Rethinking our organic resources:

Beyond organic waste treatment to a bioeconomy

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Rethinking our organic resources

Outline

- Circular economy and bioeconomy
- Why focus on food value chains?
 - Socioeconomic: output value, GDP, job creation
 - Environmental: GHG emissions reduction
- Strategies to improve the resource productivity of bio-based residues
- Case studies: WC, SA and international
- Gaps



GreenCape

Who we are

- GreenCape is a sector development agency that supports businesses operating within the green economy in the Western Cape
- Not-for-profit organisation
- Established in 2010 by the Western Cape Government & City of Cape Town



GreenCape's mandate



Circular economy

- What is a circular economy?
 - A restorative and regenerative system with optimal use of resources and the production of primary raw materials from renewably sourced feedstock
 - A model that decouples economic growth from resource constraints by reducing reliance on virgin materials
 - The goal is to keep materials functioning at their highest utility at all time, preventing would-be waste from reaching landfills
 - This is contrast to a linear economy which is a 'take, make, dispose' model of production



Circular economy

- Fuelled by:
 - More urgent recognition of commodity risks in supply chains
 - An increase in zero-waste regulations, and
 - A pursuit of the financial opportunities that come with more efficient reuse strategies





Bioeconomy

- What is a bioeconomy?
 - The biological motor of a future circular economy
 - The production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy
 - Its sectors and industries have strong innovation potential
- Transitioning to a bioeconomy
 - The bioeconomy offers a future opportunity to reconcile economic growth with environmentally responsible action
 - The transition requires historically developed structures and ways of life that appear normal today to be completely rethought
 - It is crucial to align research on a broad basis to the solution of the emerging societal challenges



The move towards bioeconomies: globally, nationally and regionally



Green Chemistry Centre of Excellence



The Bioeconomy

Framing WWF-SA's engagement

South African perspective

Relevant national documents:

- The Bio-economy Strategy (DST, 2013)
- Biodiversity Economy Strategy (DEA, 2015)
- Biofuels Industrial Strategy (DME, 2007)
- Biotechnology Strategy (DST, 2001)
- AgriParks (DRDLR)
- The Bio-energy Atlas (DEA, 2015)
- No integrated vision, some conflicts in priorities, moderate policy incoherence.
- Land sector transforming (land reform and farm consolidation)
- Strong potential for rural livelihood improvement (agri-hubs)
- Industrial clustering and beneficiation



Europe's bio-based and circular economies:

Standards and regulations

- Mandated standardisation voluntary trade documents
 - Increased focus on bio-based products
- Directives centrally determined targets
 - Targets for renewable energy, emissions, waste and the circular economy
- Regulation enforced laws
 - E.g. REACH, CLP
 - Stimulating new products





The demand for green chemicals





(Source: Pike Research)

The bio-refinery – a work in progress

GreenCape's Bioeconomy Programme

Bioeconomy Programme

- Goal:
 - Unlock the potential of the Western Cape's bio-based resources & drive the "greening" of agricultural value chains
 - Done through promoting the uptake of investment in green technology, processes & systems
- Structure:
 - Builds on insights from the resource efficiency analysis done in 2013-15 for the Western Cape economy
 - Comprises of:
 - Agriculture sector desk
 - Bioenergy and resource productivity projects

Why focus on food value chains?

Global perspective

Food waste

1.3 bn MT edible waste3? bn MT inedible food supply chain waste1 bn needed for the chemical industry

Western Cape

The importance of food value chains

Agriculture & agri-processing have significant potential based on			
Economic output	Labour intensity	GHG emissions reductions	

Regional Resource Flow Model Project (2013/15)

Identification of carbon-intense sectors & potential interventions

The Bioeconomy in SA

A brief overview

Waste in the SA Bioeconomy: Food & Feed

The importance of resource productivity

Resource productivity & value-add projects

Why and how?

- Resources could become constraints to economic development
- Necessary to use resource inputs as effectively as possible for:
 - business viability / competitiveness
 - sustained & sustainable economic growth
- Two key strategies:
 - Improving resource efficiency
 - Using less land, energy, water or materials to produce the same outputs
 - Value-add or waste beneficiation
 - Recycling or producing new products from wastes

Guiding principles

Waste hierarchy & bio-based value add hierarchy

Sources: http://www.epa.nsw.gov.au/wastestrategy/waste-hierarchy.htm Bioeconomy Study Tour, Netherlands Department of Foreign Affairs (2015)

Prioritising value-add opportunities for full value extraction

Value-add hierarchy

Source: adapted from the Bioeconomy Study Tour, Netherlands Department of Foreign Affairs, 2015

The Bioeconomy in SA

A brief overview

After: Sirkin and ten Hour

Key Concepts

- Cascading resource minimises total consumption, maximises return
- Ultimate use is often bioenergy or landfill
- "Waste" is critical it is only waste Resource Quality when there's no further use to which it can be put, or when it is consumed
- The more beneficiation that is possible, the better value from a product.

Utilization time

Resource productivity & value-add projects

Approach

- Focus on high impact opportunities that align with GreenCape's mandate & support capabilities
- Past and current work: Make recommendations for (provincial) government
 - How to create an enabling environment for both immediate & longer term value-add opportunities
- Future work: Match businesses to local & overseas companies & expertise to realise value-add cost savings & income

Value-add within Western Cape food value chains

Conclusions

- Several opportunities for improved resource productivity within WC
 - Cost savings through increased resource efficiency
 - Increased resource security
 - Lower GHG emissions meet increased export market demand for low-carbon production
- Value-add is a strategy for improving the resource productivity of value chains & sectors
 - The hierarchy acts as a guide & motivates for a cascading approach for residues
 - Value-add solutions are highly context-specific
 - GreenCape's work suggests there is value on taking an ecosystem approach to adding value to organic waste, rather than focusing on specific technologies

Western Cape food value chains

Scoping study: Value-add to organic residues

- Strategic scoping study on value-add opportunities for organic waste/residues in food value chains
 - Duration: 3 month study (Nov 2016 Feb 2017)
 - Identify at least 2 value add opportunities for further development
 - Inform recommendations to government & direct GreenCape & partners' efforts to support business

Recommendations

Key value chains with potential for value-add

- Value chains selected based on:
 - Potential economic benefits (i.e. investment, sales & job creation)
 - Industry drivers (e.g. landfill diversion)
- Two key focus areas:
 - Fruit and vegetable value chains
 - With a particular focus on:
 - Packhouses, distribution centres & retail
 - Specific commodities (e.g. potatoes)
 - Red meat value chains
 - With a particular focus on abattoir wastes

Key insights

General

- Residues & wastes are generated but the majority is used
 - South Africa has very good "layering" or cascading of organic materials (products and residues) between different end-uses
 - <2.5% of wastes (by volume) did not already have a use
- Rapid change driven by legislative pressures and, in part, GreenCape's assistance
 - 3 months ago approximately 30% of abattoir wastes were unused
 - Currently used for value-add, primarily composted

Key insights

General

- The dominant alternative use appears to be animal feed
 - Potentially a high level end use but this is quality-dependant
 - In many cases can be considered "cheap disposal" & thus a lower value-add
 - 20% diverted to animal feed
- Economies of scale remain a key constraint, especially for the uptake of biogas
 - Agricultural residues have strong seasonal attributes
 - Typically spatially dispersed
 - Some of these opportunities may be unlocked by collating smaller waste streams, however transport costs remain a key barrier

Key insights

General

- The basics of the value add hierarchy seem to hold in the Western Cape
 - Greatest revenue being generated by application to insects production for animal feed, followed by animal feed, composting & then electricity from biogas
 - If biogas' heat & digestate values is also included, biogas should be great than composting
- The greater seasonality of fruit means that vegetables may have larger opportunities or technology should be adapted to deal with large batches of wastes rather than continuous streams

Bio-based value-add hierarchy

Heuristic used for value-addition assessment

(a) General bio-based hierarchy

(b) Suggested bio-based hierarchy

From WWF:

SA bioeconomy activities

The Bioeconomy in SA

A brief overview

Waste in the SA Bioeconomy: fine chemicals and valorisation

- Brenn-o-kem (Grape residues; seeds & skin)
 - Tartaric acid, calcium tartrate, oils,
- UKZN/CSIR: Chicken feather valorisation/ sugar residues
 - Extraction of keratin & protein elements (high value)
 - Manufacture of derivative composites
 - Bioplastics
- CEBER (UCT): confectionary industry waste
 - Polyglutamic acid & polyhydroxyalkanoates
 - Biorefinery development
- Innovus & SBMT (UniStel): Integrated engineering & bioprocessing of cellulose into biofuels
 - Bioplastics, multiple intermediaries
 - Lignocellulosic derived
- Bioplastics
 - Coca-Cola & Woolworths import components for green bottles: potential for local manufacture (currently imported from Brazil)

The Bioeconomy in SA

A brief overview

Waste in the SA Bioeconomy: Food & Feed

- High rate of reuse of organic waste from many industries
- Lower quality to processed foods
- Food waste often redirected to animal feed
- AgriProtein
- Composting (municipal and commercial)

Waste in the SA Bioeconomy: Biofuels

- Multiple pilots for first generation crops
- Some pilots for second generation crops
- Good potential for integration with SASOL manufacturing process around Secunda, & PetroSA in George
- Algal production with captured CO₂
- Fully regulated field which requires government clarity.
- Potential very dependent on location: logistics to hubs or local processing.

The Bioeconomy in SA

A brief overview

Waste in the SA Bioeconomy: Waste to energy

- Anaerobic digestion (CCT, Bio2Watt, abbatoirs, dairies)
- Produce biogas/generate electricity
- Biomass (SAPPI, Mondi – good use for some residues)

- Potential scoped in the BioEnergy Atlas: limited potential for crop residues primarily because of competing uses
- Pyrolysis and in-field processing to increase value

Value-add case studies

Case studies

Western Cape organic waste solution providers

Volume

Source: WISP & Bioeconomy

Case study #1 Brenn-O-Kem

Brenn-O-Kem

- Processes the waste of the wine industry:
 - Wine lees (tank bottoms)
 - Grape skins and seeds
- Recover the following products:Ethanol
 - Tartrates that are converted either to cream of tartar or tartaric acid
 - Animal feed from dry grape skins
 - Crude grape seed oil from grape seed oil
 - Biofuel from grape seeds or grape seeds after oil pressing
- Most of the ethanol and tartrates goes back into the wine industry

Brenn-O-Kem

- Challenges:
 - SA wine industry is small
 - Unique product to work with and no local equipment to work with
 - Simple things like transport, storage and conveying was not easy
 - Rising costs, especially transport
 - Pressure on raw material supply
 - Ethanol recovery made a steam boiler and distillation plant necessary large investment and challenging to run
 - Pomace wet product with changing consistency and spoilage issues

Brenn-O-Kem

- Key insights/learnings
 - Utilise any competitive advantages
 - Learn from processing plant partners
 - Examine niche areas BUT keep in mind that recovered products need to have a market
 - Small company and hands-on approach quick decision making at the top
 - We process waste so costs have to be kept low from the start
 - Start slow and have a narrow focus gradual development in products
 - Starting with small amounts and trials before progressing
 - Started trails in 1998
 - Processed 300 tons only in the first year
 - Only recovered ethanol and tartrates
 - Processed pomace went to compost

Value-add business case: Insects as an alternative source of protein in animal feed

Insects as an alternative source of protein in animal feed

Why insects for feed?

Insects could replace 25-100% of fishmeal or soymeal in animal feeds

Insects are an environmentallyfriendly & sustainable source of feed Insect protein is a costcompetitive alternative for fishmeal

Economic drivers

Global fishmeal and soymeal prices from 1979-2014

Source: Graph produced using data from the World Bank Global Economic Monitor (GEM) Commodities database (World Bank, 2016).

What's the opportunity?

Motivation for WC investment

- AgriProtein is the industry leader for the commercial production of insects
 - Agriprotein is already set up & expanding
 - Produce insect protein meal & other by-products
 - Strong R&D in collaboration with Stellenbosch University
- There is a current market in Southern Africa
 - Specific focus on aquafeed & pet food
 - Lower cost price supports viability & competitiveness of aquaculture
- Emerging global market & competitors
 - Particularly large feed markets in USA and EU

Source: Animal Feed Manufacturer's Association annual report and statistics

Potential demand for insect meal

Market based on current inclusion of fishmeal & soymeal in feeds

Sector	Feed	Fishmeal	Fishmeal &	Market access for insect protein
Pets	Dog food	substitution	soymeal	SA & international markets
Aquaculture	Aquafeed		substitution	SA & international markets
Poultry	Layer feed		1.5 million	SA
	Broiler feed	eed36,000 tonnes1.0 minionfeedper yeartonnes peryearyear	SA	
	Breeder feed		year	SA
Pigs	Pig feed			SA
Total				SA & international markets

¹ AMFA feed sales was used to provide an indication of the market size. Note that AFMA membership is open to companies in South Africa and in the SADC and thus these estimates are based on regional sales rather than national sales.

² Includes non-protein feed components (e.g. maize)

³ Assuming 0.35% inclusion in feed for all sectors, except aquaculture, which is estimated at 40%

⁴ Assuming 14.5% inclusion in feed

Source: AFMA animal feed sale statistics from April 2014 to March 2015 (AFMA, 2015b). Totals are rounded to 2 significant figures.

Supply of insect meal

Current and potential production in South Africa

	Organic waste (tonnes per year)	Protein meal (tonnes per year)	Proportion of fishmeal market in target feeds (%)
Current production	36,500	2,500	7%
Additional production	180,000	12,800	36%
Total	~220,000*	>15,000	42%

*GreenCape estimates >300,000 tonnes of organic waste produced per year from retailers & large food processors

Opportunities

Capitalising on R&D capacity & opportunities for innovation

- Develop novel technology & applications specifically drying tech
- Assess opportunities for decentralised small-scale insect production in the context of rural development
- Consider integrating small-scale production with centralised processing in agri-processing parks

Value-add / clean tech business case: biogas in the WC

Biogas Value Add Hierarchy

Volume

Photos from WISP/Bioeconomy abattoir site visits

Uilenkraal, Darling

Zandam Cheese, Durbanville

Elgin Fruit Juice, Grabouw

New Horizons Energy, Athlone

Biogas: case study findings

Key **barriers** for project viability

COMBINED HEAT AND POWER	GAS
Grid feed regulations and tariffs	Lack of established gas infrastructure
	Upgrading costs and utilities of scale

FEEDSTOCK	ANAEROBIC DIGESTION	ENERGY DIGESTATE	
 Low cost of landfill Feedstock procurement 	High relative capital cost Tech adaption to local conditions	LIQUID DIGESTATE	SOLID DIGESTATE
and logistics	Lack of local expertise/skills CHP maintenance costs Familiarity/awareness of tech Long payback periods	Transport costs	Lack of demand (market perception?)
		Legislation	
			GreenCape 50

Langeberg Municipality: an ecosystem approach to value-add

Langeberg Municipality

An overview

- Population: 98 000
- Agriculturally-driven economy
- 15+ organic waste producers identified
- Increasing legislative pressure
 - Stringent municipal waste regulations, certain organic wastes banned from landfill
- Enables major opportunity for greentech uptake & industrial symbiosis

Langeberg Municipality

Current waste management situation

Langeberg Municipality Organic Waste Project

Vision

Investment facilitation project to identify waste streams (mass, location) and encourage beneficiation of organic waste and landfill diversion in the Langeberg Municipality.

Barriers to the bioeconomy

What are the gaps?

- Understanding potential: breaking the "waste" barrier
- Knowledge: low value opportunities available, higher value chains not yet established
- Demand: growing from both sides
- Investment: cautious until proven, so only pilots at present
- Sustainability: insufficiently embedded in policy/processes
- Policy: largely in place, needs strengthening and investment

Thank You

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