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# Adaptation & mitigation in the South African processed vegetable industry

Country report



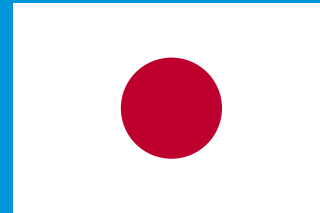
# Acknowledgements

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From the People of Japan

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- **Capital:**

Cape Town

- **Surface:**

1,219,602 km<sup>2</sup>

- **Population:**

54 million

- **Annual rainfall:**

450mm



# BACKGROUND OF THE PROCESSED VEGETABLE INDUSTRY IN SOUTH AFRICA

In 2014, exported vegetable products (a category that includes vegetables, but also fruits, grains, oils, nuts, spices etc.) represented 5.71 billion USD, 10% of all exports and 3% of total South African GDP. Processed vegetable products (excluding oils) made up 2%, 231 million USD of the value of food-related exports, (Center for International Development at Harvard University, 2016; World Bank, 2016). Major processed products include ‘homogenized vegetable preparations’, ‘vegetables preserved in vinegar’, and other ‘preserved or prepared vegetables’ (Food and Agriculture Organization, 2015).

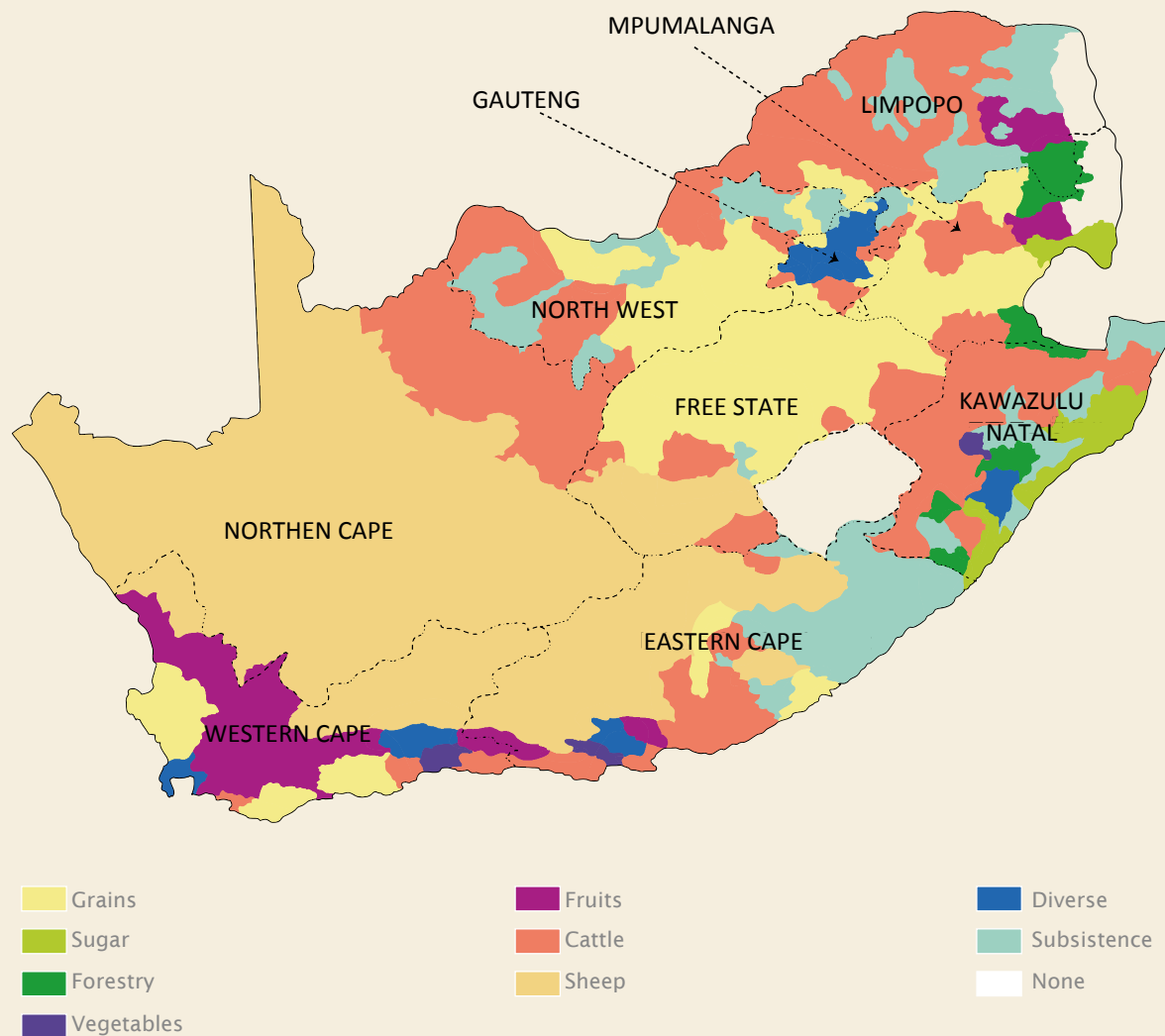
South Africa has a highly developed industrial and commercial infrastructure. Agricultural production is mostly commercial, but with only 11% of the arable land, most of the areas are located in marginally viable areas. Less than 20% of the country’s production is from small-scale agriculture. Although the GDP contribution of agriculture and agroprocessing may be relatively low, the sector is a critical source of employment, especially in rural areas; 8.5 million people are heavily dependent on agriculture as a source of employment or income (Baleta & Pegram, 2014; Johnston, Thomas, Hachigonta, & Sibanda, 2013). In 2008, the fruit and vegetable agroprocessing sector employed 21900 people (Embassy of the Kingdom of the Netherlands, 2011), mainly in canning (Figure 2), freezing, dehydration, and juicing.

Vegetables are produced in various parts of the country. In certain areas, farmers tend to concentrate on specific crops: for example, green beans are grown mainly in Kaapmuiden, Marble Hall and Tzaneen, green peas in George and Vaalharts, onions in Caledon, Pretoria and Brits, and asparagus in Krugersdorp and Ficksburg (Department: Agriculture, Forestry and Fisheries, 2013). South Africa’s potato crop (the most economically important vegetable) is grown mainly in the high-lying areas of the Free State and Mpumalanga, Limpopo, the Eastern, Western and Northern Cape, and KwaZulu-Natal. Tomatoes, the second-most important vegetable, are mainly produced in Limpopo, Mpumalanga Lowveld and Middleveld, the Pongola area of KwaZulu-Natal, southern parts of the Eastern Cape, and the Western Cape (SouthAfrica.info, 2012). Most of South Africa’s food processing industry is based in Gauteng and the Western Cape (Department of Environmental Affairs, 2011). The South African farming sector is characterized by medium-level exposure risk, coupled with medium to high levels of social vulnerability (Gbetibouo & Ringler, 2009). Chart 1 under Figure 1 shows the significant vegetable type in the South Africa.





**Figure 1. a) Agricultural regions of South Africa**

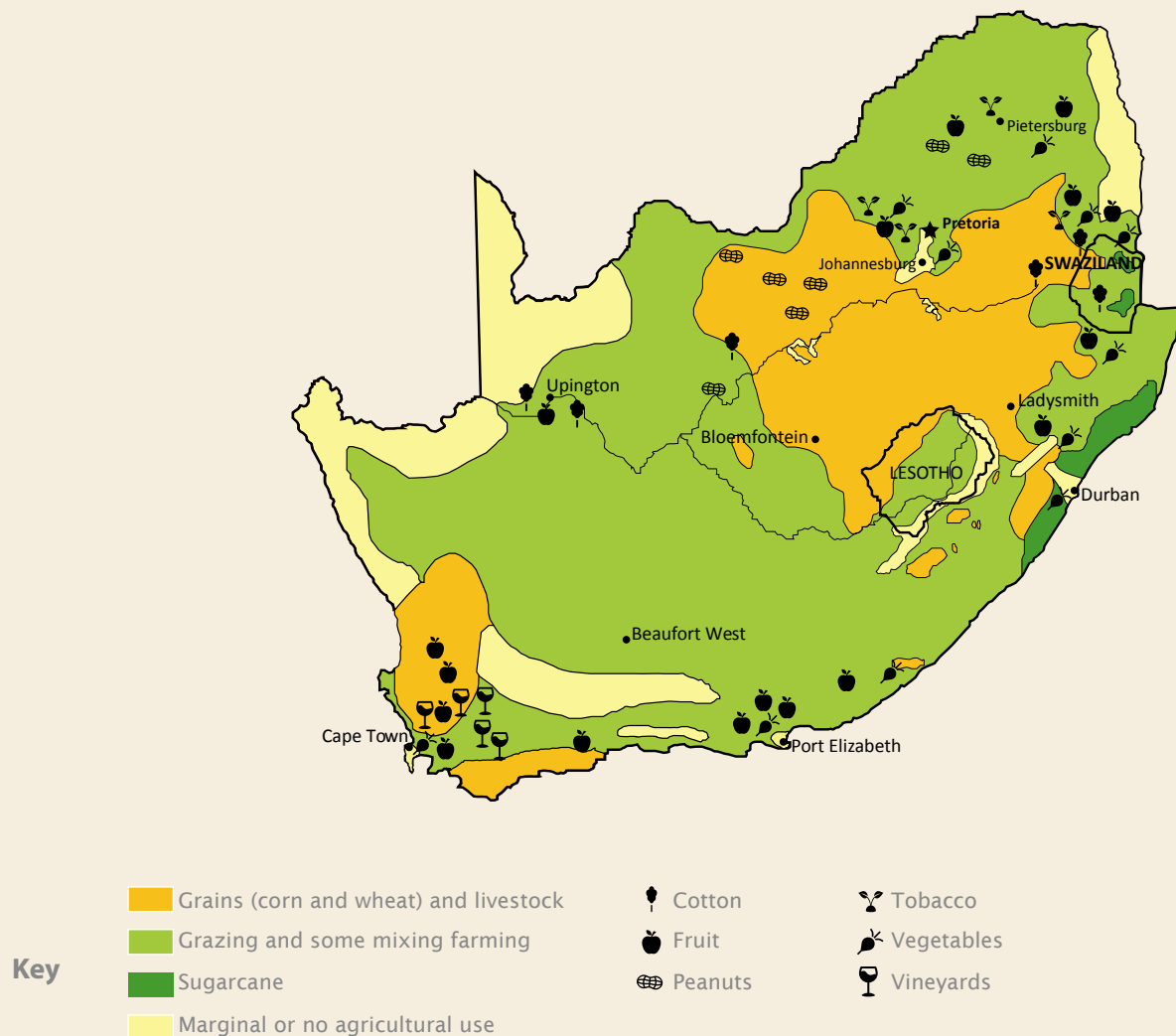


**Source:** ARI, 2013.

**Comment:** Vegetables are mainly symbolized in the North East of South Africa, although Cape Town, Port Elizabeth and East London are also indicated to have some vegetable horticulture.



**Figure 1. b) Current distribution of agricultural areas of South Africa.**



**Source:** Baleta & Pegram, 2014.

**Comment:** Vegetables are mainly symbolized in the North East of South Africa, although Cape Town, Port Elizabeth and East London are also indicated to have some vegetable horticulture.



“Tomato is one of the most significant vegetable types in South Africa.”

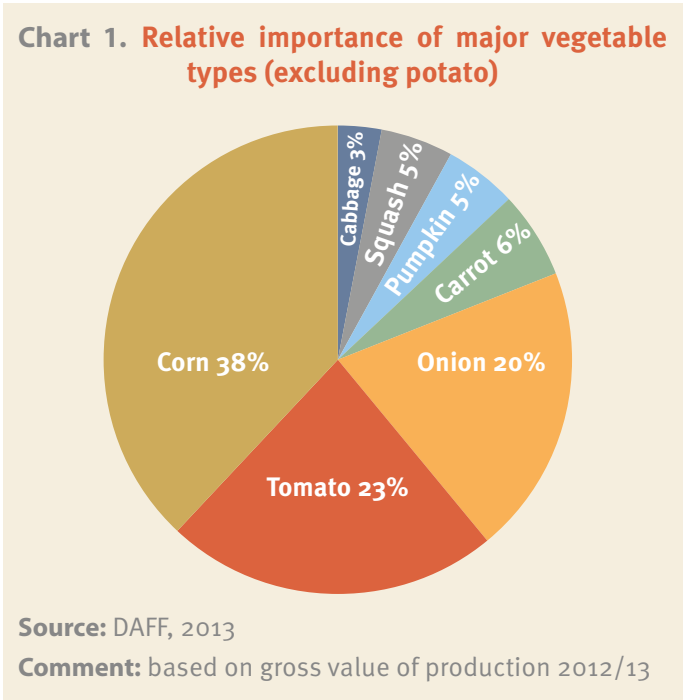






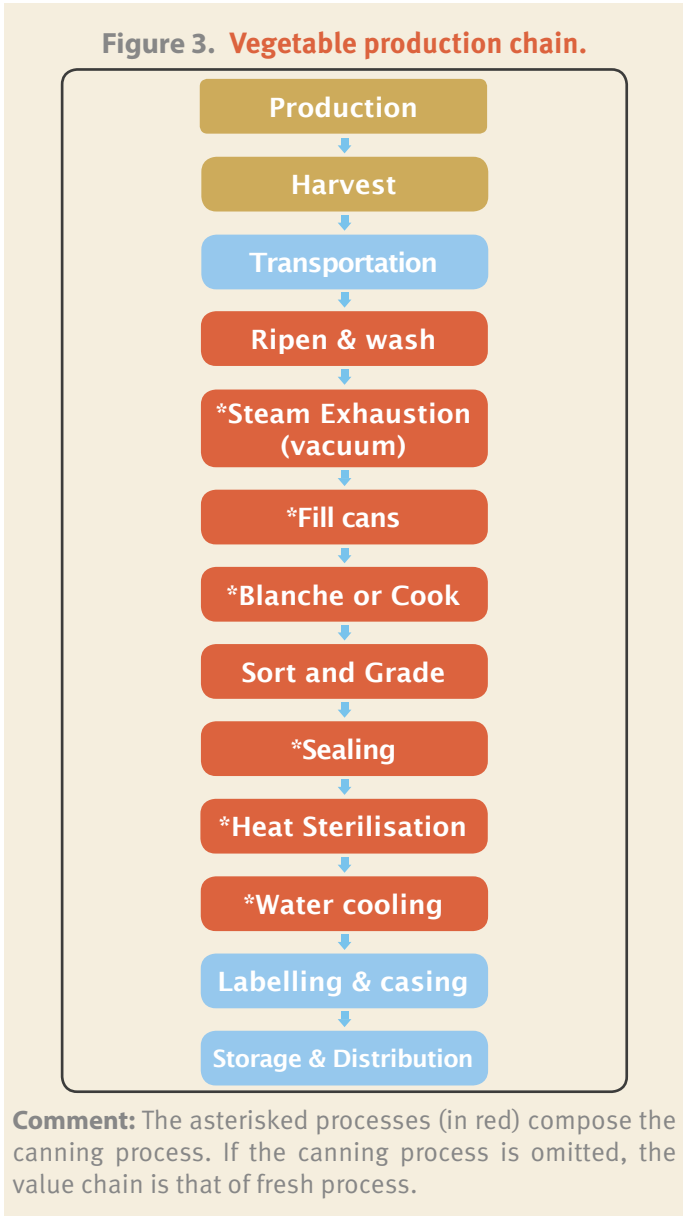
# A GENERIC VALUE CHAIN OF VEGETABLES IN SOUTH AFRICA

Tomato is the focus of this study as tomato is one of the most significant vegetable types in South Africa (Chart 1). Although the canning process is focused upon, the fresh tomato value chain is also described as it is economically important (Figure 3).



## Production and Harvest: Land Preparation, Planting, Plant Husbandry

Tomatoes require regular fertilizing and soil monitoring to achieve and maintain suitable soil nutrients. It is important that irrigation is managed to release sufficient water and critical growth stages. Tomatoes are treated with fungicides and pesticides for pests





and disease. At harvest, tomatoes are usually picked green and treated with ethylene to ripen. There are three growing seasons per year with harvesting in the commercial field in February and in trial field on March (Van der Waals, et. al 2003; McLeod, et. al. 2001). This information of harvesting season along the year can help to adapt with changing pattern of weather later.

### Primary Processing: Wash, Sort and Grade

Harvested tomatoes are usually thoroughly washed by high-pressure sprays or by strong-flowing streams of water while being passed along a moving belt or on agitating or revolving screens. Vegetables are sorted and graded for size, quality and maturity to market requirements; any waste here or further along the chain can be diverted to animal feed.

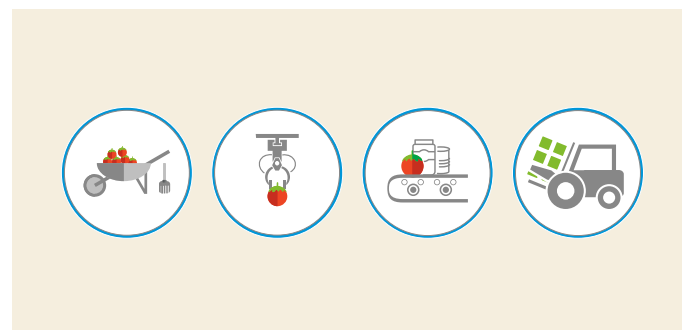
### Secondary Processing: Canning

Vegetables including tomatoes can be canned, then washed and peeled and/or cut as required, then blanched or cooked (sometimes peeling occurs after cooking). Formerly, tomatoes were initially scalded followed by hand peeling, but steam peeling and lye peeling have also become widely used. Coring is done by a water-powered device with a small turbine wheel. After peeling and coring, the tomatoes are conveyed through washers, to the point of filling. Before being filled, the can or glass containers are cleaned by hot water, steam, or air blast. A machine fills containers with the solid

product, then tops it with tomato juice or puree. Seasonings and preserving agents, such as citric or acetic acids, calcium chloride, water, sugar, oil or salt, may be added at the manufacturers specification. Filled containers are vacuum-sealed to remove oxygen, seamed, heat sterilized via atmospheric steam or hot-water cookers, then immediately cooled with cold water.

### Labelling and Casing, Distribution

The cans are automatically labelled and cased for distribution, then put into storage to await distribution. Unprocessed tomatoes require continuous refrigeration, both in storage and transit. Fresh produce markets and direct sales constitute 69.2% of the total volume of tomato sales (DAFF, 2013). Tomatoes are mainly produced for the local market, with limited exports to the Seychelles, Zimbabwe, Zambia and Mozambique. The current geographic distribution and production of tomatoes mean a sufficient volume of good-quality tomatoes is produced to meet year-round daily demand.





# PROJECTED IMPLICATIONS OF CLIMATE HAZARDS AND CLIMATE VARIABILITY

## Decreased Rainfall

Anomaly of rainfall has been generating drought in South Africa. A study by Blignaut et al. (2009) found that eight of the nine provinces in South Africa has received progressively less rainfall since 1970. The exception was the Western Cape, which, on average, received consistent annual rainfall over the entire study period. The Northern Cape and the North West provinces were the most affected.

Whilst horticulture makes extensive use of irrigation that temporarily offsets any sudden decline in rainfall, the water resources upon which irrigation depends are at risk of decline and exhaustion, due not only to hotter conditions and decreased rainfall, but also increasing usage pressures (Johnston et al., 2013). Decreased water availability will reduce yields and increase costs of production because farmers will have to pay for water solutions (Arndt, 2014; University of Capetown, n.d.). Surface water use is increasing rapidly, with no signs of a decline in use in any sector (Baleta & Pegram, 2014). Use of groundwater is also increasing rapidly (Vegter, 2001). The recent increment in water abstraction of both surface and groundwater is primarily to drive the development of agriculture, particularly horticulture (Johnston et al., 2013). As most of the surface water resources are already utilized to their full potential, and heavier pressure is placed on underground aquifers, water shortages could pose a problem in the future, and climate



change could exacerbate this further (Department of Environmental Affairs, 2011). Small scale farmers and subsistence farmers are most vulnerable to the effects of water shortages and droughts, and, while larger commercial farmers have better infrastructure, such as boreholes, windmills, pumps and irrigation systems, that may help them to cope with water shortages, they may also be effected by water restrictions.

Decreased water availability will adversely affecting topsoil via nutrient depletion and land degradation (Department of Environmental Affairs, 2011). When irrigation becomes more efficient, through either technology or improved practice, salts are concentrated in the root zone. This can have a negative impact on production, and therefore needs to be managed. There is gen-



erally a higher salt load in reuse water and, when coupled with more efficient irrigation, the understanding of the movement of salt and nutrients in the rootzone and beyond becomes even more critical (Department: Agriculture, Forestry and Fisheries, 2013).

Rainfall distribution and patterns are also shifting in South Africa and the increasing unpredictability of rainfall distribution and patterns is having negative effects. Much of South Africa already experiences variable rainfall, with access to sufficient safe drinking water posing a problem in some communities (Baleta & Pegram, 2014). Tshiala & Olwoch (2010) surmise that the underperformance of tomato production in the past could be attributed to the seasonal weather variability and the effects of such variability on how insects, diseases and weeds influence tomato production.

## Extreme Rainfall Events

There were historical events of rainfall anomaly which are severe rain and less rain since 1970 and even earlier than that. Extreme rainfall events have increased in frequency since 1970 (Blignaut et al., 2009; Ziervogel et al., 2014) and, indeed, greater climate variability means that flooding is interspersed with fairly regular drought episodes, resulting in extensive yield losses and lower average agricultural yields (Johnston et al., 2013). Flooding is projected to increase over the period from 2010 to 2041, and, in some coastal areas, combine with storm surges (Department of Environmental Affairs, 2013b).

## Increased Temperatures

South Africa is also experiencing a gradual, yet steady, change in climate. Temperatures have risen significantly over the last 60 years, and this rising trend is predicted to continue, with a rise in temperature of 1-2°C expected in coastal regions, and 3-4°C expected in interior regions by 2050. By 2100, an increase of 3-4°C in coastal regions, and 6-7°C in interior regions, is predicted (Blignaut, Ueckermann, & Aronson, 2009). Much of South Africa is arid or semi-arid and even small variations in rainfall or temperatures would exacerbate this already stressed environment.

For South Africa as a whole, the last 10 years have been, on average, 0.5°C—or 2%—hotter than in the 1970s. The variance increased during the same period, despite implying that changes in temperature became less predictable, but it were consistently higher in absolute terms and increased steadily over the entire period studied (Blignaut et al., 2009).

Higher temperatures have mixed impacts on horticulture. In the case of tomatoes, warmer temperatures could increase yields, providing all other inputs remain the same and temperatures do not exceed 25°C. Temperatures over 25°C are likely to cause heat stress (to which tomatoes are particularly susceptible) and reduce tomato production. Stressed plants also require more inputs. Assuming a non-linear tomato yields response and optimal temperature values, it is expected that there could be about 10% drop in tomato yield for ~1°C rise in temperature above 25°C (Tshiala & Olwoch, 2010).



Some pests and diseases will have significant growth: tomato pests of economic significance such as red spider mite and aphids thrive under hot and dry conditions. With the increase in frequency and intensity of severe weather events, there is a growing risk of storm damage to transport and distribution infrastructure, with consequent disruption of the supply chains.

Increased costs are predicted in order to install the required improved infrastructure, or even to maintain the same transport infrastructure and on-farm infrastructure (Arndt, 2014; Baloyi & Zengeni, 2015), especially for cold-chains (James & James, 2010).





**Table 1. Adaptation options for tomato processing**

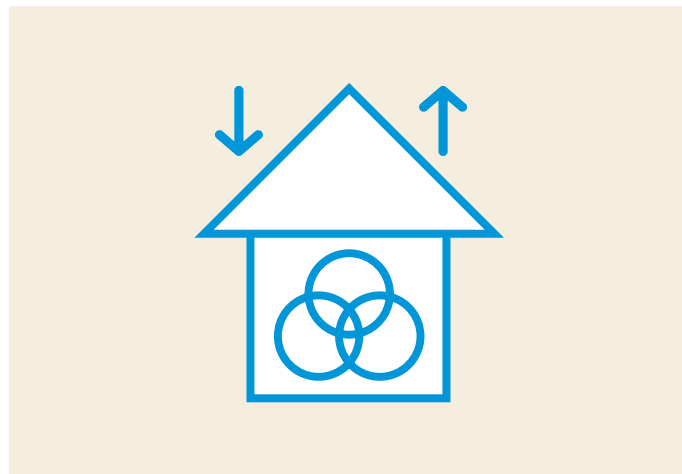
Climate exposure unit	Impact on food system assets	Impact on food system activities	Possible adaption responses	
Increase in temperature	<p>Production assets:</p> <ul style="list-style-type: none"> <li>Changes in vectors and natural habitats of pests and pathogens</li> </ul> <p>Storage, transport and marketing infrastructure:</p> <ul style="list-style-type: none"> <li>Strain on electricity grids, air conditioning and cold storage capacity</li> </ul>	<p>Producing food:</p> <ul style="list-style-type: none"> <li>Immediate crop losses due to higher evapotranspiration</li> <li>Reduced labour productivity due to heat stress</li> </ul> <p>Storing and processing of food:</p> <ul style="list-style-type: none"> <li>Upgrade in cooling and storage facilities required to maintain food quality at higher temperatures</li> <li>Increasing energy requirements for cooling</li> </ul>	<ul style="list-style-type: none"> <li>Changes in cropping patterns</li> <li>Development and dissemination of more heat-tolerant varieties and species</li> <li>Greater use of alternative fuels for generating electricity</li> </ul>	<ul style="list-style-type: none"> <li>Improved and more accessible weather related insurance</li> <li>Development of risk management frameworks</li> </ul>
Increase in frequency of drought	<p>Production assets</p> <ul style="list-style-type: none"> <li>Direct loss of crops due to water stress and increasing fire hazard</li> <li>Changes in rates of soil moisture retention</li> </ul>	<p>Producing food:</p> <ul style="list-style-type: none"> <li>Declines in yields due to crop losses</li> <li>Change in irrigation requirements</li> </ul> <p>Storing/processing of food:</p> <ul style="list-style-type: none"> <li>Scarcity of water for food processing</li> </ul>	<ul style="list-style-type: none"> <li>Development and dissemination of more drought-tolerant varieties and species</li> <li>Improved use of seasonal forecasts to inform planting time</li> <li>Improved soil management practices such as mulching to retain soil moisture</li> <li>Use of recycled wastewater for irrigation</li> <li>Use of dry processing and packaging methods</li> <li>More efficient water management policies and water use regulations</li> <li>Use of recycled wastewater for irrigation</li> </ul>	
Extreme rainfall weather events	<p>Production assets:</p> <ul style="list-style-type: none"> <li>Damage to standing crops</li> <li>Damage to buildings and equipment</li> <li>Loss of stored crops</li> </ul> <p>Storage, transport and marketing infrastructure:</p> <ul style="list-style-type: none"> <li>Damage to roads, bridges, storage structures, processing plants and electricity grids</li> </ul>	<p>Producing food:</p> <ul style="list-style-type: none"> <li>Lower yields in flooded agricultural areas</li> <li>Increased soil erosion reducing future yields</li> </ul> <p>Processing food:</p> <ul style="list-style-type: none"> <li>Pollution of water supply used in processing food</li> </ul> <p>Distributing food:</p> <ul style="list-style-type: none"> <li>Disruptions in food supply chains and increase in marketing and distribution costs</li> </ul>	<ul style="list-style-type: none"> <li>Improved early warning system dissemination</li> <li>Establishment of soil conservation practices to reduce erosion</li> <li>Investment in infrastructure maintenance</li> <li>Improve water storage</li> </ul>	





# ADAPTATION OPTIONS FOR THE SOUTH AFRICAN VEGETABLE INDUSTRY

The following table (Table 1) lists various adaptation options specifically targeted towards tomato production, but widely applicable across the South African vegetable industry. To be most effective, adaptation strategies and implementation need to consider the entire value chain. An integrated approach should also consider the distribution of adaptation costs and benefits (Barrientos & Visser, 2012). Overall, practicing mixed farming methods will strengthen the resilience of commercial farms to climate change and access to extensions – insurance and irrigation – is likely to reduce the risks of climate change (Tibesigwa, Visser, & Turpie, 2016).







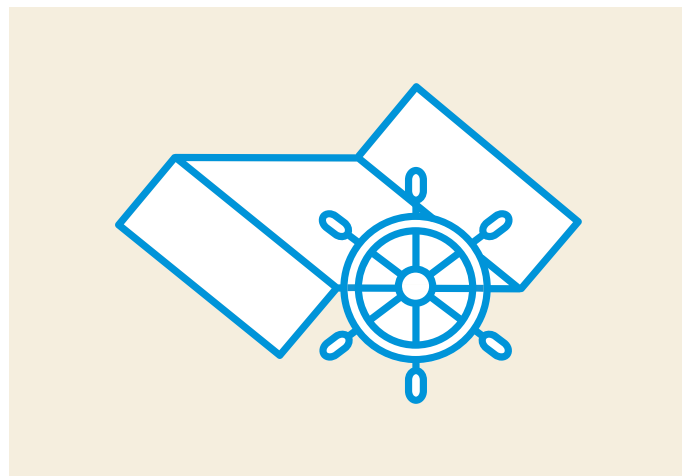
# MITIGATION OPTIONS FOR THE AGROPROCESSING INDUSTRY

## Transport

Of the three freight transport modes which are air, shipping and road, road transport is one of the key sectors with potential to mitigate the country's GHG emissions (Department of Environmental Affairs 2014b). Efficiency of road transport is also one of the fastest growing GHG emission sources (King, 2010).

The agriculture sector relies upon road transport for the supply of materials used on the farm (machinery, feed and produce), the transport of raw materials to the factory and the transport of manufactured goods to distribution depots and then to retail markets. Furthermore, the transport of processed foods in bulk is expected to increase in the future. For example, about 44% of the bulk commodities transported on the main road freight corridors of Gauteng-Durban and Gauteng-Cape Town will only be composed of processed foods and chemical products by 2041 (Havenaga, 2011). As such, the mitigation of GHG emissions from the road freight transport of manufactured food products is important to the mitigation of GHG emissions within the transport sector.

From the case studies reviewed in this study, it was found that transport activities contribute variably to the GHG emissions within the value chains of various food products. For example, waterborne freight (shipping) and air freight were found to be important GHG emission sources for the fruit industry (Blignaut et al. 2014), while road freight was an important emission source for the poultry and animal feed industry



(Astral Foods 2011; RCL Foods 2015). In the case of the fruit production industry, shipping freight and air freight were greater GHG emission sources than road freight for final international seaport and airport destinations (Blignaut et al. 2014). Transport sources were found to be the dominant GHG emission sources when the supply chain included the exportation of fruit produce (Ntombela et al., 2014). Transport was identified as a minor GHG emissions source within the milk, sugar and pork value chains. Whilst there are numerous approaches to reducing road transport emissions, there is very limited opportunity to reduce the emissions from international air and shipping freight (Blignaut et al. 2014).

## Manufacturing

The mitigation of GHG emissions from manufacturing is recognised as the second most important sec-



tor in terms of its potential to reduce South Africa's national GHG emissions (DEA 2014b). Therefore, the mitigation of GHG emissions from manufacturing processes within the value chains of agro-food products will contribute significantly to the mitigation of GHG emissions at a national level.

The GHG emissions from energy use and processing during production activities within the value chain of the case studies were collectively reviewed. Manufacturing activities contributed to greater than 10% of the GHG emissions relative to contributions from farm and distribution activities. From the case studies reviewed, the bulk of the GHG emissions for sugar, poultry and animal feed, pome fruit and table grape were from manufacturing activities. In the case of the fruit case studies, manufacturing included packaging and cold storage activities in pack-houses (Blignaut et al. 2014). Packaging using virgin cardboard materials was found to be a more GHG intensive activity at the pack-house level, rather than paper packaging (Ntombela et al. 2014). For milk production, manufacturing activities contributed to more than 20% of the total GHG emissions (Fair Cape 2012). These case studies indicate the increasing importance of GHG emissions specifically from energy use in manufacturing processes for food products that undergo greater processing, for example poultry, animal feed and sugar (RCL Foods 2015; Ilovo Sugar 2015).

## Waste

Food waste contributes significantly to the organic fraction of solid waste which is the main source of GHG emissions from solid waste disposed in landfills (Nahman et al., 2012). While the quantities of food waste are known (Nahman and Lange, 2013), the GHG emissions which are emitted as a result of this food waste is not. This is attributed to the complexity of quantifying the GHG emissions from food waste (Gómez et al., 2006).

The agro-food processing and beverage industry is considered to be a substantial wastewater producer which is frequently present within major cities in South Africa. Within the agro-food processing industry, poultry and sugar producers are the largest effluent producers (Cloete et al., 2010). The quantity of wastewater treated is directly related to the quantity of GHGs emitted (Gómez et al., 2006). As such, the mitigation of GHG emissions from the treatment of effluent produced from agro-food processing industries is an important source for the mitigation of GHG emissions from industrial wastewater treatment for the whole country. Furthermore, industries which have monitored their GHG emissions are able to benefit from emission reductions directly since the treatment of waste water occurs on site (see for example Astral Foods 2011 and Ilovo Sugar 2015).





Despite the potential for agro-food processing industries to contribute to GHG mitigation within the industrial waste-water treatment sector, the waste sector as a whole is only the third largest sector with the potential to contribute to the mitigation of South Africa's total GHG emissions (Department of Environmental Affairs, 2014b). GHG emissions in South Africa totaled 579 million tonnes CO<sub>2</sub>e in 2010 (Bloomberg, 2010). Three case studies, including Ilovo Sugar (2015), Oceana (2015) and Astral Foods (2014), reported minor contributions from waste to their total GHG emissions. Therefore, waste is of less importance for targeting national mitigation reduction initiatives, though within agro-food industries mitigation strategies in waste were found to be commonly implemented. It is important as wastewater contributes with CH<sub>4</sub> which twenty one times more dangerous than CO<sub>2</sub>.

## Agriculture

Farming activities were found to be important GHG emission sources for many of the case studies reviewed. Contributions from vegetable, fruit and cereal farming activities contribute to GHG emissions. The contribution of farming activities to the GHG emissions of the fruit industry decreased when the value chain included the exportation of fruit produce (Ntombela et al., 2014). Electricity consumption for the pumping of water for the irrigation of fruit orchards was found to be the most GHG intensive activity on the farm (Blignaut et al, 2014).

Although in South Africa, the agriculture sector was identified as the sector with the least potential to contribute to the reductions of the total national GHG emissions, agricultural GHG emission sources and sinks are important to the sustainability of agro-food industries. Mitigation measures in the sector in particular have synergies with the adaptation needs of the agroprocessing industry (see Table 6 for examples). This is particularly relevant for primary food producers (for example meat, milk, sugar and grain etc.) with farming operations included as part of the mainstream activities (for example van Bormann 2011; Fair Cape 2012 and Tongaat-Hulett, 2015), with these sub-sectors directly benefitting from mitigation measures in agricultural operations.





## CONCLUSION: OPPORTUNITIES AND CHALLENGES

Making the transition to low carbon and climate resilient agriculture can contribute to South Africa's green economy and potentially improve livelihoods through job creation, while reducing the environmental risks associated with climate change. The tomato value chain provides a case study of the opportunities and challenges, but broadly the transition to a more climate resilient agroprocessing industry faces a number of key challenges:

- Increasing food demand: economic growth combined with population growth generates a need for increased crop and food production. Small or large scale agro-food processing industries will be required to produce more food by increasing productivity.
- Declining levels of yield gain on the supply side due to the direct effects of water stress and climate change.
- Projected future higher costs of electricity and fuel and the implementation of carbon tax on transport vehicles could restrict efforts to increase productivity.
- Competing land uses: urban development and land degradation are placing pressure on availability of viable agricultural land

In South Africa, the agro-processing industry is highly concentrated with a few large enterprises contributing a majority share of income and employment. SMEs have been identified by the Department of Agriculture, Forestry and Fisheries as having significant potential to generate jobs in the agro-processing industry, but they are face a number of challenges. These include access to finance, inadequate skills at farm level and

inaccessible government support (DAFF 2012). Policy interventions linked with improved access to finance can assist in overcoming these challenges.

The manufacturing sector has the greatest potential to contribute to national GHG emission reductions through the adoption of energy efficient measures and the use of renewable energy sources. Agro-food processing industries have more frequently implemented mitigation strategies, targeting energy efficiency for energy use and electricity consumption in manufacturing activities. However, changes to production processes and technological investments to improve the production and distribution efficiencies within the sector could also contribute toward the reduction of emissions from transportation and agriculture. Furthermore, GHG mitigation in agriculture within the food value chain of the fruit and meat industries has the potential to have greater synergism with adaptation needs with links to water availability, economic growth, food security and human health that can be exploited. Investments that are made to reduce GHG emissions should therefore include in the cost-benefit assessment consideration of vulnerability to climate change and potential for other environmental effects.

Furthermore, despite waste being a minor source of GHG emissions, industries are compelled by other legislative requirements to develop strategies for waste, including avoidance and minimisation. Improving the sustainability and environmental friendliness of business and operations therefore has the potential for direct co-benefits for mitigation.



**“Improving the sustainability and environmental friendliness of business and operations has the potential for direct co-benefits for mitigation.”**





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This report examines South Africa's processed vegetable industry, identifying the impacts of climate change on tomato value chains specifically and suggesting options for climate change adaptation and mitigation.



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