‘Greening’ your farm

WASTE FOCUS

This guide intends to highlight the importance of **preventing and managing food waste across the agricultural value chain**.

This booklet is published in partnership with the Friedrich Naumann Foundation for Freedom, in support of a green social market economy for South Africa: resource-efficient, low CO_2, decentralised, competitive, socially inclusive with a thriving SMME sector to lift people out of poverty and into jobs.

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1 **A decision-making guide for farmers** looking to improve their waste management strategy

This guide intends to highlight the importance of preventing and managing food loss and waste across the agricultural value chain and what role farmers can play reducing food loss and waste at a farm level. A sustainable waste management and recycling system should set targets to reduce the use of resources, while ensuring that resources already taken from nature are reused multiple times, and that the amount of waste produced is kept to a minimum[1]. Figure 1 condenses concept into four main steps.

- **First and most vital step of waste management**
- **Reduction requires no collecting or processing of materials**

- **Recover requires collection but little-to-no processing**
- **Involves sorting, cleaning, repairing and/or refurbishing items or spare parts**

- **Sorting and processing recyclable products into new products**

- **Disposal is the last resort once all other possibilities have been explored**
- **Disposal refers to options that involve the landfilling of material**
- **Landfilling will not be a legal option for Western Cape-based companies from 2027**

Figure 1: Hierarchy of waste management processes[1]

2 Waste management guidelines

A circular economy designs out waste, regenerates ecosystems and keeps products, components and materials at their highest use/value for as long as possible. Thsi includes biological nutrients where organic waste is beneficiated and food is never wasted. A circular economy is more efficient, resilient and competitive than the traditional linear economy. Nowhere is this more relevant than on the farm. To unlock the elements of a circular economy and to stay competitive in a riskier environment, a number of initiatives are at a farmer's disposal.

Below in Figure 2 is a concise illustration of where these substances are derived from and mechanisms applicable for managing them. But before these actions can be taken, it is important to understand clarify when food becomes waste and what opportunities are available for its beneficiation.

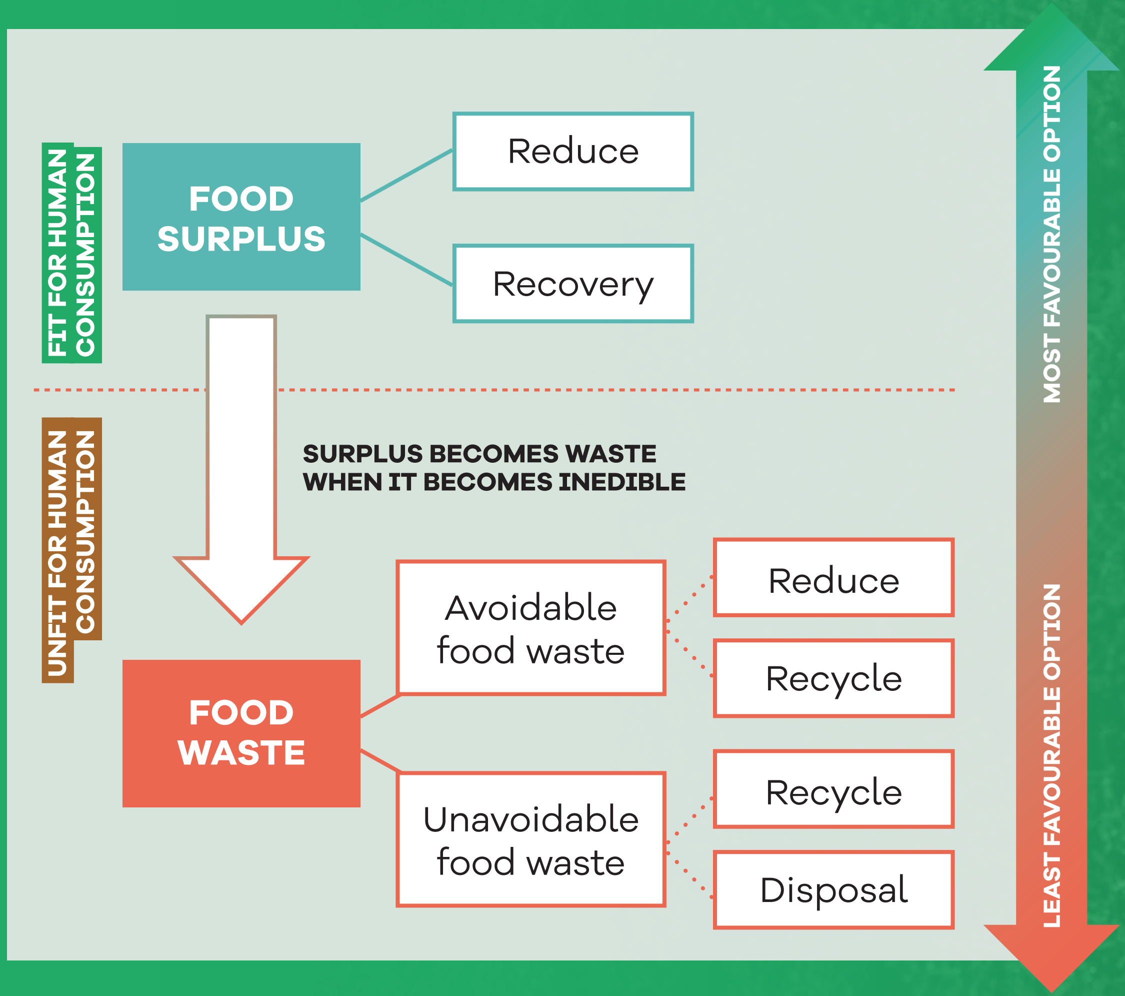

Figure 2: Defining food waste and surplus[4]

Effective waste management is key for any successful agricultural enterprise for three main reasons. **1.) Increases Profitability:** Firstly, reducing food loss results in better financial profitability i.e. the costs of inputs such as water, labour, fertiliser, energy that each commodity consumes during production is not recouped through sales, and that loss eats at overall profits. **2.) Reduces Overheads:** Secondly, reducing waste lowers the costs associated with disposal – either by paying third-parties to take on waste or the long-term environmental costs of on-farm disposal **3.) Diversifies Revenue:** Thirdly, better management of waste can result in the extraction of valuable commodities such as soil ameliorants and energy through processing of waste streams, ultimately unlocking greater productivity on farm.

3 The solutions

3.1. Reduce

The reduction of waste has immediate economic benefits - and often doesn't require significant capital investments. Often, signicant waste reduction can be realised, just by optimising harvesting time and technique to ensure product quality and shelf-life.

3.1.1. REDUCING FOOD SURPLUS THROUGH OPTIMISING THE HARVEST

Farmers wanting to take the first steps in optimising their harvest should start by engaging with potential markets to establish market needs (commodity types, quantity and quality specifications). This includes engaging with markets that can accept a multitude of grades, so products rejected by high-end markets can be directed to alternative markets[6]. Having established the market needs and quality specifications, farmers should optimise their harvesting times and techniques to ensure they preserve product quality and shelf-life[6]. Imperfect and misshapen commodities, unable to find a market, can be processed further into higher-value products – not only helping to reduce waste but also creating opportunities for alternative revenue generation[6].

CASE STUDY

Most commonly, farmers use spreadsheets, paper records and other offline tools to plan their crop production and record farming activities. These records can often get lost, be hard to synthesis into a single report and/or inaccessible to other members of the team working on the farm. Farm management applications are assisted in record-keeping and the collation of data into reports that farmers can give to external parties. Examples of such as are **fieldmargin** www.fieldmargin.com (freemium app with additional functionalities up to R8 640 per farm per month), **Farmable** www.farmable.tech (freemium app with additional functionalities up to

R4 999 per farm per annum) and **BenguFarm** www.bengufarm.co.za (livestock and game/wildlife management software at R6 975 per Beef, Sheep & Goats, Game and Pigs modules). Additionally, industry associations such as **SASRI** www.sasri.org.za/decision-support-tools, have developed tools such as StalkGro and CANESIM that simulate sugarcane crop growth and produce forecasts of cane and sucrose yields with inputs of climate zones, weather forecasts and irrigation. These free applications are great tools for ensuring greater consistency in the quantity and quality of yields, and farmers are able to reliably supply markets with minimum produce going to waste.

3.1.2. REDUCING AVOIDABLE FOOD WASTE AT PRODUCTION

Table 1 provides a comprehensive list of the drivers of food loss and possible technology solutions to combat them.

DRIVERS	CAUSES	RESULTS	TECHNOLOGY SOLUTIONS
Weather	• Drought • Floods • Hail • Wind • Heat waves • Cold spells	• Damage to crops • Stress to animals • Reduced quality of food • Delayed harvesting if the fields are inaccessible	• Shade netting • Stormwater management • Grazing management • Cover cropping • Mulching • Weather forecasting
Harvest	• Mechanical damage • Spillage during harvest • Crops left behind due to poor harvesting techniques • Crops not harvested due to price drops	• Damage to crops • Reduced quality of food • Crops ploughed back in	• Harvest forecasting apps • Silos and hermetic bags • Tarpaulins
Disease and pests	• Animal deaths during breeding • Animal sickness • Disease of crops • Crops eaten or damaged by pests	• Condemnation at slaughterhouse • Milk discards • Crops ploughed back in • Reduced quality	• Precision spraying • Pesticide prediction app • Grazing management
Demand forecasting	• Uncoordinated production e.g. all farmers produce tomatoes	• Oversupply at markets	• Farm and harvest management apps • Online marketplace apps
Grading	• Grading errors • Out-grades	• Rejected at market	• Online marketplace apps
By-catch	• Non-target species caught by fisheries	• Discarded • Processed as animal feed	• Turtle excluder devise • Gear modifications

Table 1: Drivers of food loss and possible technology solutions

3.1.3. **REDUCING AVOIDABLE FOOD WASTE AT POST HARVEST, STORAGE AND DISTRIBUTION**

About 5.1 million tonnes and 2.0 million tonnes of food is lost during agricultural production and post-harvest handling and storage and distribution stages respectively[6]. While the solutions in 3.1.1 are helpful in reducing waste at ta production level, the technology solutions in this sections address waste from post-harvest handling and distribution.

- **Modified atmosphere packaging** is a packaging technique that can prolong the shelf-life of fresh foods by controlling the atmosphere immediately around food products. Ethylene gas drives the ripening of food products and so controlling the composition of the gases to include gases such as nitrogen, oxygen and carbon dioxide can slow down the natural deterioration of the food product **e.g. Xtend ® Activebag ®**
- **Evaporative coolers** are cost effective and efficient method of cooling whereby mist is blown into the air and the liquid evaporates, thus cooling the air[7]. Farmers of field crops often use irrigation sprayers in this manner to cool the atmosphere during durations of high temperatures. Evaporative cooling systems for the storage are most applicable for relatively high perishable products such as fresh horticultural crops (excluding tree nuts), meats, fish and cheeses and can potentially extend the shelf life of produce up to ten-fold (e.g. the use of these system resulted in tomatoes and guavas shelf-life increasing from 2 to 20 days)[7]. **e.g. Zero Energy Brick Cooler (ZEBC) AVRDC – USAID**

3.2. Recover/Rescue

Where farmers are unable to ensure that their full harvest makes it to market, there are still opportunities to ensure that food that is still edible can make it to those who need it the most. There are four main types of food recovery[8]:

- Food gleaning – the collection of crops from farmers' fields that have already been mechanically harvested or on fields where it is not economically profitable to harvest
- Perishable produce rescue – the collection of perishable produce from wholesale and retail sources
- Perishable and prepared food rescue – collection of prepared foods from the food service industry
- Non-perishable processed food collection – the collection processed foods, usually with long shelf lives from wholesale and retail sources

CASE STUDY 2

There are a number of SA non-profit organisations that work in redirecting surplus food to disadvantaged people; companies such as SAHarvest, NOSH Food Rescue and FoodForward SA to name a few. In the 2020/21 financial year alone, FoodForward SA directed approximately 7 215 tonnes of surplus food to feed 475 000 beneficiaries daily[9]. During the Covid-19 crisis, the Philippi Economic Development Initiative (PEDI), in partnership with UCook's Food Fund and Ladles of Love, provided 3 667 parcels of food between March and June 2020 from produce procured from small scale farmers who lost their market due to the lockdown diverting 7.3 tonnes of food from landfill.

3.3. Recycle

Where waste cannot be reduced or recovered, opportunities are available for further processing of waste into products that can be of benefit on farms, products such as compost, compost teas, energy and biochar. Below are common technologies used at a farm-level for waste reduction and beneficiation.

TECHNOLOGY	DESCRIPTION	MINIMUM VIABLE SIZE	ADVANTAGES	DISADVANTAGES	AVERAGE CAPITAL COST
Open Windrow composting (Biological treatment)	Composting takes place in the open air in large, elongated, uniform 'piles' of waste known as windrows. Waste feed stock is mechanically shredded and water added depending on the moisture content. Windows are regularly turned, several times during the compost process	Recommended size above **10 000 ton/annum** (smaller volumes are possible but with higher average cost)	• Low operational cost • Low capital cost • Saleable by-product • Improves nutrient qualities • Green waste dependent on the weather conditions • There can be respirator/health issues associate with bio aerosols from turning compost	• Requires mechanical treatment to remove contaminants • Compost should not be in close proximity to settlement in case of odour/bio aerosol issues	R6 – 10 million for 8k tonnes per annum facility
In-vessel composting	A way of accelerating the composting process within an enclosed environment. Waste is shredded or chipped to increase surface area to accelerate composting	Recommended size **above 190 000 ton/annum** (volumes between 90 000 – 190 000 are possible but with a higher average cost)	• Low operational cost • Relatively small footprint • Ability to maintain rapid decomposition process year-round regardless of external ambient conditions	• Long timespan for decomposition • Requires mechanical agitation • Moisture content must be controlled through blending with co-substrates or dry feedstock • High use of water	R1.4-1.8 billion for 100k tonnes per annum facility
Vermicomposting	Also known of worm composting, this is the use of earthworms to convert organic waste to compost	Recommended size **above 10 000 ton/annum** (smaller volumes are possible but with higher average cost)	• Provides nutrients to the soil • Increases the soil's ability to hold nutrients in a plant-available form • Improves the soil structure • Provides numerous beneficial bacteria	• Long timespan for decomposition • High maintenance, in terms of feed composition and moisture levels • Doesn't treat pests or pathogens such as fruit flies, centipedes etc.	R6 – 10 million for 8k tonnes per annum facility
Anaerobic digestion (Biological treatment)	A biological process that produces a gas which is mainly composed of methane and carbon dioxide AD focuses on the biological degradation of biodegradable wastes by microbes under controlled conditions	Recommended size **above 190 000 ton/annum** (volumes between 90 000 – 190 000 ton/annum possible but with a higher average cost)	• AD can potentially treat a variety of organic waste streams • GHG and harmful gases are prevented • AD has potential for energy production	• Requires an intensive monitoring and control over conditions to maintain the digestion process • Can be sensitive to imbalances in feedstock • Health and safety issues can arise • Significant odour issues • Quality is often insufficient for the digestate to be used as a soil enhancer	R120 – 220 million got 25k tonnes per annum wet AD process
Incineration	Incineration is the direct combustion of material coupled with subsequent energy recovery. Resultant heat can be used to generate heat and electricity through a steam circuit system	Recommended size **above 50 000 ton/annum** (smaller volumes are possible but with higher average capital cost)	• Low operational cost • Robust technology that can treat a variety of waste streams • Revenue from both gate fees and energy generation can make the technology competitive	• Not suitable for bulky or large items • Requires specialist grate to handle higher temperatures • Energy recovery efficiencies are lower for electricity than heat • Flue gases can pollute the environment • Requires feedstock to be pre-treated to a RDF	R1.395 – 1.86 billion for 100k tonnes per annum facility
Pyrolysis	The thermal degradation of a substance at high temperatures in the absence of oxygen. It involves the simultaneous change of chemical composition and physical phase and is irreversible and requires a relatively consistent waste stream	Recommended size **above 230 000 ton/annum** (volumes between 130 000 – 230 000 ton/annum possible but with higher average capital cost)	• Can be used for all types of solid products • Can easily adapt to changes in feedstock composition • Can be integrated into micro turbine, fuel cell or thermophotovoltaic systems for power generation	• High capital costs • Qualified and experience personnel needed to operate machinery • Pyrolysis is energy intensive which reduces the gross energy output of the plant significantly • Metal and inert material much be removed before thermal treatment	R380-620 million for a 60k ton per annum facility

Table 5: Waste management technologies [1,10]

Theoretically, a farmer should implement technologies that can process the multiple types of waste streams produced on farm at one time. However, this is not always practical; in fact, farmers can derive greater value by sorting mixed waste before processing. An example of this is mechanical biological treatment. Mechanical biological treatment (MBT) combines a series of treatment steps for different waste streams, combining mechanical sorting and biological treatment of the organic fractions. A simple MBT involves sorting, mechanical treatment of the dry fraction and windrow composting of the wet fraction. More complex MBT systems can incorporate an additional step of intensive fermentation of the organic fraction.

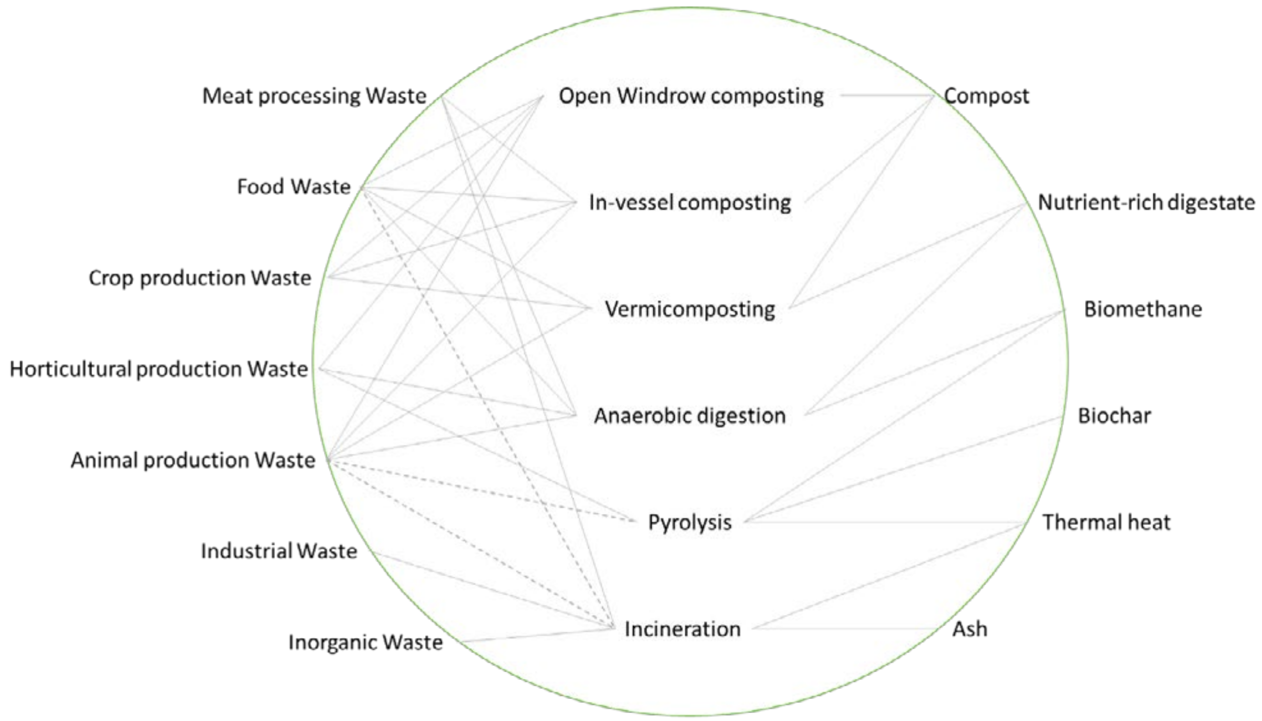

Figure 3: Associated inputs and outputs of waste management technologies [11]

CASE STUDY

The Rustenburg Local Municipality conducted a feasibility study in 2009, comparing the costs of variations of MBT plants of increasing complexities (simple to complex from left to right).

TREATMENT COSTS (R/T)	OPEN WINDOWS PASSIVELY AERATED	OPEN/ COVERED WINDROWS ACTIVELY AERATED	IN-VESSEL ACTIVELY AERATED BIOLOGICAL	AEROBIC BIOLOGICAL DRYING	COMBINED ANAEROBIC WET (LOW SOLID) DIGESTION FOR ORGANIC WASTE	COMBINED ANAEROBIC DRY (HIGH SOLID) DIGESTION
Wages and salaries	22	26	30	17	67	67
Repair and maintenance	26	51	106	145	194	234
Variable cost/ consumables	7	20	39	38	60	65
Depreciation of investment	55	131	266	319	453	524
TOTAL	**110**	**228**	**441**	**519**	**774**	**890**
LABOUR INTENSITY						
Skilled workers	8	10	12	8	12	12
General workers	15	15	12	6	10	10
TOTAL	**23**	**25**	**24**	**14**	**22**	**22**

Table 6: Specific treatment costs for different MBT options

The different MBT options have roughly the same requirements in terms of labour intensity, except for aerobic biological drying. However, aerobic biological drying, combined anaerobic wet digestion and combined anaerobic dry digestions require more skilled labours due to the higher capital cost and associated higher repair and maintenance costs that require specialised knowledge. This feasibility study shows the need for any farmer wishing to invest in waste treatment technologies, to fully investigate not only the capital cost, but consider the operation and labour requirements and whether a farm has capacity to fulfil those requirements.

4

Next Steps

For more information about implementing waste management systems and technologies, please visit the GreenAgri website (**greenagri.org.za**). A wider pool of resources can be found on the site under the Waste section of the Agri Resilience tab.

Moreover, feel free to contact us at GreenCape's Sustainable Agriculture sector desk: agri@green-cape.co.za, for further information and support on any of the content provided here.

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