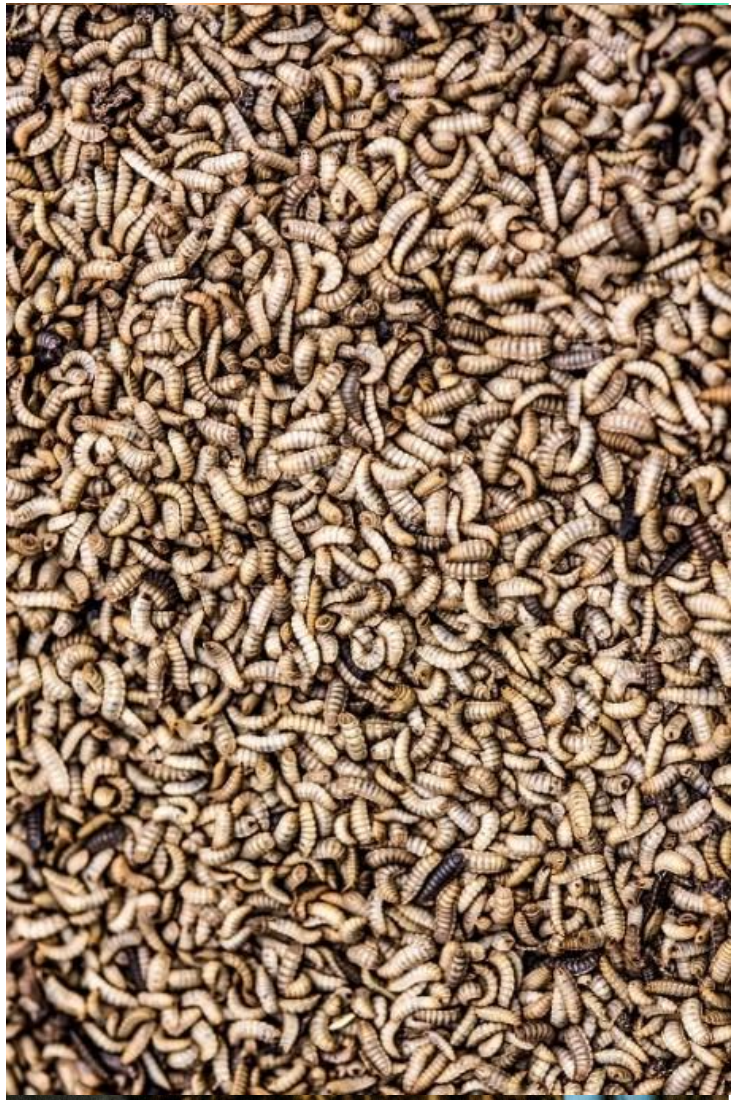
A Solution: The Humble Black Soldier Fly … The Process



A Solution: The Humble Black Soldier Fly … The Process



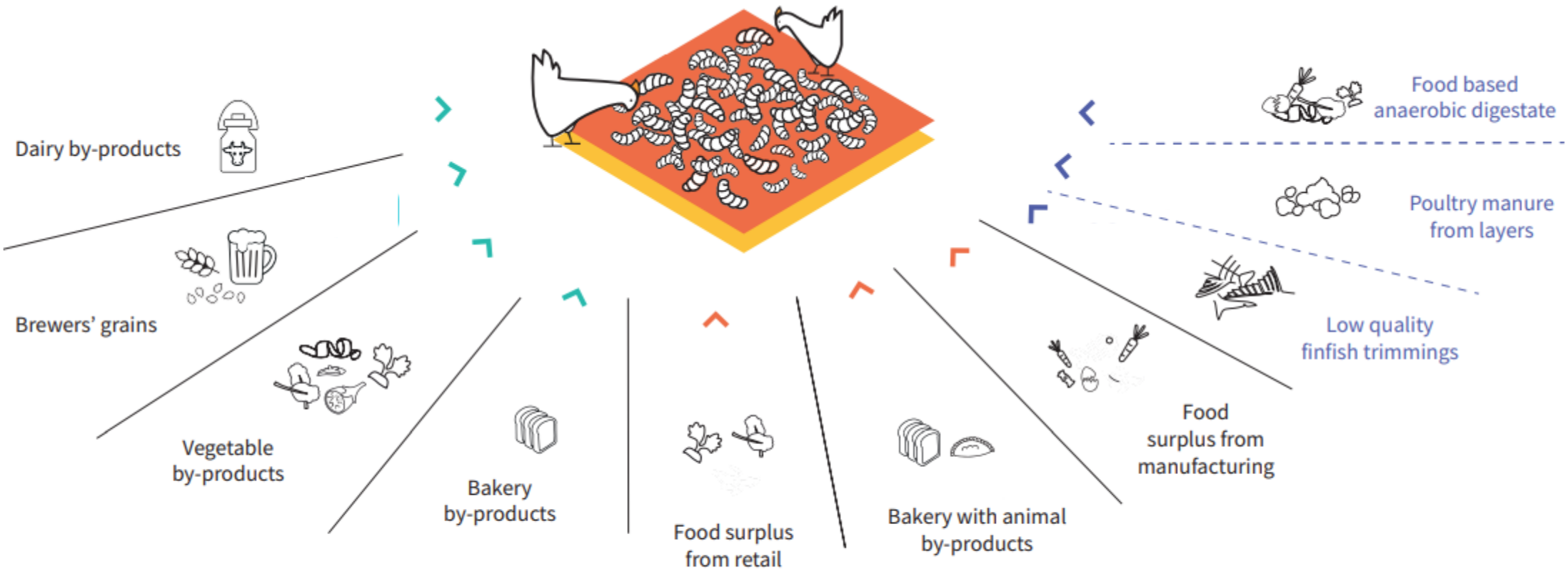
A Solution: The Humble Black Soldier Fly … some pics



Images: www.inseco.co.za

The Inputs

The Inputs: The Substrates



www.wwf.org.uk/sites/default/files/2021-06/The_future_of_feed_July_2021.pdf

The Outputs

The Outputs: High Value Products … Feed

Grubs

Dried larvae, high in protein, oils, and nutrients that serve as an ideal feed for poultry, aquaculture, reptile, and wild birds.

Protein Meal

Defatted larvae that is dried and milled into a high quality protein meal. It serves as an alternative to wild fish and soy based protein feeds for livestock and pets. It is highly digestible, hypoallergenic, antimicrobial and anti-inflammatory

Oil

Quality oil extracted and purified during the protein meal preparation. It is an alternatives to less sustainable price volatile oils from wild fish, coconut and palm oil.

Eggs

Eggs supplied to BSF producers to boost genetic diversity, or for aquaculture farms, access to reliable and affordable forms of live feed for your hatchlings is often unavailable. Eggs are also an alternative source of feed for fish fry.

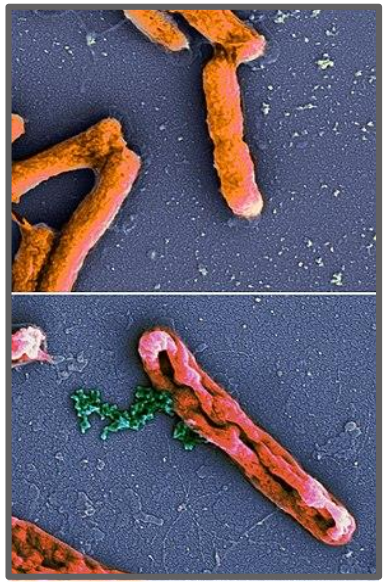
Chitin

Larvae exoskeleton that has a wide array of applications from pharmaceuticals and cosmetics to animal feed and human food. Chitin boosts healthy gut bacteria and suppresses inflammation

Images: www.inseco.co.za

The Outputs: High Value Products … More than just feed

Antimicrobial Peptides



AMPs are key components of the insect immune system, and prevent harmful pathogens (viruses, bacteria, fungi, and parasites) from infecting a host. Some propose the use of AMPs as an alternative to antibiotics.

+

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+

Lauric acid

Lauric acid is the major component of BSF lipid fraction. It is a medium chain fatty acid commonly sourced from coconut and palm oils. It has shown to have of antimicrobial properties and has been proposed as an alternative to antibiotics.

=

Healthy Livestock and Healthy Pets

Images: www.inseco.co.za

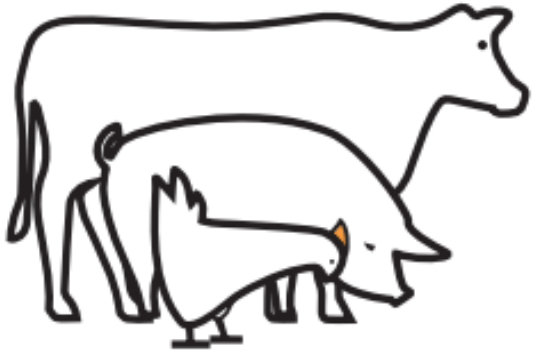
The Outputs: High Value Products … Feed and future food

Pets

+

Aquaculture

+



Livestock

Humans

+

Pharmaceuticals

The Outputs: High Value Products … protein impact comparison

ENVIRONMENTAL IMPACT		SOYBEAN MEAL	FISHMEAL	INSECT MEAL
State indicators (i.e. changes to the state of nature)				
Land use change		High conversion risk	No impact	No land use change at scale
Soil condition		Intensive agriculture	No impact	No impact
Climate impact		Conversion	Relatively low emissions from shipping	Operation of facility
Water removed		If irrigated	Low impact	Operation of facility and substrate moisture adaptation
Nitrogen		If NPK applied to soy or to crops in rotation	No impact	Nitrogen accumulation in frass
Biodiversity		Conversion and intensive agriculture	Reduced fish stocks, by-catch	Low ecological impact
Pollution		Pesticide use and eutrophication	Effluent discharge	Limited evidence
Waste		Limited evidence	Limited evidence	By-products chitin and frass have uses
Pressure indicators (i.e. environmental footprint assessments)				
Land use footprint		Large area required	Small area used	Small area used
Carbon footprint	Direct	Cultivation and shipping	Fishing vessels	Heating requirement
	Indirect	Land use change	Low indirect footprint	Substrate dependent
Water footprint		High water use	Limited evidence	Low water use

https://www.wwf.org.uk/sites/default/files/2021-06/The_future_of_feed_July_2021.pdf

The Outputs: High Value Products … Its all about the Soil

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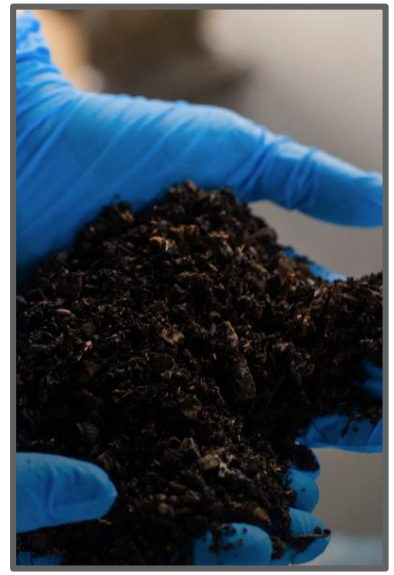
Frass

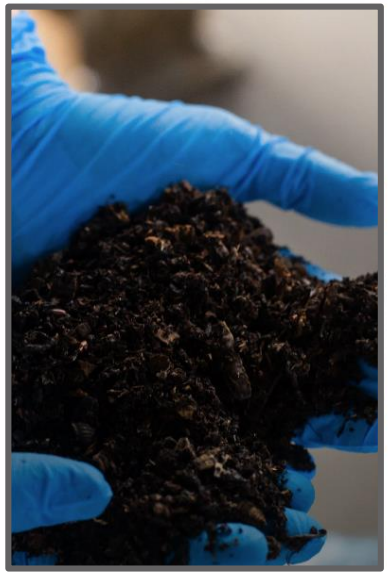


An organic fertiliser / bio-stimulant consisting of a mix of excreta, insect exoskeletons, and food residues. It is high in nitrogen and is an ideal replacement to fossil fuel based chemical fertilisers.

Images: www.inseco.co.za

The Outputs: High Value Products … Its all about the Soil

Frass



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Improves Soil Health and Resilience
- Rich microbial diversity
- Low pathogen count
-

Enhances Growth
- Improves overall plant growth
- Contains growth promoting compounds
- Source of plant nutrients (NPK)

Boosts Natural Defences
- Affects soil biology and plant growth
- Fungi, insects, nematodes, bacteria viruses
- Wounding healing

Increase Water Holding Capacity
- Direct and indirect means
- High Carbon content
- Increased microbial activity

Suitable for all soil types
- Slow release of organic NPK
- Diverse micronutrient profile
- Good Cation Exchange Capacity
- Reduce risk of salinity
- Mitigate erosion damage

Carbon Credits
- High organic (carbon) matter
- Farmers claim carbon sequestration
- see Climate Neutral Group

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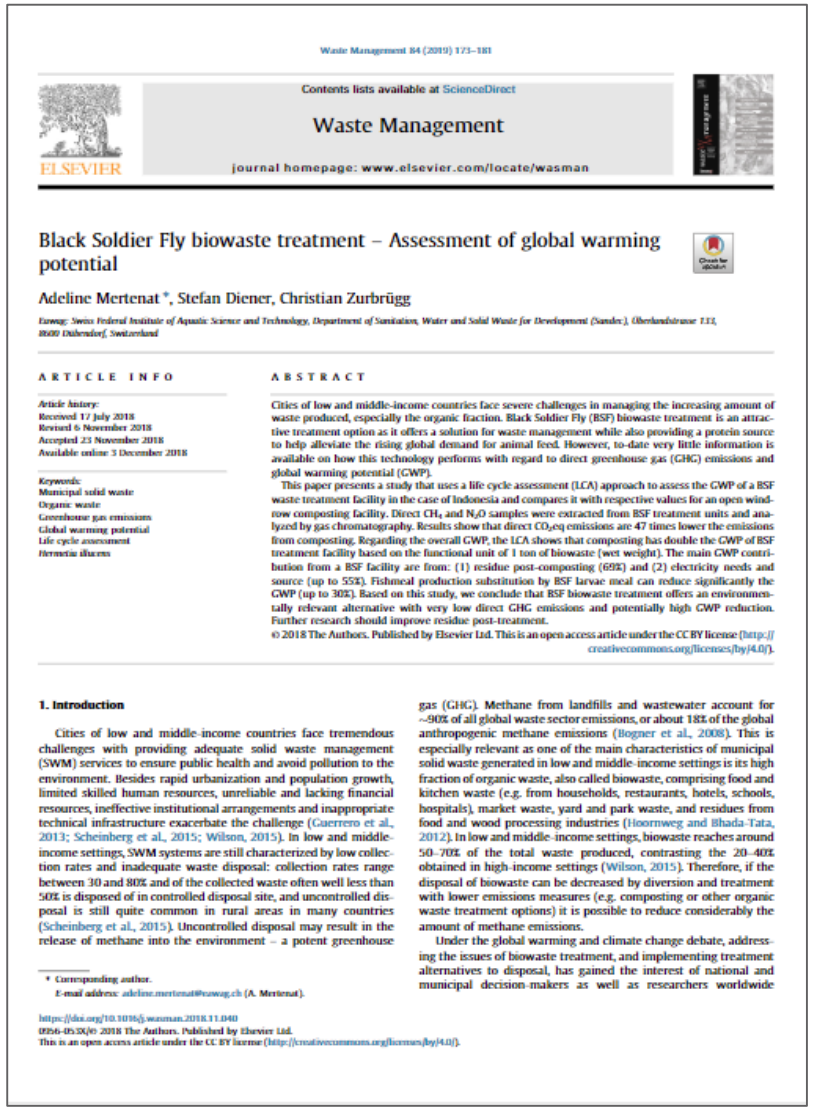
Images: www.inseco.co.za

The Outputs: High Value Products … Its all about the Soil



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Black Soldier Fly biowaste treatment – Assessment of global warming potential

Adeline Mertenat *, Stefan Diener, Christian Zurbrügg

Eawag: Swiss Federal Institute of Aquatic Science and Technology, Department of Sanitation, Water and Solid Waste for Development (Sandec), Überlandstrasse 133, 8600 Dübendorf, Switzerland

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Hermetia illucens

ABSTRACT

Cities of low and middle-income countries face severe challenges in managing the increasing amount of waste produced, especially the organic fraction. Black Soldier Fly (BSF) biowaste treatment is an attractive treatment option as it offers a solution for waste management while also providing a protein source to help alleviate the rising global demand for animal feed. However, to-date very little information is available on how this technology performs with regard to direct greenhouse gas (GHG) emissions and global warming potential (GWP).

This paper presents a study that uses a life cycle assessment (LCA) approach to assess the GWP of a BSF waste treatment facility in the case of Indonesia and compares it with respective values for an open windrow composting facility. Direct CH_4 and N_2O samples were extracted from BSF treatment units and analyzed by gas chromatography. Results show that direct CO_2eq emissions are 47 times lower the emissions from composting. Regarding the overall GWP, the LCA shows that composting has double the GWP of BSF treatment facility based on the functional unit of 1 ton of biowaste (wet weight). The main GWP contribution from a BSF facility are from: (1) residue post-composting (69%) and (2) electricity needs and source (up to 55%). Fishmeal production substitution by BSF larvae meal can reduce significantly the GWP (up to 30%). Based on this study, we conclude that BSF biowaste treatment offers an environmentally relevant alternative with very low direct GHG emissions and potentially high GWP reduction. Further research should improve residue post-treatment.

1. Introduction

Cities of low and middle-income countries face tremendous challenges with providing adequate solid waste management (SWM) services to ensure public health and avoid pollution to the environment. Besides rapid urbanization and population growth, limited skilled human resources, unreliable and lacking financial resources, ineffective institutional arrangements and inappropriate technical infrastructure exacerbate the challenge (Guerrero et al., 2013; Scheinberg et al., 2015; Wilson, 2015). In low and middle-income settings, SWM systems are still characterized by low collection rates and inadequate waste disposal: collection rates range between 30 and 80% and of the collected waste often well less than 50% is disposed of in controlled disposal site, and uncontrolled disposal is still quite common in rural areas in many countries (Scheinberg et al., 2015). Uncontrolled disposal may result in the release of methane into the environment – a potent greenhouse gas (GHG). Methane from landfills and wastewater account for ~90% of all global waste sector emissions, or about 18% of the global anthropogenic methane emissions (Bogner et al., 2008). This is especially relevant as one of the main characteristics of municipal solid waste generated in low and middle-income settings is its high fraction of organic waste, also called biowaste, comprising food and kitchen waste (e.g. from households, restaurants, hotels, schools, hospitals), market waste, yard and park waste, and residues from food and wood processing industries (Hoornweg and Bhada-Tata, 2012). In low and middle-income settings, biowaste reaches around 50–70% of the total waste produced, contrasting the 20–40% obtained in high-income settings (Wilson, 2015). Therefore, if the disposal of biowaste can be decreased by diversion and treatment with lower emissions measures (e.g. composting or other organic waste treatment options) it is possible to reduce considerably the amount of methane emissions.

Under the global warming and climate change debate, addressing the issues of biowaste treatment, and implementing treatment alternatives to disposal, has gained the interest of national and municipal decision-makers as well as researchers worldwide

* Corresponding author.
E-mail address: adeline.mertenat@eawag.ch (A. Mertenat).

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47x Global Warming Potential compared to composting

The Outputs: High Value Products … Its all about the Soil

Where fertilizers feed plants for short term gains but long term risk, frass feeds the soil for long term productivity, helping weather supply crisis.

Images: www.inseco.co.za

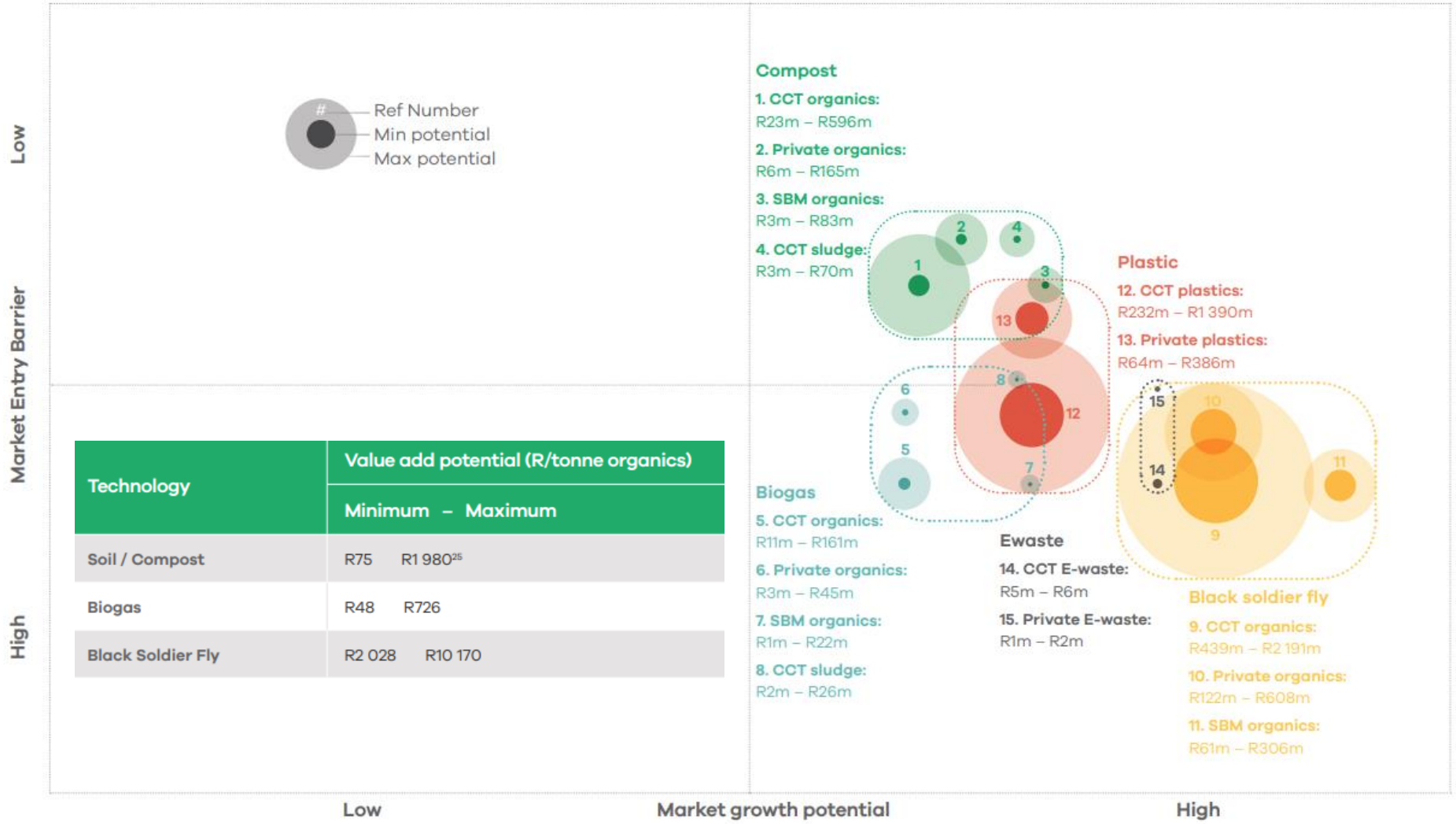
Worth Noting

One Solution: The Humble Black Soldier Fly … worth noting

- Hyper-localises protein production
- Urban agriculture = urban jobs
- Controlled Environmental Agriculture (indoor)
- Fast protein turnaround time (27 days - 45 days)
- Large centralised or Small decentralised
- Evolutionary far from mammals / humans = less chance of disease transfer
- More stable price than soy and wild fish sources
- Pre-biotic fibre = better gut health = healthier livestock
- Anti (bad) microbial properties = less antibiotics
- Rich in trace elements + vitamins (including B12)
- LCA shows 47x Lower GWP than composting
- Strongest business case as an organic waste solution – Largely built on sale of products not services / gatefees

A High Level Potential

The Potential: High Level Waste Potential for CPT



Technology	Value add potential (R/tonne organics)
	Minimum – Maximum
Soil / Compost	R75 R1 980[25]
Biogas	R48 R726
Black Soldier Fly	R2 028 R10 170

Figure 1: Opportunities prioritisation matrix

Cape Town’s Innovation Hub

BSF Farmers: Cape Town Companies

inseco

Maltento

BSF Breeding

Nutrisek
Bug-Powered Nutrient Recycling

NUTRIENT LOOP

Amesect

- Cape Town is epicentre of South Africa
- SA is a global leader in BSF production
- However, EU, USA and UK are catching up quick
- This is largely due to red tape reduction
- We need to support progressive regulatory reform

BSF Farmers: Cape Town Companies

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BSF Breeding

Nutrisek
Bug-Powered Nutrient Recycling

NUTRIENT LOOP

Amesect

- Philippi based - Centralised
- Organic waste treatment + protein production
- Agri residues + industrial by-products
- Commercial + hospitality food waste
- Processes 40 t/d food waste
- Scaling 60 t/d and then 100 t/d
- Largest BSF factory in southern hemisphere
- Includes industrial 100t/d de-packaging plant
- Raised largest-ever seed round ($5.3m / R92m)

BSF Farmers: Cape Town Companies

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BSF Breeding

Nutrisek
Bug-Powered Nutrient Recycling

NUTRIENT LOOP

Amesect

- Epping based - Centralised
- Protein + function feed production
- Innovative products – palatants (flavour enhancers)
- Processes 20 t/d food waste
- Agri residues & spent brewers grain only
- Scaling 50 t/d and then 100 t/d
- First company to export 40ft container to EU

BSF Farmers: Cape Town Companies

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- Epping based - Nursery
- Neonate (baby-babies) production
- Supply cheap + strong larvae to industry
- Export of neonate to offshore markets
- No food by-products input

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BSF Breeding

- Decentralised processing
- Organic waste treatment
- Inputs depend on client

Nutrisek

Bug-Powered Nutrient Recycling

NUTRIENT LOOP

Amesect

BSF Farmers: Cape Town Companies

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BSF Breeding

Nutrisek
Bug-Powered Nutrient Recycling

NUTRIENT LOOP

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- Capricorn Park - decentralised
- Focus on 25t/d input modular units
- Inputs are broad and client specific
- Vertical automated plants
- Biogas integration option

BSF Farmers: Cape Town Companies

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BSF Breeding

Nutrisek
Bug-Powered Nutrient Recycling

NUTRIENT LOOP

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- Worcester based - Centralised
- Organic waste treatment + protein production
- Agri residues + industrial + commercial by-products
- Processes 20 t/d (expanding)
- Transporting from Cape Town
- Exporting products

BSF Farmers: Cape Town Companies

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- Stellenbosch based - Decentralised
- More information TBD soon

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BSF Breeding

Nutrisek
Bug-Powered Nutrient Recycling

NUTRIENT LOOP

Amesect

BSF Farmers: Future Interests

regenorganics

SANERGY

AngloAmerican

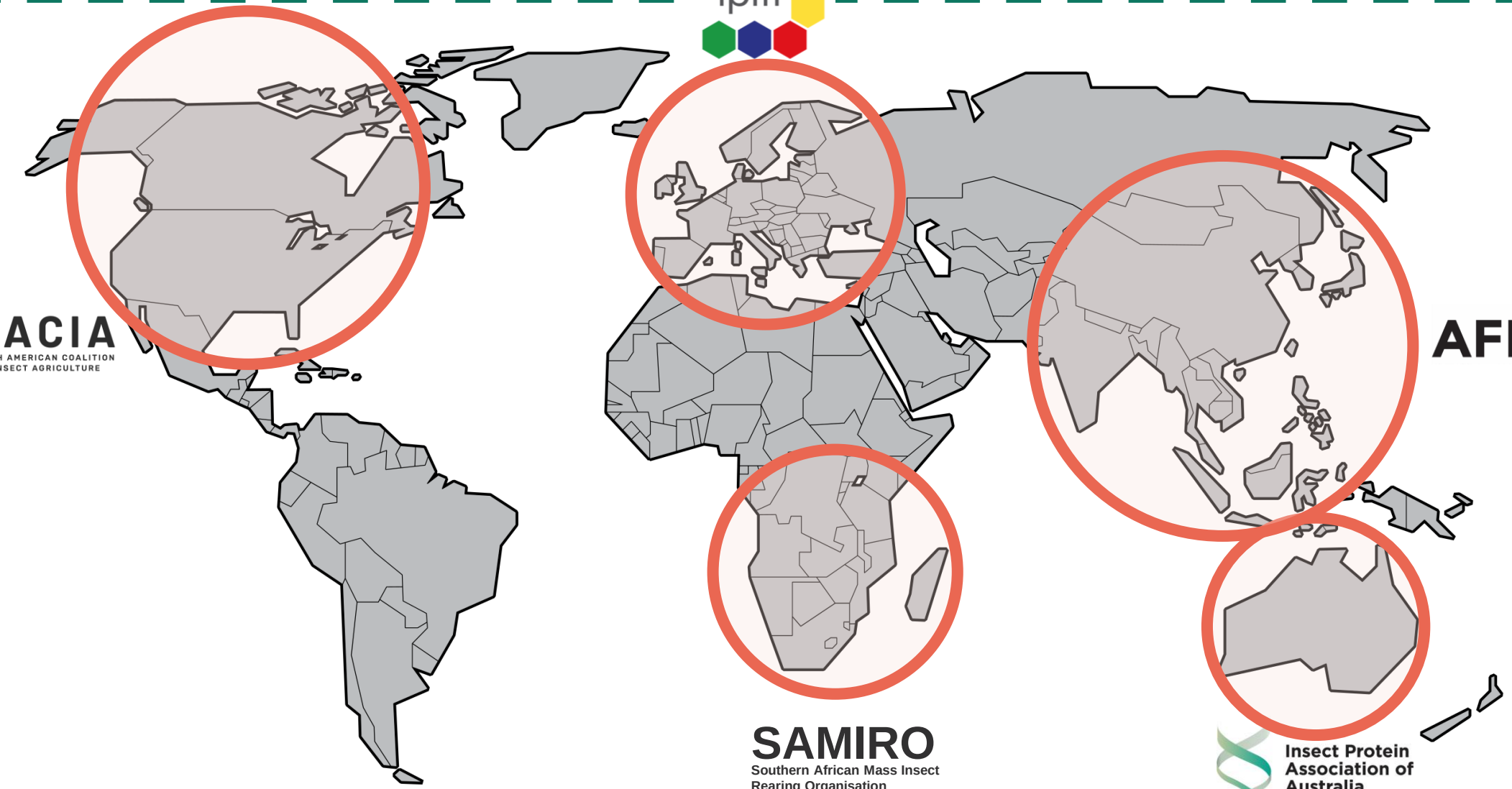
Sanergy have partnered with Anglo American to expand operations, notably in South Africa

www.engineeringnews.co.za/article/anglo-investing-in-expansion-of-organic-waste-upcycling-company-sanergy-2022-06-28

One Solution: Many Industry Associations

EIF Center for Environmental Sustainability through Insect Farming

ipiff



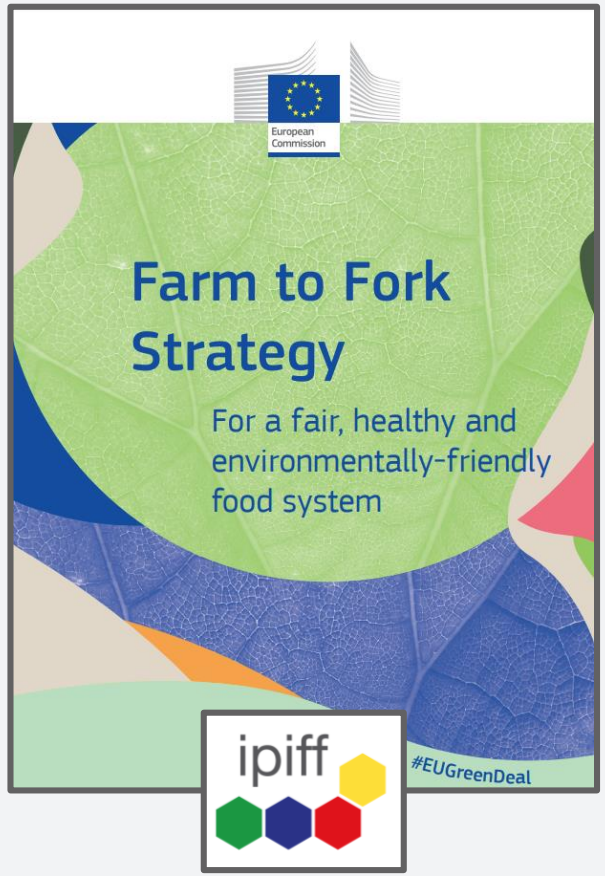
NACIA
NORTH AMERICAN COALITION FOR INSECT AGRICULTURE

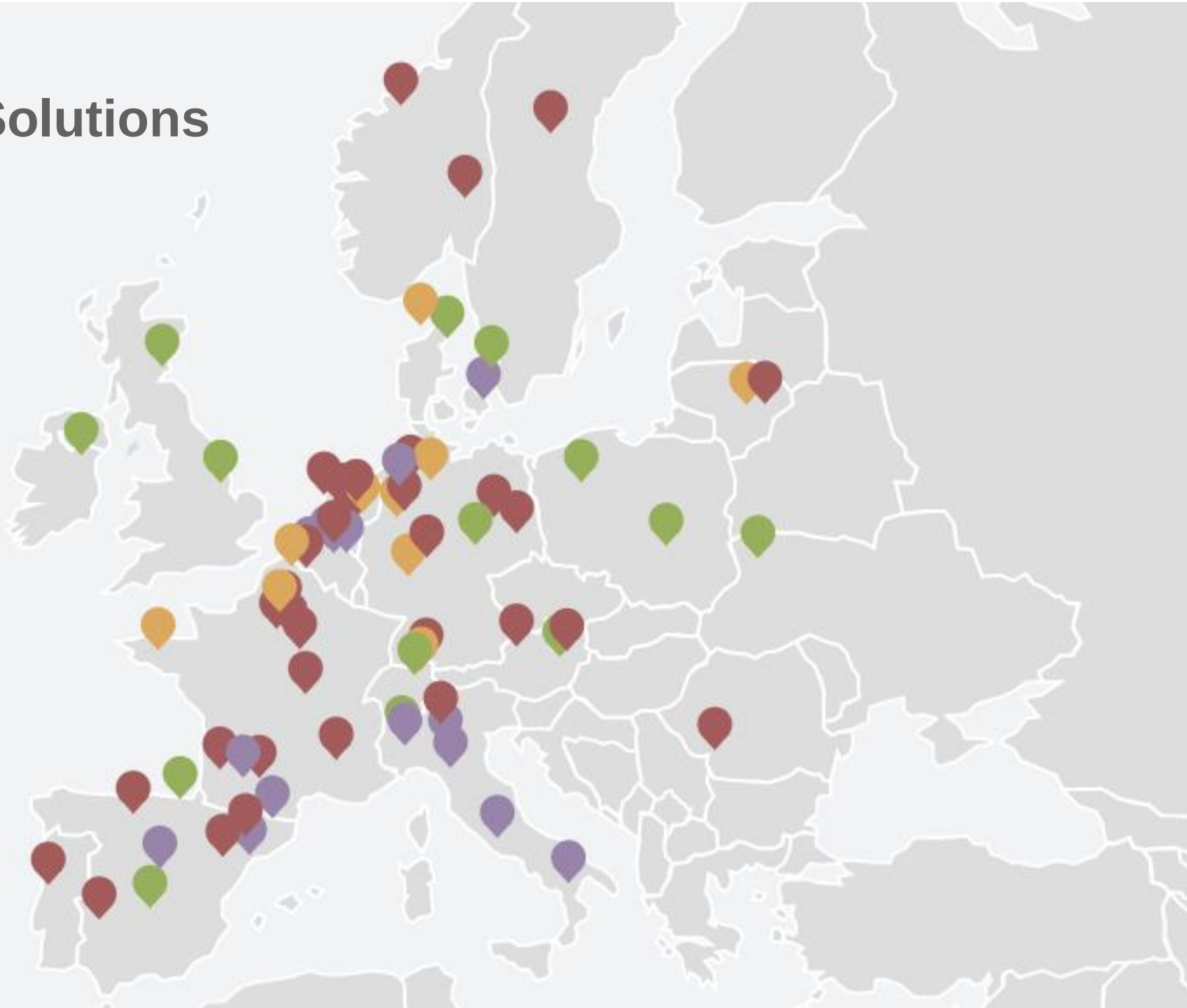
AFFIA

SAMIRO
Southern African Mass Insect Rearing Organisation

Insect Protein Association of Australia

One Solution: Many Solutions





www.ipiff.org/ipiff-members/

But there are Barriers
Feed Barriers

Barriers to Growth: Fertilizer and Air Emission

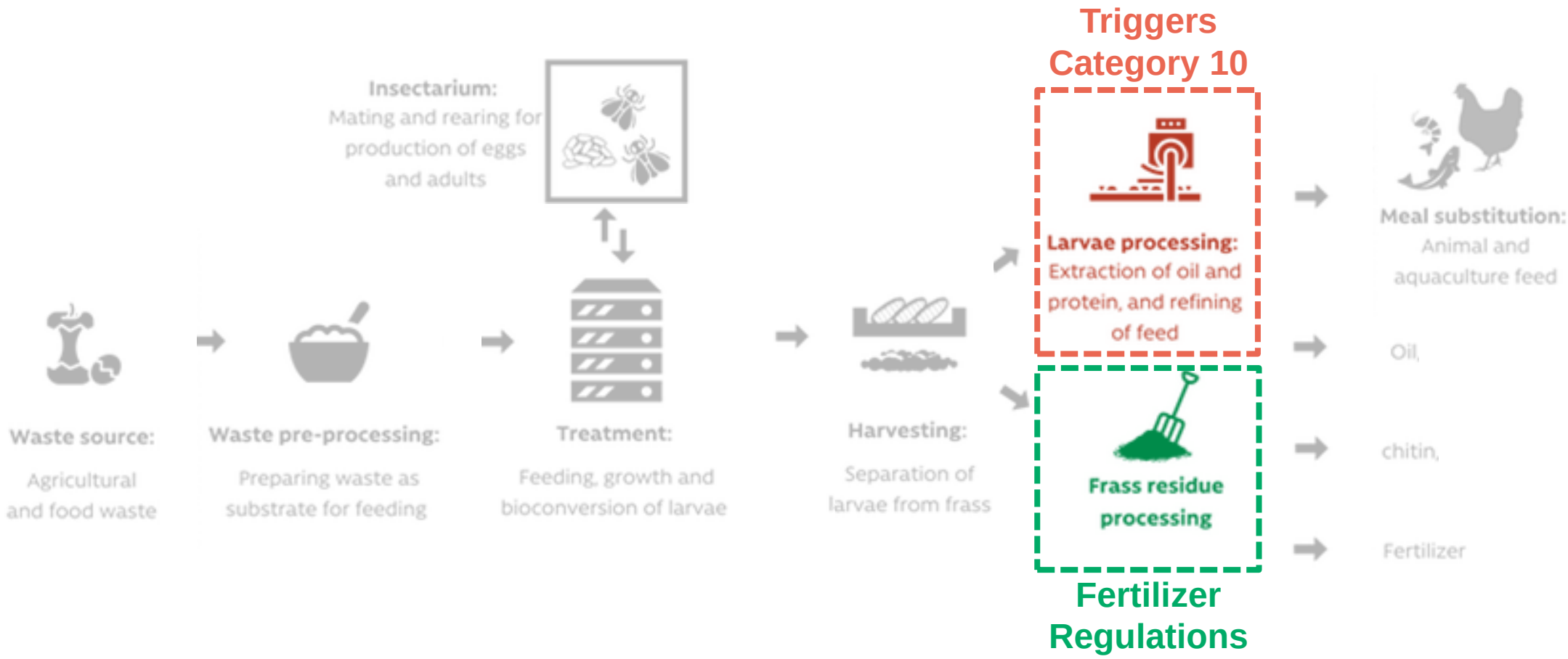
Fertilizer Regulations

- Lengthy registration process (18months)
- Onerous registration process
- Registration process is complicated

Air Emissions Licensing

- Listed Activities - Category 10 (Animal Matter Processing)
- Environmental Impact Assessment

Barriers to Growth: Fertilizer and Air Emission



A Resilient Food System Cannot Exist without Black Soldier Fly Integration

Thank you

Circular Economy Lead

Sam Smout

Sam@greencape.co.za

(021) 811 0250

INTERNATIONAL CLEANTECH NETWORK

Key Readings: