AN ANALYSIS OF THE IMPACT OF LOADSHEDDING ON THE WESTERN CAPE AGRICULTURAL SECTOR

Report for the Western Cape Department of Agriculture

Bureau for Food & Agricultural Policy (BFAP)

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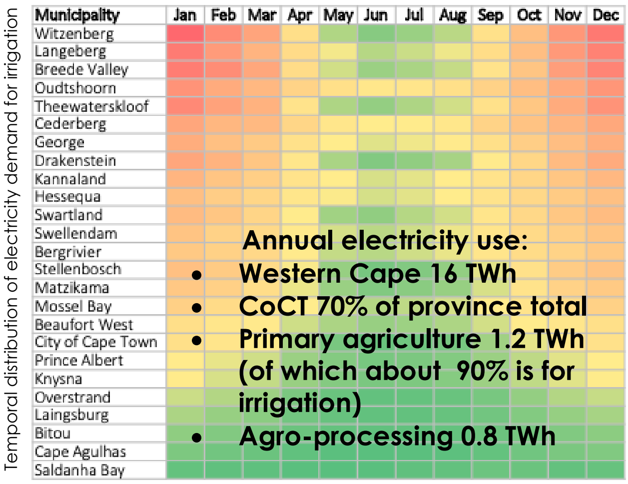
MAIN MESSAGES

Electricity dependency overview of the Western Cape agricultural sector



- Western Cape primary production and agro-processing electricity use was estimated at ±2 TWh in 2022.
- Intensive livestock operations are primarily situated in Swartland, Hessequa, Drakenstein, City of Cape Town (CoCT), Swellendam and George municipalities.
- Biggest electricity demand for irrigation purposes is in the Witzenberg, Langeberg, Breede Valley, Oudtshoorn, Theewaterskloof and Cederberg municipalities, where 80% of demand for electricity is from October-March.
- >90% of producers are dependent on Eskom as their primary, or only, source of electricity, but some businesses have already started investing in alternatives.

Impact of loadshedding on the Western Cape agricultural sector

- The causality analysis showed that the biggest drivers of impact in the system are operational capacity and scheduling, together with input supply.
- Four case studies were conducted to analyse the short- and longer-term impact of loadshedding, indicating that the risk posed by interruptions in electricity supply in the livestock industry is very high, but the impact on volume, area, jobs and GPV is even greater in the horticulture industry.
- Small and informal businesses are more vulnerable.
- Running primary production and agro-processing facilities in the Western Cape uninterrupted for a full year at stage 6 loadshedding will demand spending of R3.95 to R4.08 bn per annum, with savings on Eskom expenditure (R1.42 bn).

Annual cost impact	Per stage	Blackout
Loadshedding indicators		
% Eskom supply loss	7%	100%
On-farm (1 200 GWh) – Rand billion		
Solar PV & Lithium-ion	0.46	6.50
Diesel generator	0.45	6.30
Eskom saving	-0.18	-2.58
Agro-processing (844 GWh) – Rand billion		
Solar PV & Lithium-ion	0.33	4.57
Diesel generator	0.32	4.43
Eskom saving	-0.09	-1.27
Cost per unit (R/kWh)		
Solar PV & Lithium-ion	R5.42	
Diesel generator	R5.25	
Eskom saving	R2.15 (on-farm) | R1.50 (agro-processing)	

Potential interventions to consider for the Western Cape agricultural sector

- The responsibility of generating electricity can be forced upon businesses, but with such a responsibility businesses still depend on government to create an enabling environment.
- Industry organisations can ensure the effective communication of the strategic actions taken at various levels of government with agribusinesses.
- If any level of government implements alternative energy solutions to reduce/remove loadshedding, these implementations could ease the responsibility on businesses to invest in their own electricity generation, avoiding additional constraints on individual agribusinesses.
- Risk mitigation priorities should include water supply, an enabling regulatory environment and curtailment rather than loadshedding for agro-processing facilities.

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EXECUTIVE SUMMARY

The objective of this study is to provide a description of the energy dependency of the Western Cape agricultural sector on the national grid, within the context of the loadshedding situation, and to describe the on- and off-farm implications and quantify its socio-economic impacts. To reduce and/or mitigate the impact, the study provides recommendations on potential interventions that can be implemented by value chain role-players, industry, and the various spheres of government.

To provide the context of the industry assessed with respect to energy dependency and the impact of loadshedding, an overview of the value of the agricultural value chain in the Western Cape, with focus on GDP and employment is presented. The report also presents findings from existing literature on the impact of loadshedding on the South African economy and the agricultural sector, and a brief look at the cost of alternatives and the policies regulating the implementation thereof.

A matrix was built of the structure of the agricultural value chain in the Western Cape. This included linking the flow of products from farm to consumer, calculating the number of jobs, income and electricity spend per value chain actor. To provide an overview of the energy dependency of the Western Cape agricultural sector by industry, consideration was given to the type of energy being used and the suppliers of energy, and the spatial and temporal distribution of energy use.

The Western Cape's total energy demand in 2021 equated to 16 067 GWh (16 TWh). The City of Cape Town metropolitan were responsible for 70% of the total demand and the other 24 municipalities combinedly responsible for 30%. Within these municipal electricity use, the use by primary agriculture and agro-processing are included. The distribution of commercial agricultural expenditure by municipality provides an indication of the relative intensity of agriculture's electricity usage. While the Western Cape is responsible for 8% of South African electricity demand, its share of national agricultural electricity expenditure in 2017 equated to 22.4%, indicating that the primary agricultural sector in the Western Cape is more energy intensive than agriculture in other provinces. Intensive livestock operations are primarily situated in Swartland, Hessequa, Drakenstein, City of Cape Town, Swellendam and George municipalities. Biggest electricity demand for irrigation purposes is recorded for the Witzenberg, Langeberg, Breede Valley, Oudtshoorn, Theewaterskloof and Cederberg municipalities, where 80% of demand for electricity is from October-March.

An estimate of economic activities of the primary agricultural sector, which includes gross farm income, total costs and the share of electricity and fuel costs to total costs, formed the basis of the analyses in this report. Producers in the Western Cape spend around R75.3 billion to generate around R79 billion worth of outputs. The R2.6 billion spent to buy electricity were 3.43% of total costs. When spending on fuel was added, the combined total reached 7.4%. Given these estimates, an official Eskom tariff of R2.15/kWh was used to calculate total electricity use of around 1 200 GWh in 2022. In a similar calculation, agro-processors in the Western Cape spend around R89.8 billion to generate around R105.6 billion worth of outputs. The total estimated spend on electricity of R1.27 billion implies that, at an Eskom tariff for industrial firms of R1.50/kWh for 2022, these agro-processing industries used a combined 844 GWh. In relative terms, , processors spend around 1.4% (of total costs) on electricity and another 1.7% for fuel, with a combined spend of 3.1%.

A systematic approach was used to address the quantification of the impact of loadshedding at various stages. Firstly, the relationships between causes and effects in the Western Cape agricultural sector were analysed and described. Thereafter, impact was evaluated based on operations, volume and price, and ultimately profitability. These analysis steps and findings provide the necessary platform to unpack loadshedding's socio-economic impact and the impact on government objectives.

One of the golden threads throughout the study has been the interconnectedness of value chains – not only within a single commodity, but across commodities. The second thread widely observed is that loadshedding sets off a series of events, many of them having a knock-on effect on other matters. Interactive Qualitative Analysis (IQA) was employed to establish causality and identify potential feedback loops. Highlights from the causality analysis include that the chain of events as a result of loadshedding starts with 'Operational capacity & scheduling' (biggest delta – net relationship direction – between causes and effects, thus ranked first), followed by 'Input supply & availability'. The biggest outcomes – elements subjected to change in the system – are the ones with the biggest negative delta, namely 'Socio-economics' and 'Product selling prices'. Four feedback loops exist in the system, which strengthen the argument of complexity and interconnectedness in agricultural value chains. The recursive nature of causality also exposes the risk continued loadshedding poses.

Given the outcomes of the causality analysis, a matrix approach was followed to indicate the impact of different stages of loadshedding on operations. The objective was to highlight the biggest risks for businesses, as derived from surveys and interviews, by making use of a Likert scale schematic. The highest risk for value chain disruptions and output reduction are related to water (supply and irrigation), intensive livestock production, and the processing and cooling of produce. From the interviews with stakeholders, it became clear that smaller role-players are more vulnerable. This holds true throughout the different value chains, but especially in the case of emerging producers, informal processors, and smaller commercial producers. One could, to a large extent, assume that impact of loadshedding on these role-players are typically one level higher than what has been indicated on average, and the operational activities of these producers and agro-processors would be disrupted at one stage of loadshedding earlier than for the average. At the same time, large scale producers and agro-processors, who have already invested extensively in alternatives, can at an additional cost temporarily absorb more of the impact of various stages of loadshedding.

Three case studies – one per sub-sector – were conducted to simulate the impact of loadshedding stage 6 against a business-as-usual baseline. Assuming that the case studies are indicative of the impact on volume and price by sub-sector, the impact can be summarised as follows. For livestock (poultry), 20% of the cost incurred due to loadshedding is passed on to the consumer, with 80% absorbed in the value chain. Although production volume is marginally affected in the short run, and increased imports are triggered, it mostly reverts to baseline conditions in the long run, assuming that the energy situation normalises due to current investments in private generation capacity. Thus, while adding to food price inflation, availability should not be affected, as imports can replace the production contraction.

For field crops (canola), it was assumed that one third of the additional cost incurred due to loadshedding can be passed onto consumers, with one third pushed to producers and one third absorbed by the agro-processors. Contraction of area and volume of 2-3% in the short run could be expected, which also curtails exports, where applicable, somewhat. Similar to livestock, a recovery to baseline levels over the latter part of the outlook is expected. Prices are well integrated in global markets and while the need to import may increase, food availability should not be affected. Since wheat is already mostly priced at import parity, price impacts will be limited, but imports will rise to ensure availability.

The horticultural sub-sector could be split into two: produce predominantly cultivated for exports, e.g., fruit, and produce cultivated primarily for local consumption, e.g., vegetables. Regarding the former (apples was used as case study), a negative impact of up to 10% GPV is projected under a "conservative" scenario modelled for loadshedding stage 6. Negative quality and volume impacts – up to a 12-15% decrease in exports – in the short run could have long run structural implications for the industry, as water limitations emanating from increased loadshedding could reduce the area under cultivation. Although not modelled, the vegetable industry would emulate grains to the extent where the cost of loadshedding is partially passed on to the consumer as volume reductions will increase the prices of fresh produce for consumers. A product like wine, which has a large domestic and international footprint is likely to experience a combination of both the fruit and vegetable impacts. The most critical component to surviving this crisis was identified as sustained supply from water schemes and irrigation at farm-level.

The impact of loadshedding inevitably affects the socio-economic aspects of agricultural value chains and the provincial government objectives. This report reiterates that job opportunities in the horticultural sector, which is the biggest employer of on-farm and off-farm agri workers in the Western Cape, are most vulnerable, putting those jobs at risk. The WC DoA aims to create an enabling environment for producers and processors to grow Value Added and grow employment opportunities. It is clear that the ongoing energy supply shortage are set to influence some of the major outcome indicators that the Department has set out to achieve towards 2024. In this regard, growing exports, value added and ensuring continued success on land reform projects will be difficult to maintain. A high-level overview of the policy environment applicable to the study highlighted the slowly changing regulatory environment that still constraints the implementation of alternatives, especially with respect to the implementation of green energy options.

Considering the direct and indirect cost, operational impact and risk to individual role-players in the agricultural value chains, a set of potential interventions were developed. The matrix outlining this non-exhaustive list of interventions considers both the mandates and competencies of businesses, industry, and government to implement interventions during the season on hand, the rest of 2023 and over a 10-year period. Given the complexity and magnitude of interventions required, a collective effort from all stakeholders is necessary to mitigate this electricity crisis in the Western Cape. To illustrate, running primary production and agro-processing facilities in the Western Cape uninterrupted for a full year at stage 6 loadshedding will demand spending of around R4 billion per annum on alternative energy sources, with savings on Eskom expenditure of R1.42 billion.

While the responsibility of generating electricity can be forced upon businesses, with such a responsibility businesses still depend on government to create an enabling environment. Industry organisations can ensure the effective communication of the strategic actions taken at various levels of government with agribusinesses. If any level of government implements alternative energy solutions to reduce/remove loadshedding, these implementations could ease the responsibility on businesses to invest in their own electricity generation, avoiding additional constraints on individual agribusinesses.

Given the findings regarding the impact of loadshedding in the Western Cape agricultural sector, it is recommended that risk mitigation priorities should include water supply, an enabling regulatory environment and, in particular in the livestock sub-sector, curtailment rather than loadshedding for agro-processing facilities.

In conclusion, every attempt has been made to reflect the true state of energy dependency, the impact of loadshedding and the potential implementable interventions to mitigate the impact on the Western Cape agricultural sector within the timeframes provides. However, ample scope exists to refine, enrich and expand the research in collaboration with businesses, industry and government.

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1. INTRODUCTION

South Africa is currently experiencing a major energy crisis, brought about by several longstanding challenges in the energy sector. Although large parts of the population and business community has been dealing with intermittent interruptions in the electricity supply for most of the past decade, the situation has deteriorated substantially over the last year and the scale and magnitude of current supply shortages will have significant bearing on the agricultural sector and larger economy. To date, there has been no research undertaken to assess the on and off-farm implications of loadshedding as it relates to production, processing and marketing of agriculture and food products.

The aim of this report is to provide a description of the energy dependence of the Western Cape agricultural sector and to contextualise and assess how loadshedding impacts the various economic activities related to agricultural production located in the province. It provides a best possible estimate of the extent to which food production and processing is dependent on Eskom Holdings (SOC) Entity Ltd (Eskom - South Africa's state-owned energy company), municipalities and/or other sources of energy and evaluates the exposure of the various segments of the Western Cape agricultural value chain related to its dependence on Eskom for its energy supply.

Loadshedding is a method through which Eskom deliberately shuts down electricity supply in parts of the power distribution system in an attempt to avoid failure in the larger part of the system at times when the demand exceeds supply. The power utility's inability to generate sufficient energy to power the country's economy is well cited in various reports and in the media and will not be covered in this report. Instead, BFAP's integrated value chain approach is used, informed by multiple stakeholder engagements, to describe and assess the complexity and potential impact of loadshedding as locally produced agricultural products move from the farm, through the value chain and ultimately reach consumers, either locally or internationally.

We estimate the impact of loadshedding at different loadshedding stages - a set number of hours during which value chain actors such as producers, processing firms, service providers, traders and input suppliers are left without electricity to run operations. Despite some advancement in energy regulation to allow additional energy supplies into the national grid and significant investments in the past two years in renewable energy, there is consensus that South Africans will continue to suffer from recurring loadshedding at least until the end of 2024 (BER, 2023). The impact on individual businesses is significant, and the aggregated and spill-over impacts on the entire food system has bearing on macroeconomic outcomes such as food security, food production and processing capacity, unemployment and social unrest to name just a few. The current energy crisis in South Africa, , comes at a time of international economic downturn and a local economy battling to bring stubbornly high food inflation under control. Furthermore, the agricultural sector in South Africa, but in particular the Western Cape, has had a difficult 2022 season compared to 2020 and 2021 with factors such as farm input cost inflation growing faster than farm incomes, price pressure on exported fruit products and a stagnating SA economy dragging demand for locally consumed food products lower.

Given this context, our research on the impact of loadshedding on the Western Cape agricultural sector is aimed at ultimately drafting a set of potential interventions that would minimise the main negative impacts whilst recognising the limited mandate of the Department to directly fund energy investments. We also discuss the mechanisms through which loadshedding is expected to impact the value chains by identifying causal relationships linking energy shortages to business operations, impacts on volumes and prices in the market, profitability considerations and some socio-economic impacts on consumers and farm workers in the Western Cape. Loadshedding will also undoubtedly impact several government objectives since already scarce resources will need to be re-allocated to continue providing services at a higher cost, but also the broad impact of loadshedding is set to negatively impact on key strategic outcomes. More specifically, loadshedding will impact the WC DoAs ability to shape and direct increased agricultural production in a sustainable manner, improve food security and safety and enhance inclusivity and (WC DoA, 2020). This document concludes with some recommendations and potential interventions for the Department, producers and value chain actors.

2. OVERVIEW OF THE AGRICULTURAL VALUE CHAIN IN THE WC

From the outset it is important to define what is meant by the agricultural sector under review in this report. Traditionally and at the macroeconomic level, the extent of the agricultural sector is often depicted in terms of its contribution to the Gross Domestic Product (GDP) and formal employment, which is presented in **Figure 1**. Considering just the primary level of agricultural production, the value-added contribution of farms producing agricultural outputs were estimated at 3% of the total Western Cape economy in 2022, whilst agro-processing added another 4%. This combined 7% contribution to GDP is significant in itself but if one also takes into consideration the 14% contribution that these two sectors make in terms of employment, the importance of the broader agricultural value chain is clear. While significant, this description of the agricultural sector does not yet include all the different linkages that agriculture has to other parts of the economy, both in terms of utilising inputs and services from other industries, as well as producing products used in downstream segments of the economy. Structurally, agriculture and agro-processing can also not exist independently of one another, unless all processed products are imported, and/or all fresh produce exported. Rather, the interconnectedness of farms and processors is what makes the entire supply chain able to competitively produce products. Thus, external risks that impact any component or linkage of the agricultural value chain, impacts the whole as well.

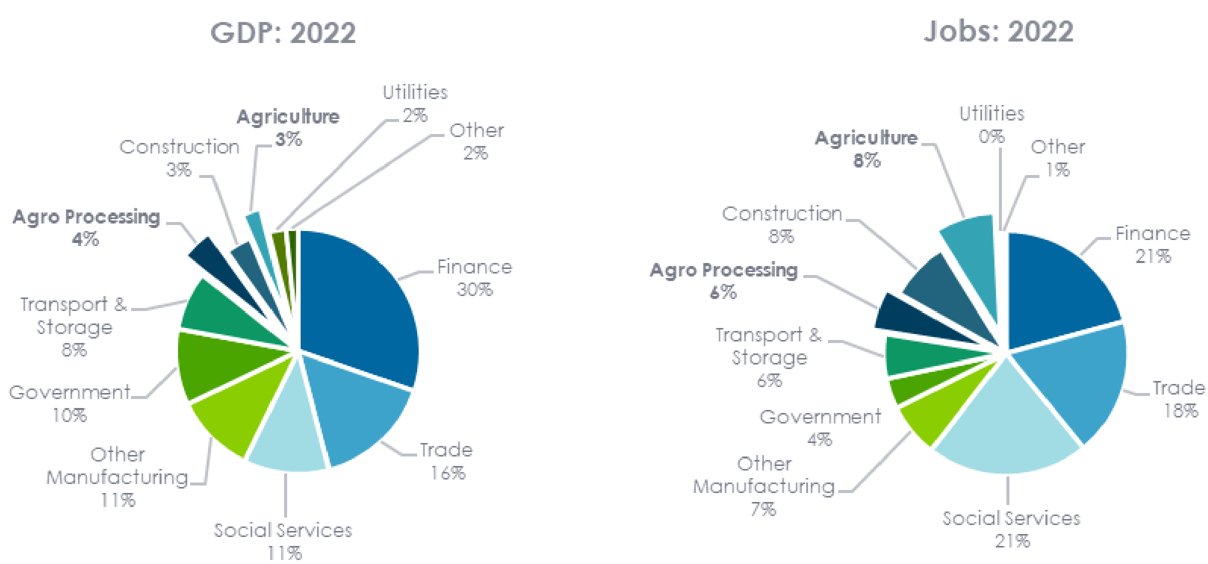


FIGURE 1: AGRICULTURE AND AGRO-PROCESSING CONTRIBUTION IN THE WESTERN CAPE IN 2022
SOURCE: QUANTEC, 2023

The Western Cape agricultural sector is internationally competitive, and a large proportion of South Africa's fruit and wine exports are from the province. At the time of the last completed farm census there were around 6 500 commercial producers in the province and another 3 800 emerging growers (StatsSA, 2020; DALRRD, 2021). No official data provides a breakdown of the number of agro-processing firms located in the Western Cape, but published information from 2014 suggests that food and beverage manufacturers made up 25% of both national sales income and the number of employed (StatsSA, 2014). We estimate that the number of agro-processors in the Western Cape is between 1 000 - 2 000 firms, which produce a variety of value-added products. Before embarking on the main objective of this report which is to describe, assess and analyse the impact of loadshedding on the agricultural sector, this next section provides a brief explanation of the integrated nature of the food value chain and provides the base from which we'll assess the economic impact of loadshedding. This will also be used as the base through which we identify causal relationships within the value chain as it relates to energy dependence and the impact of loadshedding.

Figure 2 presents a schematic diagram of the agricultural value chain in the Western Cape, specifically linking different agriculture and agro-processing industries with industries that supply goods and services as products move through the various stages towards final consumer markets. The values shown in the figure represents gross output (for farming), gross income (for inputs and services), or gross value of production (for agro-processing. Thus, inputs and services are reported as costs to the industry, incorporated into the value of produce reported at farm and/or agro-processing level. Values reported for farming are incorporated into the total value of production reported at agro-processing level where value is added or products are processed.

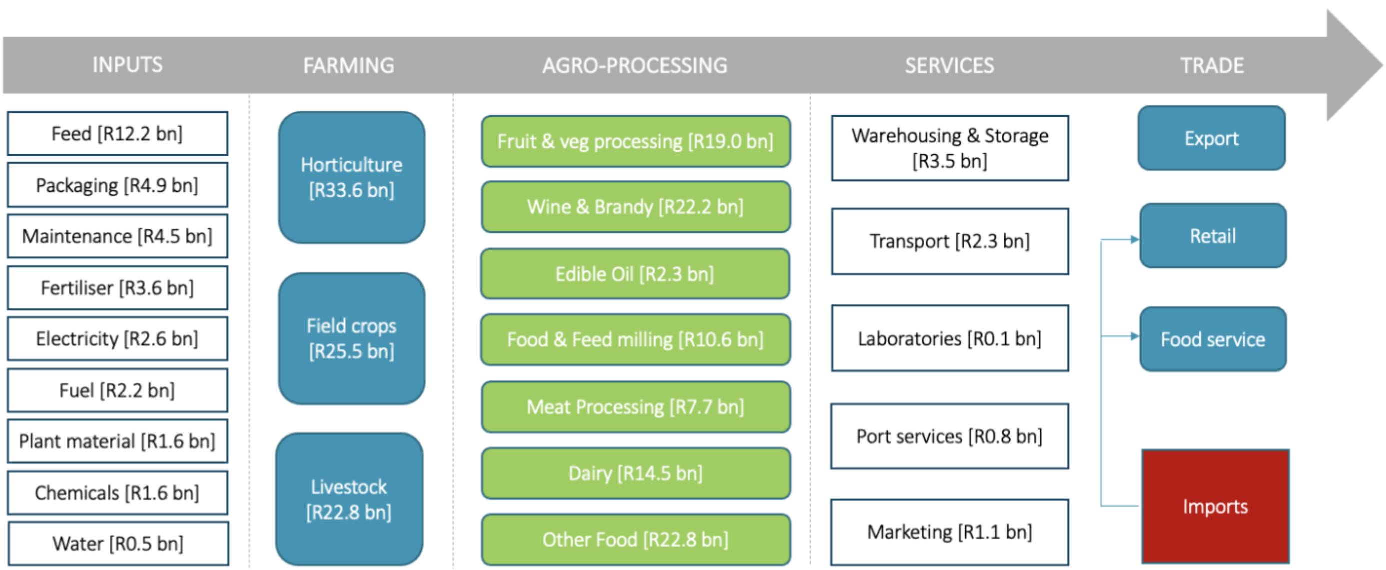


Figure 2: Western Cape agricultural value chain linkages: 2022
Source: Compiled by BFAP from various sources, 2023

This compilation was compiled using various sources that detail the structure of the economy. In the absence of recently updated statistics, we estimate the total value of agricultural output in the Western Cape at R81.3 billion in 2022. Of this, 50% came from horticulture gross farm income and 33% and 16% from field crops and livestock farming respectively. In order to generate this farming income, Western Cape farms were reliant on several input industries with the most notable for our research focus being feed, packaging, fertiliser and electricity. In total, farming costs (excluding labour) were approximately R61 billion in 2022, which resulted in Value Added of around R20.7 billion. Two important direct costs related to the focus of this study is the spending of farms on electricity and fuel, which had a combined value of sales to the agricultural industries of R4.8 billion.

Moving beyond the farm-gate, agro-processors realised an estimated combined gross income of around R106 billion, which is disaggregated into the main industries in **Figure 2**. Other food products, which includes potato chips, nutritional and dietary supplements, herbs and spices and infant food to name a few, are the biggest categories. Other substantive industries in the Western Cape include cellars and distilleries (beverages), fruit processing, dairy processors and animal feed. Quantification of loadshedding's impact must be assessed on each of these processing segments of the Western Cape economy largely due to significant differences in the nature of processing and the related electricity intensity between them. These firms are mostly directly integrated to farms located in the province, such that fruits are canned or juiced, wine grapes pressed, grains milled and so forth. Often the single biggest expenditure item for agro-processing firm is the purchasing of raw materials coming from farms, usually in the order of 70% of total costs at the secondary level. This again highlights a fundamental principle when thinking about the functioning of agricultural supply chains. In order for processors to be competitive, farm products need to be procured at low prices (compared to imported raw material), on a consistent basis to ensure ample throughput. Whereas farms mostly operate on a seasonal basis that depends on the nature of production, processors operate at a much larger scale due to agglomeration effects and large capital equipment and other assets means that plants often need to have high (>70%) utilisation rates to remain competitive. If this cannot be maintained over long periods of time, the relatively large, fixed costs cannot be sustainably recovered.

But, agro-processors are not only dependent on raw material from farms, they often also depend on one another for raw material and services. Consider the feed industry as an example - feed manufacturers buy grains from producers as the main ingredient to manufacture compound feeds, but also buy raw materials from other agro-processors such as oilcake (oil crushers). This dynamic also has bearing when anticipating the impacts of loadshedding on agro-processing firms, since primary agriculture then also depends on feed mills to supply feed competitively. Thus, an escalation of prices in the chain, even relatively small margins, can easily scale and create multipliers working against producers in the economy.

Now that we have detailed the size and linkages of the agricultural economy with its related products and services, we briefly review some of the available literature on the impact of loadshedding in South Africa.

3. LITERATURE

The significant increase in loadshedding hours in 2022 has brought about a greater emphasis on the policies restricting or enabling alternative solutions, the direct and indirect implications of loadshedding and the potential alternative solutions to mitigate loadshedding. The dependency of the agricultural sector on the national electricity grid is undeniable. The focal point for this literature overview is to summarise existing literature with respect to policy, impact reports compiled by recognised research institutes and agriculturally focused surveys.

3.1. Overview of electricity use

The Western Cape's total energy demand in 2021 equated to 16 067 GWh (16 TWh). The City of Cape Town metropolitan were responsible for 70% of the total demand and the other 24 municipalities combinedly responsible for 30% (**Table 1**). Of the municipal electricity use shown, the use by primary agriculture (**Table 2**) and agro-processing (**Table 3**) are included. The distribution of commercial agricultural expenditure by municipality provides an indication of the relative intensity of agriculture's electricity usage. While the Western Cape is responsible for 8% of South African electricity demand, its share of national agricultural electricity expenditure in 2017 equated to 22.4% (Enerdata, 2023; GreenCape, 2022a; StatsSA, 2020a; StatsSA, 2020b), indicating that primary agricultural sector in the Western Cape is more energy intensive than agriculture in other provinces.

TABLE 1: WESTERN CAPE ENERGY DEMAND AND CONSUMPTION: 2021

#	Municipality	Total annual demand (GWh)	Total Western Cape %	Cumulative %	Commercial agriculture electricity expenditure (2017)
1	Drakenstein	794	4.9%	4.9%	7.8%
2	George	494	3.1%	8.0%	3.5%
3	Stellenbosch	429	2.7%	10.7%	6.5%
4	Breede Valley	354	2.2%	12.9%	10.7%
5	Langeberg	319	2.0%	14.9%	6.0%
6	Mossel Bay	318	2.0%	16.9%	1.3%
7	Saldanha Bay	267	1.7%	18.5%	0.5%
8	Overstrand	252	1.6%	20.1%	0.8%
9	Witzenberg	212	1.3%	21.4%	14.8%
10	Knysna	202	1.3%	22.7%	0.8%
11	Swartland	202	1.3%	23.9%	5.2%
12	Oudtshoorn	176	1.1%	25.0%	4.8%
13	Bitou	116	0.7%	25.7%	0.3%
14	Hessequa	94	0.6%	26.3%	2.4%
15	Matzikama	88	0.5%	26.9%	3.2%
16	Berg River	83	0.5%	27.4%	3.5%
17	Cape Agulhas	78	0.5%	27.9%	1.6%
18	Cederberg	70	0.4%	28.3%	7.1%
19	Theewaterskloof	64	0.4%	28.7%	7.8%
20	Beaufort West	63	0.4%	29.1%	0.4%*
21	Swellendam	56	0.3%	29.5%	2.2%
22	Kannaland	34	0.2%	29.7%	0.9%
23	Prince Albert	10	0.1%	29.7%	0.4%*
24	Laingsburg	8	0.1%	29.8%	0.4%*
25	City of Cape Town	11 282	70.2%	100%	7.1%
	Total	**16 067**	**100%**	**100%**	**100%**

SOURCE: GREENCAPE, 2022A & STATSSA, 2020A
NOTE: * REPORTED COMBINEDLY AS CENTRAL KAROO

In estimating the energy usage of the agricultural value chain in the Western Cape, one requires a sense of the type of economic output generated by the various industries located in the province. Limitations on data availability and access (Eskom could not provide data on electricity use per province) required that we compile a set of analyses from various sources to gage the energy use of agriculture and agro-processing in the Western Cape. It should be noted that much of the data that is available is outdated. Consequently, the compilation in **Table 2** and **Table 3** required a series of adjustments and collations from various sources (Hortgro, CGA, BerriesZA, SATI, SAWIS, Vinpro, WC DoA, SAGIS, FPMs, MilkSA, RPO, SAPA, SAPPA, and others).

TABLE 2: ESTIMATED WESTERN CAPE PRIMARY AGRICULTURAL ENERGY USAGE: 2022

Primary Agriculture	Total income R' million	Total costs R' million	Electricity		Fuel		Combined share (%)
			Spend R' million	Share of total costs (%)	Spend R' million	Share of total costs (%)	
Livestock	26 559	75 333	2 585	3.43	2 965	3.94	7.37
Horticulture	36 927						
Vegetables	4 101						
Field Crops	11 819						
Total	**79 405**						
Estimated Electricity Use	1 200 GWh @ R2.15 per kWh						

SOURCE: COMPILED BY BFAP FROM VARIOUS SOURCES, 2023

Table 2 presents a brief synthesis of economic activities of the primary agricultural sector, which includes estimations on gross farm income, total costs and the share of electricity and fuel costs to total costs. Producers in the Western Cape spend around R75.3 billion to generate around R79 billion worth of outputs. In total, the R2.6 billion spend to buy electricity contributed 3.43% to total costs, whilst if we add the spending on fuel the combined total energy spend reaches 7.4%. Given these estimates, we use the official Eskom tariff of R2.15/kWh as per their annual report to calculate total electricity use of around 1 200 GWh in 2022.

A similar calculation for the agro-processing sector in the Western Cape is even more challenged by data limitations. However, in broad industry terms, we calculate much of the same indicators for the Western Cape presented in **Table 2** but utilise national statistics to estimate current levels of economic output and energy expenditure. The last time that StatsSA published information about the provincial share of manufacturing output was in 2014. The data revealed that in South Africa's total sale of goods and services from the food and beverages sub-sector, the Western Cape contributed a share of 24.7%. Similar shares were reported for the total value of wages (25.4%) and number of employees (25.8%) (StatsSA, Manufacturing Industry: Financial, 2014). In the process of updating agro-processing indicators, we assume that the Western Cape retained 25% share of total income and estimate a relative share between different agro-processing industries. Our base data originated from the Supply and Use Tables published by StatsSA (2021) with a base year of 2019. We adjust the levels of these indicators using a combination of Producer Price Indices (PPI) to update costs of manufacturing and total income from StatsSAs (2023) Manufacturing Production and Sales publication to calculate best estimates of 2022 income and costs per industry, as well as the estimated spend on electricity and fuel. **Table 3** provides the estimated energy use in agro-processing in the Western Cape. The total estimated spend on electricity of R1.27 billion implies that, at the standard Eskom tariff for industrial firms of R1.50/kWh for 2022, these agro-processing industries use a combined 844 GWh. In terms of shares to total costs, processors spend around 1.4% on electricity and another 1.7% added for fuel spending to get to a combined 3.1%.

TABLE 3: ESTIMATED WESTERN CAPE AGRO-PROCESSING ENERGY USAGE: 2022

Industry	Total income R' million	Total costs R' million	Electricity		Fuel		Combined Share (%)
			Spend R' million	Share of total costs (%)	Spend R' million	Share of total costs (%)	
Meat, fish, fruit, veg, oils	28 950	25 750	300	1.16	256	1.00	2.16
Dairy	14 500	12 718	160	1.25	174	1.36	2.62
Grain and animal feeds	10 600	9 824	128	1.30	89	0.91	2.21
Other food products	29 300	24 803	345	1.39	673	2.71	4.11
Beverages (excl. beer)	22 235	17 089	334	1.95	304	1.78	3.73
Total	**105 585**	**89 826**	**1 266**	**1.41**	**1 496**	**1.67**	**3.08**
Estimated Electricity Use	844 GWh @ R1.50 per kWh						

SOURCE: COMPILED BY BFAP FROM VARIOUS SOURCES, 2023

The breakdown presented in **Table 2** and **Table 3** shows that primary agriculture and agro-processing utilise roughly the same amount of GWh, but the spending share in primary agriculture is more than double that of processors (3.4% vs 1.41%). This is partly due to the price difference of electricity, but also because agricultural production is more energy intensive per unit of output. It is also worth noting that fuel expenditure at farm level is double the expenditure at agro-processing level.

3.2. Overview of the economic impact of loadshedding

Despite the relatively low demand for electricity from agriculture, agriculture is the economic sector most affected by loadshedding. The South African Reserve Bank [SARB] (2019) evaluated the impact of loadshedding on the agriculture, forestry and fisheries sector's real output growth and found that these are negatively correlated. An increase in the intensity of loadshedding (more MW not supplied) decreased the South African agricultural sector's real GDP growth by 0.27%. In a follow-up study, SARB (2022) estimated the impact of loadshedding on real GDP (quarter-to-quarter seasonally adjusted not-annualised) growth per 1 GWh of loadshedding (**Figure 3**). The outcome of the analysis shows that under the four different measures (previous estimate, unadjusted, adjusted for weekends and public holidays, and adjusted for weekends and public holidays and outside conventional working hours), agriculture consistently is the economic sector most affected by loadshedding. When adjusted for weekends, public holidays and non-conventional working hours, one additional GWh of loadshedding was estimated to lower agriculture's quarterly growth in real GDP by -0.0134 percentage points, on average (that is ten times the percentage point impact per 1GWh electricity supply reduction on total GDP).

For the third quarter of 2022, the loadshedding intensity was measured at 1 692.5 GWh[1] when adjusting for weekends, public holidays and non-conventional working hours. This implies that loadshedding lowered agriculture's quarterly real GDP growth for 2022 Q3 by an estimated -22.7% (1 692.5GWh x -0.0134% (*Real GDP growth reduction per 1GWh loadshedding)*), compared to the 2.3% total GDP growth reduction for the same time period. It appears that this could be an overstated/exaggeration of the impact on agriculture's GDP, but it is the official figure supplied by SARB. It could also be an indication of agriculture's resilience to be able to mitigate the immediate impact, where possible, and at additional cost. Thus, if industry did not take action, this impact on agriculture could have realised unless role-players started implementing mitigation strategies.

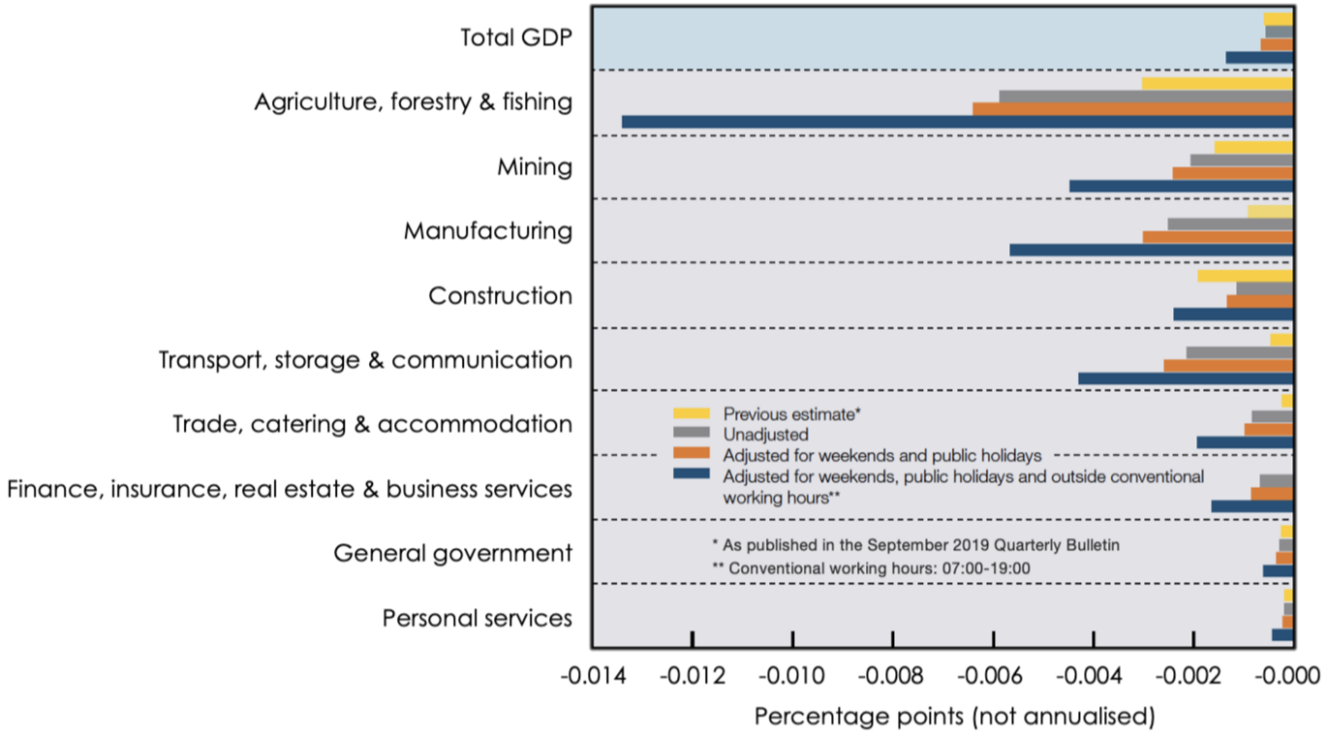


FIGURE 3: ESTIMATED IMPACT OF LOADSHEDDING ON QUARTERLY GROWTH IN REAL GDP
SOURCE: SARB, 2022

[1] GWh is a unit measure of energy used per hour and quantifies the intensity of loadshedding for a particular timeframe. Here, it captures the total Gigawatt hours of loadshedding that occurred during Q3 2022.

While the economic impact of electricity outages is undeniable, quantifying the impact requires a distinction based on the nature of the outage. The cost of unserved energy (CoUE) is an international measure used to quantify infrequent, unplanned and sudden occurrences of electricity outages that typically have a duration of less than 3 hours. For the South African agricultural sector, the CoUE per unit of energy not supplied is quantified at R67/kWh (for the period 2018-2019 in 2020 value). Loadshedding is argued to fall into a different category, defined as "electricity not delivered due to frequent, recurring, and planned outages". Consequently, the estimation of the cost of loadshedding (CoLS) "accounts for the inherent resilience and adaptive response of end-users" and considers the immediate direct and indirect damages and cost but does not account for the longer-term indirect cost (Nova Economics, 2023).

Nova Economics (2023) conducted their study to estimate CoLS at a macro level, not at an individual industry level. Thus, on a national level, the impact of loadshedding on the economy is estimated at R9.53/kWh, with agriculture bearing 10.4% (or R0.99/kWh) of the total cost. However, when considering the contribution to GDP, the normalised CoLS for agriculture is estimated at R4.01/kWh, which shows that it is the sector most adversely affected by loadshedding.

While perhaps important to distinguish between the cost associated with the different natures of outages – unplanned/sudden vs planned/recurring occurrences – the probability and magnitude of Eskom's unplanned outages (breakdowns) are increasing. **Figure 4** highlights the relative shift from 2018 to 2022 with respect to the loss factors of planned maintenance and unplanned outages (CSIR, 2023). One of the consequences of these unplanned outages are loadshedding schedule changes at (very) short notice, which severely limits end-users' ability to respond.

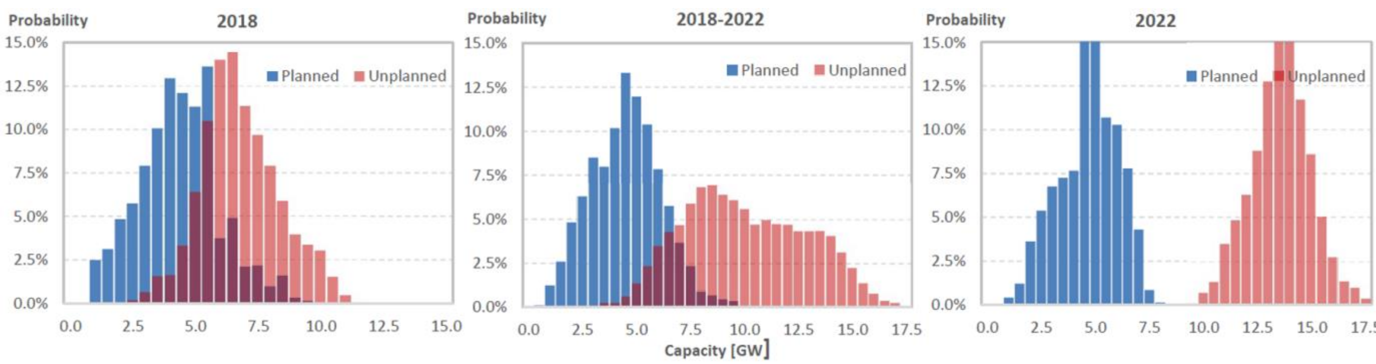


FIGURE 4: PLANNED AND UNPLANNED OUTAGES (BREAKDOWNS) TREND: 2018-2022
SOURCE: CSIR, 2023
NOTE: DATA PRESENTED IS HOURLY TEMPORAL RESOLUTION

Given the trend described above, it is not surprising that 2022 has been the most intensive loadshedding year. South Africans experienced more loadshedding in quarter 3 of 2022 than in any other preceding year. This gruelling loadshedding schedule was trumped in December 2022, where more loadshedding was experienced in a single month than in any year before 2022. **Figure 5** highlights the extent of loadshedding in 2022 compared to previous years (CSIR, 2023).

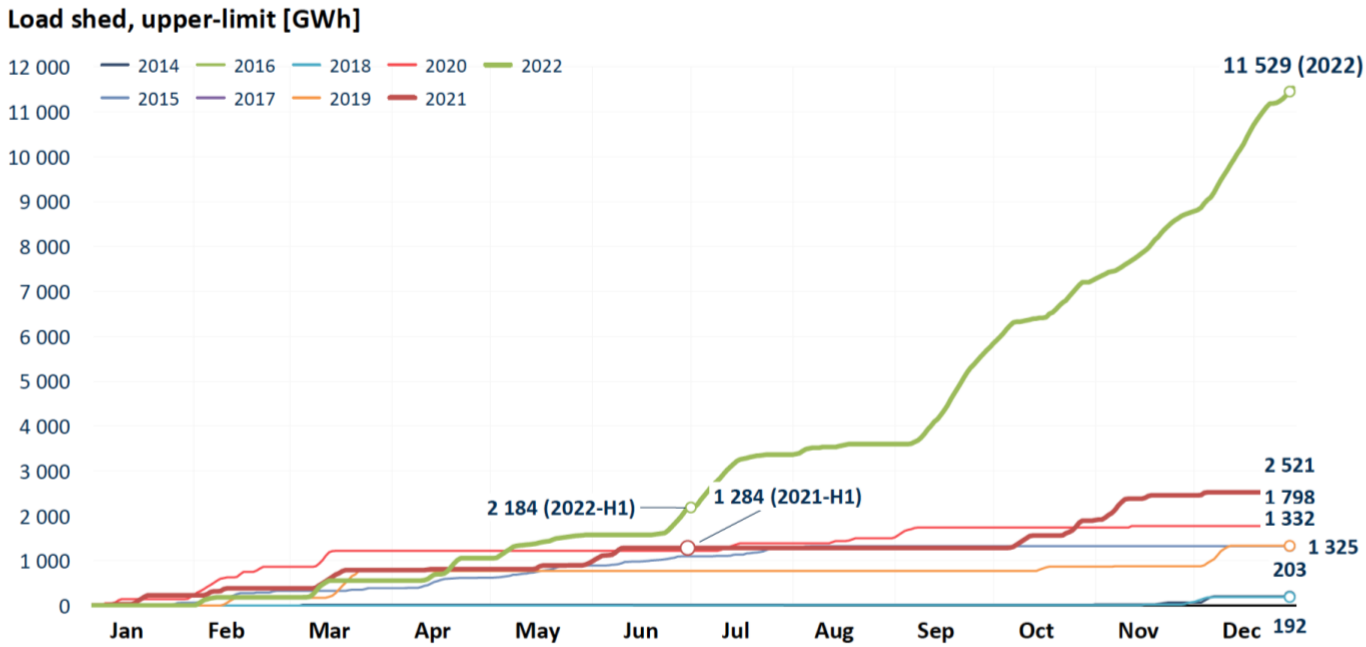


FIGURE 5: UPPER LIMIT OF CUMULATIVE LOADSHEDDING ANNUALLY: 2014-2022
SOURCE: CSIR, 2023

Figure 6 breaks down the hourly distribution of loadshedding, highlighting the contrast between the first and second half of the year as well as the extent of switches between stages. The figure also provides context on the most occurring stage (stage 4) compared to the previous norm (stage 2). Lastly, this figure is paramount to quantify the short- and medium-term impact of loadshedding on the upstream, on-farm and downstream operations of the Western Cape agricultural sector.

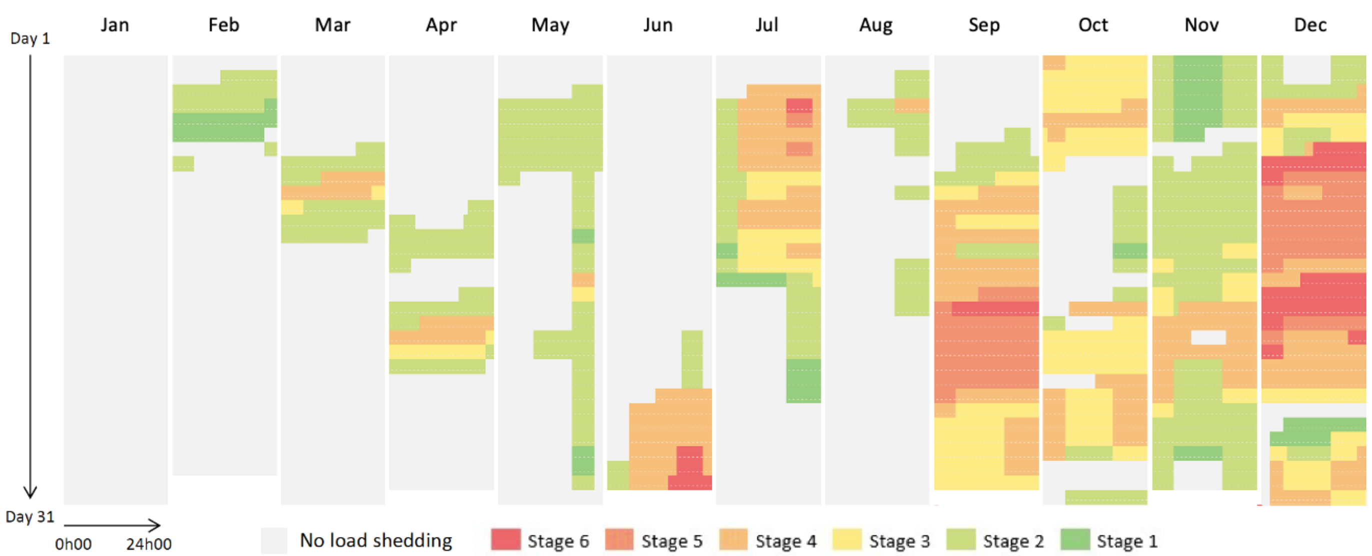


FIGURE 6: HOURLY DISTRIBUTION OF LOADSHEDDING: 2022
SOURCE: CSIR, 2023

Although loadshedding is considered planned outage, the rapid escalation in the extent thereof highlighted in **Figure 5** and **Figure 6,** left many role-players in agricultural value chains vulnerable and underprepared to mitigate its impact. The life-time cost comparison of batteries, diesel generators and solar in **Figure 7** provides a high-level overview of both the initial capital investment required for the different options, as well as a levelised cost of storage (LCOS) and procurement of electricity from a solar power provider (GreenCape, 2023a). LCOS accounts for all costs incurred, including the cost of replacement in the case of batteries, and energy produced throughout the lifetime of the device. Except for solar, which is the most expensive option from an investment cost perspective, the cost of operating on any other alternative source starts at R4/kWh, which is 2-3 times more expensive than electricity sources from Eskom.

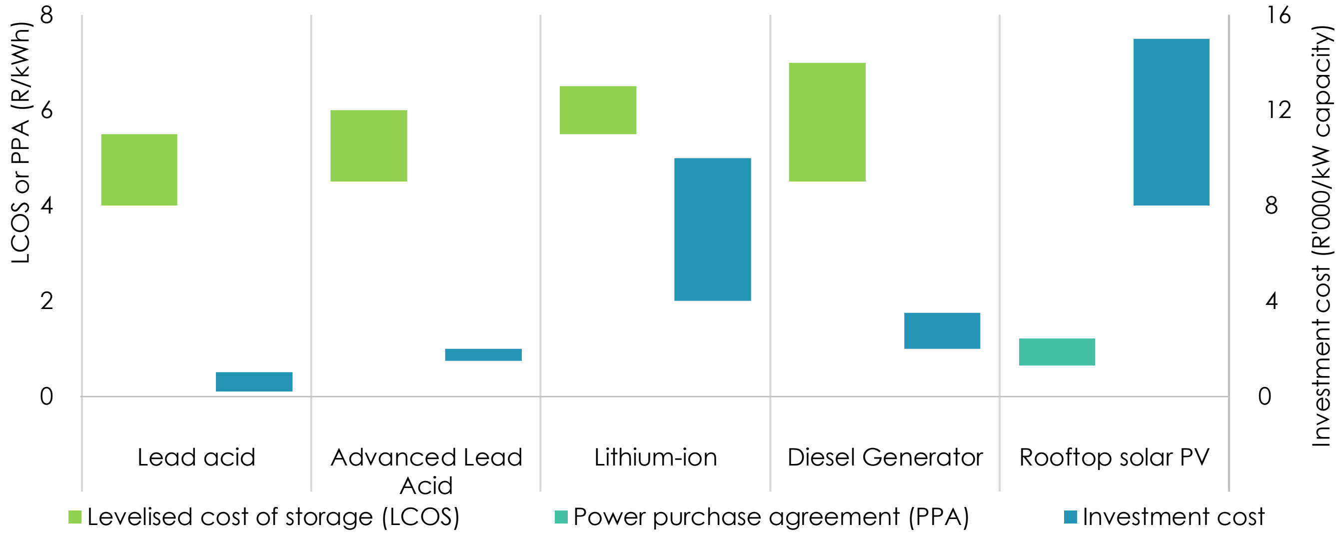


FIGURE 7: INVESTMENT COST AND LCOS COMPARISON OF BACKUP TECHNOLOGIES
SOURCE: GREENCAPE, 2023A

3.3. High-level policy overview

There are critical policy components applicable to the analysis of the impact of loadshedding on the Western Cape Agricultural sector. **Table 4** below highlights these.

TABLE 4: HIGH-LEVEL OVERVIEW OF POLICY APPLICABLE TO THE LOADSHEDDING IMPACT STUDY

Exclusion of critical infrastructure	**Tax rates and rebates**
Regulation NRS048-9, the national standard for loadshedding, regulates the implementation of loadshedding with consideration for: • the safety of people and the environment • the potential damage associated with plants of a critical nature, e.g., waterworks • constraints of a technical nature in the execution of loadshedding (Department of Economic Development and Tourism [DEDAT], 2019) Critical infrastructure, and properties sharing dedicated electricity supply lines with such infrastructure, is therefore excluded. This includes, but is not limited to hospitals, ports, railways, water treatment plants, food production and storage facilities (where technically feasible), critical electronic communication and broadcasting infrastructure, and other essential infrastructure. If loadshedding were to be implemented at the Cape Town port terminal, Transnet requires two-weeks' notice, after which negotiations between Eskom and the port authorities will start to determine the extent of loadshedding the port will experience.	To uphold the commitment made at the 2021 United Nations Climate Change Conference (COP26), South Africa's carbon tax rate will increase annually to reach R450/tonne by 2030. The current effective rate is R159/tonne (GreenCape, 2023a). According to the most recent budget speech (National Treasury, 2023), a rebate of 25%, up to a maximum of R15 000, can be claimed for rooftop solar panels installations from 1 March 2023. Businesses can also take advantage, using the Section 12B capital allowance, to depreciate 100% of the initial cost in year 1, effectively increasing the tax rebate to 12%. According to PwC (2023), businesses will be able to claim a deduction of 125% in the first year on all new renewable energy projects. This allowance is valid until February 2025 on wind, solar, hydropower and biomass, but excludes batteries and inverters. Manufacturers of foodstuffs can claim a refund on the Road Accident Fund levy for diesel to reduce the impact of loadshedding on food prices. This applies to the fuel used to run infrastructure used in the manufacturing process, e.g., generators (National Treasury, 2023).

Curtailment	**Energy supply regulation**
Curtailment – the action of power usage reduction – can either be voluntary or required on a specific energy supply zone. The goal of curtailment is to reduce dependency on electricity supply to avoid or reduce loadshedding. Large customers with the own electricity supply from a main station can implement curtailment to avoid loadshedding. Where more than one customer is supplied from a main station, curtailment relies on collaboration by the customers in the zone. Curtailment arrangements – the extent of power usage reduction – is specified by zone and level of loadshedding (DEDAT, 2019). In February 2023, around 20 farms on the Broodkraal feeder line in the Berg River Valley avoided loadshedding by reducing their electricity usage when requested by Eskom to do so (Scholtz, 2023).	Continuous approval of energy trading licences by the National Energy Regulator of South Africa (NERSA) allows developers to contractually supply energy to the energy trader via power purchase agreements (PPA). A diversified customer pool is provided by the trader, together with flexible and affordable energy contracts for the South African market. The action reduces developers' overall off-take risk (GreenCape, 2023a). Proposed amendments to Schedule 2 of the Electricity Regulation Act, 2006 (ERA) were published by the Minister of Mineral Resources and Energy for public comment. The proposed changes include: • Removal of the current 100 MW threshold • Clarification on the activities that can occur without requiring a generation license, but would still require registration with NERSA (GreenCape, 2023a).

3.4. Overview of agricultural surveys

Three voluntary, online surveys by industry bodies were executed over the last 18 months to extract essential details with respect to the impact of loadshedding on operations in the agricultural sector. While some were completed at a national level, the application and relevance within the context of the Western Cape agricultural sector holds.

A total of 360 respondents participated in the Agri Western Cape survey in November 2021. A large proportion of the respondents are involved in primary agriculture (92%), with 49% of respondent only involved in primary agriculture, compared to the 43% of respondents that are vertically integrated primary producers, and 8% are value chain role players outside of primary production. Most respondents (93%) are fully dependant on Eskom, either directly or via their municipality, and do not have any permanent alternative sources, with less than 1% completely independent from Eskom. Of the complement (6%), half is still 70% or more dependent on Eskom, with the other relying on Eskom for less than 70% of their total energy needs. Given the limited alternative energy sources recorded and the vast majority of respondents involved in primary production, it is not surprising that the biggest demand of energy occurs during daytime (06:00-17:00). Of the 360 respondents, 196 require electricity supply for 12 hours or less a day, whereas 106 require supply for more than 18 hours a day. The complement (58 of the 360) typically require supply between 12 and 18 hours a day. Although not explicitly stated, a logical explanation for the timing of electricity demand is related to the typical work hours – single shift on farms, double shifts in packhouses and processing facilities, with cold storage facilities requiring continuous (24/7) supply (Agri Wes-Kaap [AWK], 2021).

In a voluntary national survey by AgBiz, 489 operators in agricultural value chains provided input into the impact of loadshedding on their businesses (**Table 5**). The table indicates the spread by node and size of participants. From the survey results, it was found that the biggest impact of loadshedding include losses incurred in terms of irrigation water and time, operational hours and cooling abilities, product quality and/or volume are the biggest risks. In addition, greater operational and capital expenditure, together with equipment damage are affecting businesses in the agricultural value chains. Additional operational expenditure ranges from R2 000 per month to R10 million per month, with reported indirect cost of up to R20 million per month, whilst capital expenditure of up to R220 million to mitigate loadshedding was recorded. The bulk (90%+) of participants indicated that they cannot or can only partially pass this additional cost on into the value chain. Given the cost that has to be absorbed in the chain together with the losses incurred, 70% of the respondents indicated that they expected shortages of agricultural products and food to occur. To mitigate the impact of loadshedding and invest in alternative energy sources, the majority of respondents indicated that financial assistance such as a subsidised loan (57%) would persuade them to invest in self-sufficient electricity supply solutions, followed by the ability to sell excess electricity freely (16%) and the removal of barriers to grid access (8%). One tenth of respondents indicated the nature of their energy consumption is such that no alternative sources can feasibly meet the demand.

TABLE 5: OVERVIEW OF PARTICIPANTS BY VALUE CHAIN NODE AND OPERATIONAL SIZE

	Small (<R10m turnover per annum)	Medium (R10m-R50m turnover per annum)	Large (>R50m turnover per annum)	Total	%
Upstream	28	13	36	**77**	16%
Production	143	132	82	**357**	73%
Downstream	13	13	29	**55**	11%
Total	**184**	**158**	**147**	**489**	100%
%	38%	32%	30%	100%	

SOURCE: AGBIZ, 2023

Fruit SA surveyed more than 200 role-players in the fruit industry across the country. In the survey, 95% of the participants are more than 50% dependent on Eskom, with only 7% of those participants indicating a reliance of 50-80%. While these results do indicate that there has been investment in alternative energy infrastructure to supplement operational energy demand, the vast majority of participants are dependent on Eskom electricity supply to run operations. Considering the energy demand to run operations optimally, 52% of participants indicated that their operations require uninterrupted 24-hour energy supply. It is believed that these participants are most likely running technologically advanced irrigation/fertigation systems at farm level and/or packhouses and cold storage facilities. Other participants typically require between 8 and 12 hours of electricity per day to run their operations optimally. It appears that there is a strong correlation between participants with back-up power in case of loadshedding and the participants with high reliance on electricity supply, as 56% of participants indicated that they have back-ups, with the bulk thereof being diesel generators (73%), followed by solar (15%) and other solutions (12%). **Table 6** highlights the average irrigation hours per commodity, on average, for the participants of the survey, as well as the average operating hours per day, in agro-processing.

TABLE 6: OVERVIEW OF PRIMARY AND SECONDARY ENERGY DEPENDENCY

Western Cape survey data	Primary				Secondary	
	Off-peak season		Peak season		In-season	
	Responses	Avg. irrigation hours/day	Responses	Avg. irrigation hours/day	Responses	Avg. usage hours/day
Berries	23	12.6	22	13.5	16	18.3
Table grapes	71	16.7	71	17.7	68	13.8
Citrus	21	16.1	22	13.8	15	16.4
Avocados	6	11.5	5	15.7	4	13.0

SOURCE: FRUITSA, 2023

4. ENERGY DEPENDENCY OVERVIEW

At a provincial level, the width and depth of the agricultural sector in the Western Cape is likely unmatched elsewhere in the country. Primary production operations span approximately 13 million hectares, of which 2 million hectares are cultivated and 320 000 hectares are under irrigation (WC DoA, 2022). Multiple livestock, field crops and horticulture commodities are produced in the Western Cape, complemented by an expansive agro-processing and value adding industry. Consequently, the energy demand and dependency in the province could differ considerably between regions, commodities, facilities and the risk associated with the demand and dependency. In order to provide an overview of the energy dependency of the Western Cape agricultural sector by subsector / industry, consideration will be given to the type of energy being used and the suppliers of energy (Eskom direct, municipality or own generation), and the spatial and temporal distribution (within a day and between seasons) of energy use.

4.1. Overview of energy sources and electricity use

Energy is a key input in the production, storage, and processing of agricultural products. While some processes are typically driven by energy sources that are not electricity, e.g., coal, the bulk of processes are primarily dependent on electricity supply. **Table 7** provides a high-level overview of the conventional and alternative energy sources by industry. The semi-structured interviews conducted with key stakeholders confirmed dependency on Eskom as the primary source, as has been identified in the AWK survey, although investment in alternatives have increased to reduce the impact. In an industry such as intensive livestock production, e.g. broilers, installation of alternative energy supply is part and parcel in the development, as the consequences of supply interruption is too great a risk to bear. Thus, while the industry may be better prepared to deal with loadshedding as it is prepared for unplanned and sudden occurrences of electricity outages, the installed infrastructure was not meant to deal with the extensive (more than 11 529 hours) loadshedding in 2022. It also implies that for the periods where producers rely on prolonged use of backup power, they are at risk of power failure if that backup fails, with no alternative. For instance, if a backup generator fails while running during a prolonged outage, broiler producers that rely on controlled environment housing can suffer significant damages. At higher levels of loadshedding, this risk is greater. The electricity demand for major actions in different industries at various nodes in the value chain are shown in **Table 8**.

TABLE 7: PREDOMINANT ENERGY SOURCES BY INDUSTRY

Industry	Conventional			Alternative		
Livestock	**Heating**	**Cooling**	**Processing/ value-add**	**Heating**	**Cooling**	**Processing/ value-add**
	Coal	Electricity	Electricity	n/a	Diesel generator/ Solar PV(& BESS)	Diesel generator
Horticulture	**Irrigation**	**Cooling**	**Processing/ value-add**	**Irrigation**	**Cooling**	**Processing/ value-add**
	Electricity	Electricity	Electricity	Diesel generator/ Solar PV (& BESS)	Diesel generator/ Solar PV (& BESS)	Diesel generator/ Solar PV (& BESS)
Field crops	**Irrigation**	**Dryland**	**Processing/ value-add**	**Irrigation**	**Dryland**	**Processing/ value-add**
	Electricity	n/a	Electricity	Diesel generator/ Solar PV (& BESS)	n/a	Diesel generator

SOURCE: COMPILED BY BFAP FROM VARIOUS SOURCES, 2023

Table 8: Electricity demand estimates by major industry, node and action

Industry	Node	Action	Unit of measure	kWh per unit
Livestock	**Primary**	Broiler	Per tonne	150-300
		Piggery	Per tonne	100-200
		Feedlot	Per tonne	30-50
		Dairy	Per 1 000 litres	30-50
	Agro-processing / value-adding	Meat processing	Per tonne processed	200-400
		Dairy processing	Per 1 000 litres	250-300
Horticulture	**Inputs**	Packaging material	Per packed tonne	15-20
	Primary	Irrigation	Per hectare	2 400-5 000
	Agro-processing / value-adding	Packhouse	Per packed tonne	30-40
		Juicing	Tonne	100-200
		Canning	Tonne	100-200
		Cellar	Tonne	90-110
	Distribution & marketing	Cooling	Tonne	80-180
Field crops	**Primary**	Irrigation	Per hectare	1 800-6 000
	Agro-processing / value-adding	Crushing	Per tonne	40-60
		Milling	Per tonne	90-110

Source: Compiled by BFAP from various sources, 2023

While it is assumed that the vast majority of commercial primary production would occur in rural areas, there is a small component (3%) of livestock production (e.g., feedlots, piggeries, dairies, chicken batteries) that is typically situated within town boundaries. An overlay of built-up/town areas[2] with the infrastructure recorded in the 2017 fly-over also provided the necessary base to develop **Table 9**. The table provides a breakdown of the number of facilities by type and location, concluding that 15% of commercial agro-processing and value-adding facilities are located in urban areas. These indicators provided the upper limits with respect to the supplier of electricity to agro-processing facilities, with 85% facilities likely to depend on Eskom directly.

Table 9: Location of commercial agro-processing and value-adding facilities: 2017

Facilities	# Urban facilities	# Rural facilities	Total	Urban share	Rural share
Horticulture					
Fruit drying	1	3	4	25%	75%
Citrus processing	1	1	2	50%	50%
Canned fruit	1	0	1	100%	0%
Berry processing	0	3	3	0%	100%
Berry	0	1	1	0%	100%
Other	140	161	301	47%	53%
Bottling and juice	0	1	1	0%	100%
Fruit packers and cold chain	24	129	153	16%	84%
Cool chain facilities	36	28	64	56%	44%
Wine cellar	73	504	577	13%	87%
Olive and wine cellar	2	32	34	6%	94%
Distillery	6	8	14	43%	57%
Agri packhouse	20	962	982	2%	98%
Fruit packers	14	74	88	16%	84%
Olive cellar	3	49	52	6%	94%
Nursery	33	191	224	15%	85%
Horticulture sub-total	**354**	**2147**	**2501**	**14%**	**86%**

[2] These are approximate and quite outdated town boundaries, therefore leading to a likely underestimation of proportion of infrastructure situated within town or municipal boundaries today (2023).

Field crops					
Millers	22	22	44	50%	50%
Grain storage	41	310	351	12%	88%
Brewery	34	29	63	54%	46%
Tea processing	1	74	75	1%	99%
Field crop sub-total	**98**	**435**	**533**	**18%**	**82%**
Livestock					
Meat processing	32	59	91	35%	65%
Livestock sub-total	**32**	**59**	**91**	**35%**	**65%**
Total	**484**	**2641**	**3125**	**15%**	**85%**

SOURCE: WC DOA, 2018

4.2. Spatial and temporal distribution of electricity use

While the total electricity demand of the value chains for livestock, horticulture and field crop industries in the Western Cape are estimated in **Table 2** and **Table 3** there is also a spatial distribution of electricity use that is linked to the density of production. In **Figure 8**, the four maps provide a spatial overview of the density of intensive livestock production, the density of drip and micro irrigation (a proxy for horticultural production), and summer and winter pivot irrigation (a proxy for irrigated field crops and pastures).

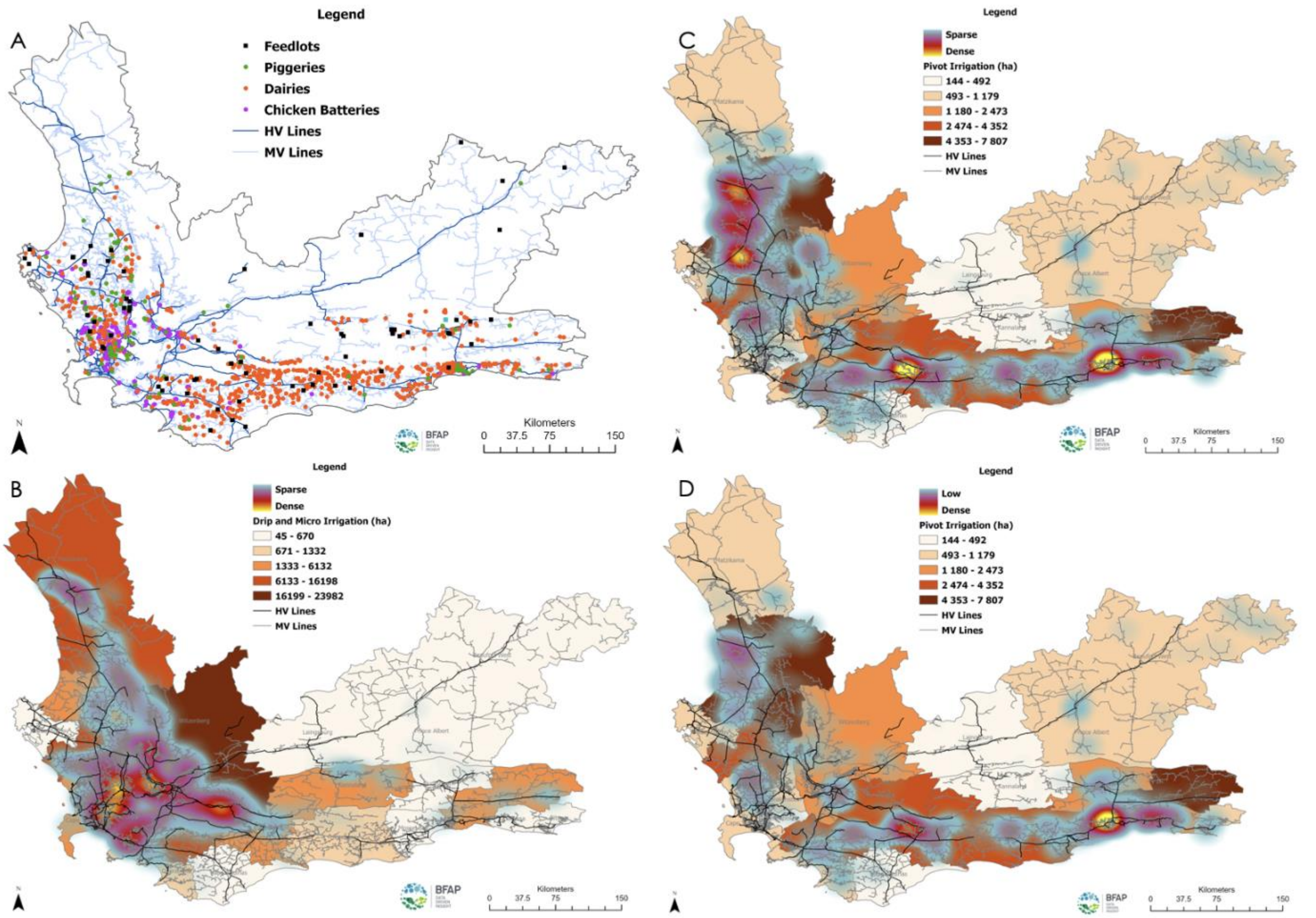


FIGURE 8: PRIMARY AGRICULTURE: (A) LIVESTOCK, (B) HORTICULTURE, (C) WINTER & (D) SUMMER CROPS
SOURCE: COMPILED BY BFAP FROM WC DOA, 2018, AND ESKOM. 2022

The most prominent intensive livestock operations in the Western Cape are dairies, chicken batteries, piggeries and feedlots. While dairies are spread across the Overberg, Southern Cape and

West Coast regions, chicken batteries are predominantly found in the rural areas in close proximity to the more densely populated southwestern parts of the province. Piggery locations follow a similar pattern to chicken batteries but does branch out further north in the province. Feedlots, although in number the smallest of the intensive livestock production group, appear to be rather scattered across the province. These operations function continuously, with a fairly even electricity demand distribution throughout the year. Higher demand for meat products during November and December results in an uptick over this period.

Considering both the density of irrigation area by municipality and the unitary electricity demand from **Table 8**, together with the seasonality of irrigation which is affected by rainfall, a temporal distribution of electricity demand for irrigation purposes per municipality can be created (**Table 10**). The table, sorted according to the total annual electricity demand in GWh for irrigation purposes indicates that the Witzenberg municipality has the highest demand at 91 GWh per annum.

TABLE 10: TEMPORAL DISTRIBUTION OF ELECTRICITY DEMAND FOR IRRIGATION PURPOSES IN GWH: 2017

Municipality	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Witzenberg	18.36	13.98	10.99	3.78	1.07	0.57	0.80	1.19	3.36	7.59	12.59	16.45	91
Langeberg	16.22	12.15	9.06	4.27	1.89	1.14	1.38	1.83	4.02	7.74	12.41	15.29	87
Breede Valley	15.87	13.97	10.68	4.09	1.47	0.82	1.00	1.33	3.10	6.83	11.82	15.06	86
Oudtshoorn	13.10	10.13	8.56	5.07	3.58	2.75	3.00	3.66	5.29	7.79	10.23	12.74	86
Theewaterskloof	14.39	11.29	9.21	3.20	1.06	0.72	1.05	1.47	3.42	6.63	10.12	13.13	76
Cederberg	10.75	8.68	8.39	4.92	2.81	2.06	2.21	2.77	5.09	7.07	8.86	10.57	74
George	9.92	7.50	6.24	3.34	2.15	1.65	1.86	2.32	3.62	5.72	7.80	9.68	62
Drakenstein	10.82	9.19	6.76	2.83	1.00	0.52	0.70	0.96	2.35	4.81	8.16	10.16	58
Kannaland	8.89	6.83	5.60	3.14	2.07	1.55	1.71	2.10	3.17	4.89	6.70	8.46	55
Hessequa	7.62	5.83	4.90	2.87	1.98	1.52	1.68	2.06	3.06	4.60	6.07	7.52	50
Swartland	8.16	6.79	4.94	2.19	0.89	0.70	1.13	1.49	2.99	4.63	6.67	8.03	49
Swellendam	7.05	5.28	4.46	2.45	1.53	1.19	1.43	1.82	3.00	4.36	5.58	6.89	45
Berg River	6.37	5.34	4.60	2.32	1.32	1.16	1.44	1.77	2.96	4.10	5.17	6.34	43
Stellenbosch	7.55	6.16	4.23	1.96	0.77	0.39	0.53	0.71	1.69	3.43	5.97	7.11	40
Matzikama	6.49	5.48	3.98	1.80	0.81	0.50	0.61	0.77	1.56	3.09	5.20	6.28	37
Mossel Bay	5.44	4.19	3.50	2.06	1.43	1.11	1.24	1.53	2.24	3.27	4.27	5.32	36
Beaufort West	3.70	2.88	2.43	1.44	1.02	0.78	0.85	1.04	1.49	2.18	2.87	3.58	24
City of Cape Town	3.65	3.00	2.14	0.99	0.42	0.24	0.31	0.40	0.88	1.75	2.92	3.51	20
Prince Albert	2.22	1.75	1.45	0.82	0.54	0.40	0.44	0.54	0.81	1.24	1.68	2.12	14
Knysna	2.04	1.55	1.31	0.79	0.56	0.43	0.47	0.58	0.84	1.26	1.65	2.03	14
Overstrand	1.39	1.11	0.86	0.43	0.23	0.16	0.18	0.23	0.41	0.73	1.10	1.34	8
Laingsburg	1.02	0.77	0.63	0.33	0.20	0.15	0.16	0.20	0.33	0.54	0.76	0.96	6
Bitou	0.67	0.52	0.43	0.25	0.18	0.13	0.15	0.18	0.26	0.39	0.51	0.64	4
Cape Agulhas	0.45	0.33	0.25	0.13	0.07	0.06	0.08	0.10	0.18	0.31	0.43	0.50	3
Saldanha Bay	0.18	0.13	0.10	0.06	0.04	0.06	0.12	0.16	0.27	0.25	0.17	0.20	2
Total	**182**	**145**	**116**	**56**	**29**	**21**	**25**	**31**	**56**	**95**	**140**	**174**	**1 069**

SOURCE: COMPILED BY BFAP FROM VARIOUS SOURCES, 2023

Total irrigation electricity demand is calculated to be slightly more than 1 TWh per annum, using the 2017 fly-over data as a basis. **Table 10** also highlights the impact of winter rainfall and growing seasons on electricity demand, with demand peaking in the hottest and most important growing months – October to March. 80% of the total electricity demand occurs within these six months, with only 20% demanded over the winter period of April to September. Considering the substantial loadshedding during the second half of 2022 (**Figure 5** and **Figure 6**), both short- and longer-term negative impacts on production could be expected.

Table 10 covers the aggregate of horticultural production, winter and summer crop production under irrigation – both spatially and temporally. In addition to electricity demand for irrigation purposes, electricity is also critical input into other nodes and value chains. Intensive livestock operations function on fairly even levels throughout the year, resulting in the consequent demand of electricity downstream to also be fairly consistent, with the exception of the uptick over the latter part of the year. In terms of field crops and horticulture, the demand of off-farm services typically increases for a period of around six months of the year, during and post-harvest, after which facilities run at much lower electricity demand levels as most energy-intensive processes are completed for the season.

BOX 1: DEPENDENCY ON ESKOM FOR EXTRACTION OF SCHEME WATER – BERG RIVER CASE STUDY

Water is the most critical natural resource in the agricultural sector, not only for irrigation purposes but also for animal husbandry and human consumption. The Berg river region is home to more than 650 000 hectares of cultivated agricultural land, of which around 80 000 are irrigated fields (WC DoA, 2018). To maintain crop yields, quality of produce, ensure sustainable farming and support animal and human consumption, good quality and consistent quantities of water is of utmost importance.

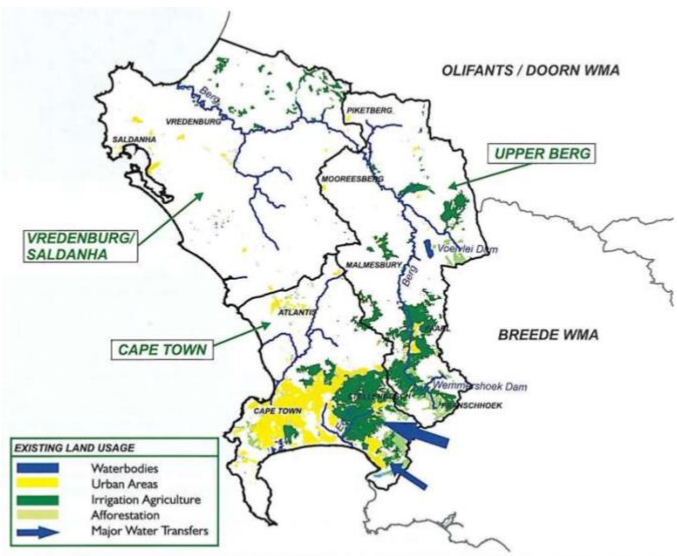


FIGURE 9: BERG RIVER WATER MANAGEMENT AREA
SOURCE: DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND DEVELOPMENT PLANNING [DEADP], 2011

Irrigated crops differ in the amount of water necessary for optimal growth and production. Within the Western Cape, the irrigation requirement is generally lower during the winter months due to lower transpiration rates and higher rainfall. However, in the summer months timely irrigation is essential to limit stress on crops, increasing the dependency on electricity in the supply of water within the Berg River Water Management Area. Sensitive crops like berries and vegetables would be impacted severely even with only little restrictions in water supply, while table grapes, fruit orchards and wine grapes could be impacted to a lesser extent, although the consequences could still be detrimental to production. Animal husbandry would also be affected since water is necessary all year round.

Within water schemes, producers are entitled to a given amount of water per annum, whereafter various limitations are set per day, week and/or month. Any external influence that inhibits users to pump the necessary daily usage, or to fill buffer dams with surplus water, results in user allocated water being lost to sea. Therefore, not being able to pump water directly from the Berg river or sub-station, due to loadshedding, will not only result in less available water for on-farm usage but also wastage of water.

Water released from the Berg River dam takes approximately four days to reach the last water-user within the scheme (whereas water released for the Zonderend Water Use Association takes ±20 days to reach the last producer). Constantly changing between stages of loadshedding causes a ripple effect and makes planning within the scheme extremely difficult. To quantify, approximately 33 million m^3 of water on average per season are released into the Atlantic Ocean in normal years (little to no loadshedding), while around 48 million m^3 of water has flowed through the estuary in the 2022/23 season due to the indirect influence of loadshedding, difficulty of planning and mismanagement. Compared to the previous summer season (1 November – 20 April), 6% less water was released from the dam in 2022/23 while water extraction from the scheme decreased by 18%. Water released for agricultural use but not extracted increases risks at farm level and is likely to result in a decrease in the economic output of the area.

BFAP DATA DRIVEN INSIGHT

One example of a direct impact of loadshedding can be seen in the Perdeberg area. This region consists mainly of vineyards and is dependent on a single large pump to extract water directly from the Berg river for irrigation purposes and human and animal consumption. Large pumps like this need approximately three hours to reach full capacity to feed the line from which individual producers extract water to their production units. Consequently, the impact on producers is already extreme during loadshedding stage 5 – not only because of the "off" hours, but because the "on" hours are in some instances limited to four consecutive hours, which effectively reduce extraction at capacity to 1 hour in 10 hours. In such a case, the pumping of water during loadshedding becomes unviable. The scheduled water available, released from the dam in the river for extraction by users in the Perdeberg area, is lost to sea and is putting production and the economic viability of farms at risk.

SOURCE: BERG RIVER MAIN IRRIGATION BOARD, 2023

5. IMPACT OF LOADSHEDDING

A systematic approach was used to address the problem of quantifying loadshedding impacts at various stages. Firstly, the relationship(s) between causes and effects in the Western Cape agricultural sector are analysed and described. Thereafter, impact is evaluated based on operations, volume and price, and ultimately profitability. These analyses provide the necessary platform to unpack loadshedding's socio-economic impact and impact on government objectives.

5.1. Causality argument

One of the golden threads throughout the study has been the interconnectedness of value chains – not only within a single commodity, but across commodities. The second thread widely observed is that loadshedding sets off a series of events, many of them having a knock-on effect on other matters. To analyse the relationship(s) between causes and effects in the Western Cape agricultural sector, Interactive Qualitative Analysis (IQA), developed by Northcutt and McCoy (2004), is employed to establish causality and identify potential feedback loops. A feedback loop is present if there is a recirculation of an influence pattern within a group of three or more system elements. The effect of the feedback is strengthened and accelerated by means of its recirculation through the various elements in the system. IQA is a research design that establishes an in-depth understanding of phenomenon by axial coding of data in a systematic process. By grouping core phrases together and assigning an appropriate name to each collection, it is possible to move away from an assortment of core phrases to a unit of meaning. The differences with respect to the extent of meaning between grouped and named phrases are first determined and then graphically depicted to show all possible relationships. The outcome of the application of this research design is a systems influence diagram (SID), which links construct relationships and clearly illustrates associations between the major influences (Northcutt & McCoy, 2004).

The data collected during the semi-structured interviews were coded, grouped and analysed to construct the causality arguments. Eight themes emerged when the coded data was grouped, which became the system elements, as outlined in **Table 11**. Determining all the "out" and "in" relationships for each element enables determining which elements are the driving forces behind most change within the system, and which elements mostly become the subject of change in the system. The inter-relationship diagram shows that the impact of loadshedding is setting of a chain of events starting with 'Operational capacity & scheduling' (biggest delta, thus ranked first). The second biggest driver is 'Input supply & availability', referring to typical inputs, as described in **Figure 2**. The biggest outcomes – elements subjected to change in the system, are the ones with the biggest negative delta, namely socio-economics and product selling prices.

TABLE 11: TABULAR INTER-RELATIONSHIP DIAGRAM

		1	2	3	4	5	6	7	8	Out	In	Δ	Rank
1	Opex & Capex	///	^	*	<	^	<	*	*	2	2	0	4
2	Financial implications (cash flow & profitability)	<	///	<	^	<	<	^	^	3	4	-1	5
3	Output quality & volume	*	^	///	<	^	<	*	^	3	2	1	3
4	Input supply & availability	^	<	^	///	*	^	^	*	4	1	3	2
5	Product selling price	<	^	<	*	///	<	*	<	1	4	-3	8
6	Operational capacity & scheduling	^	^	^	<	^	///	^	^	6	1	5	1
7	Biological, current & fixed assets	*	<	*	<	*	<	///	^	1	3	-2	6
8	Socio-economics	*	<	<	*	^	<	<	///	1	4	-3	7
										21	**21**	**0**	
/// Same element in column & row * No direct relationship exists		< Relationship exists where column element influences row element ^ Relationship exists where row element influences column element											

SOURCE: COMPILED BY BFAP, 2023

The saturated SID indicates all directions of influence between the respective elements and is therefore extremely complete and rich in data, but also difficult to understand and interpret. **Figure 10** graphically depicts the data from **Table 11,** clearly showing that there are definite drivers and outcomes in the system due to loadshedding. The relationships on the left side of the figure have more outgoing arrows than inwards, while the opposite holds true to those elements on the right side.

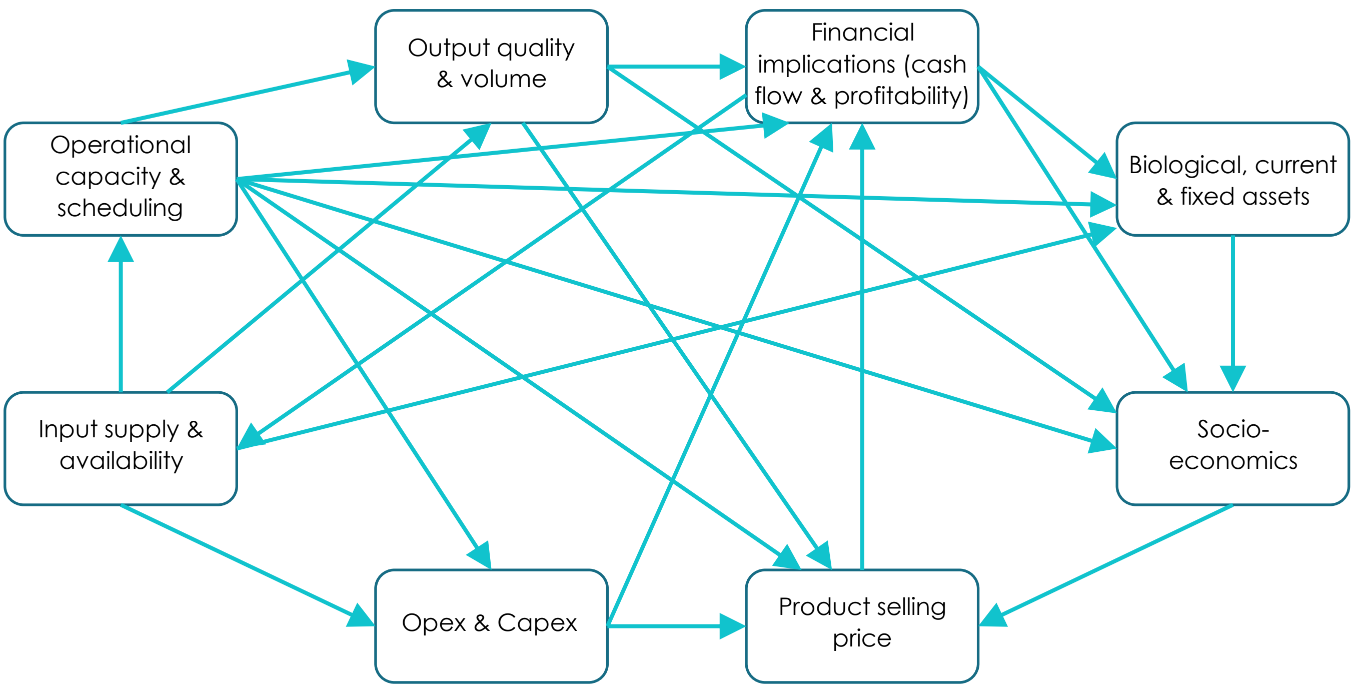


FIGURE 10: CLUTTERED SYSTEMS INFLUENCE DIAGRAM
SOURCE: COMPILED BY BFAP, 2023

Although the saturated SID shows the total range of influences, a simple, more elegant SID should make the core of the system more understandable. **Figure 11** is a cleaned version of **Figure 10**, where the directions of influence that unnecessarily complicate the diagram have been removed so that it can be interpreted more easily. It is the simplest form in which the system can be explained and depicted. The method followed to remove the unnecessary links is as follows: starting from the largest to the smallest delta, as per **Table 11**, all the direct links between relationships are removed, unless there is no indirect route (via another relationship) by which the influence can be transferred.

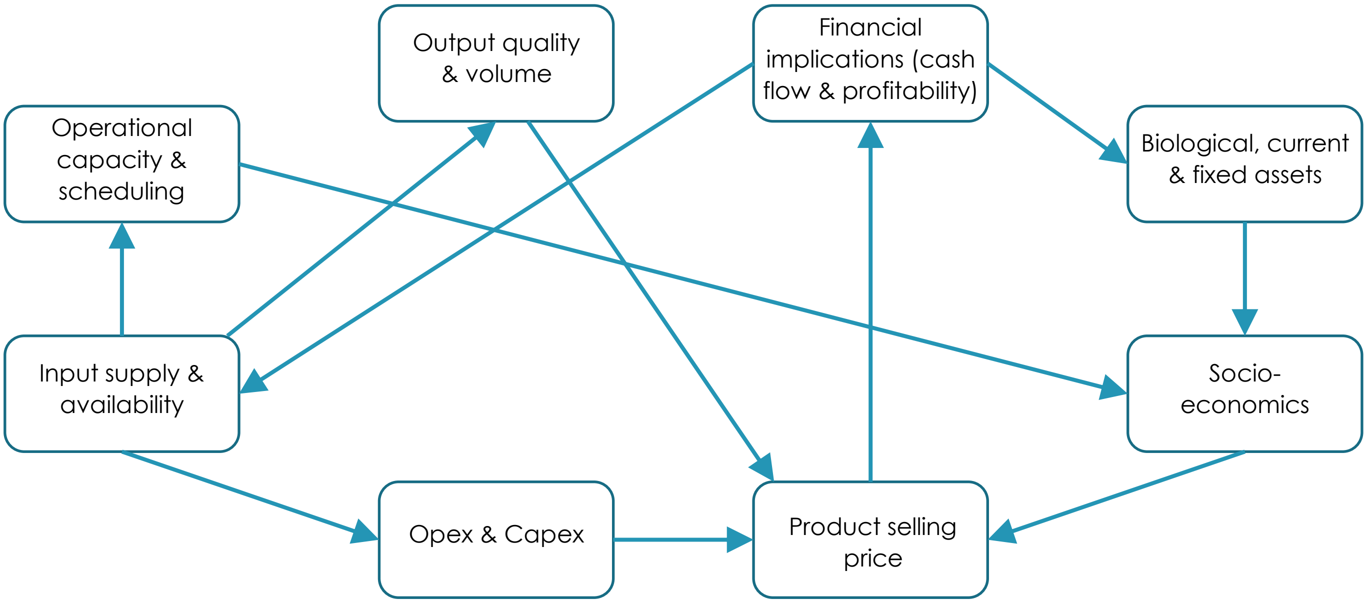


FIGURE 11: UNCLUTTERED SYSTEMS INFLUENCE DIAGRAM
SOURCE: COMPILED BY BFAP, 2023

From this uncluttered SID the chain of events caused by loadshedding on the agricultural sector of the Western Cape, the causes and effects, starts to become clearer. This figure also already indicates that there appears to be feedback loops in this system. The final SID, **Figure 12,** contains the exact same details as **Figure 11**, but it is presented in a more elegant manner to provide a clear view as to the causes and effects. This figure also highlights that four feedback loops exist in the system, as indicated by the arrows. Not only does this strengthen the argument of complexity and interconnectedness in the agricultural value chains, but it also exposes the risk continued loadshedding poses to the sector.

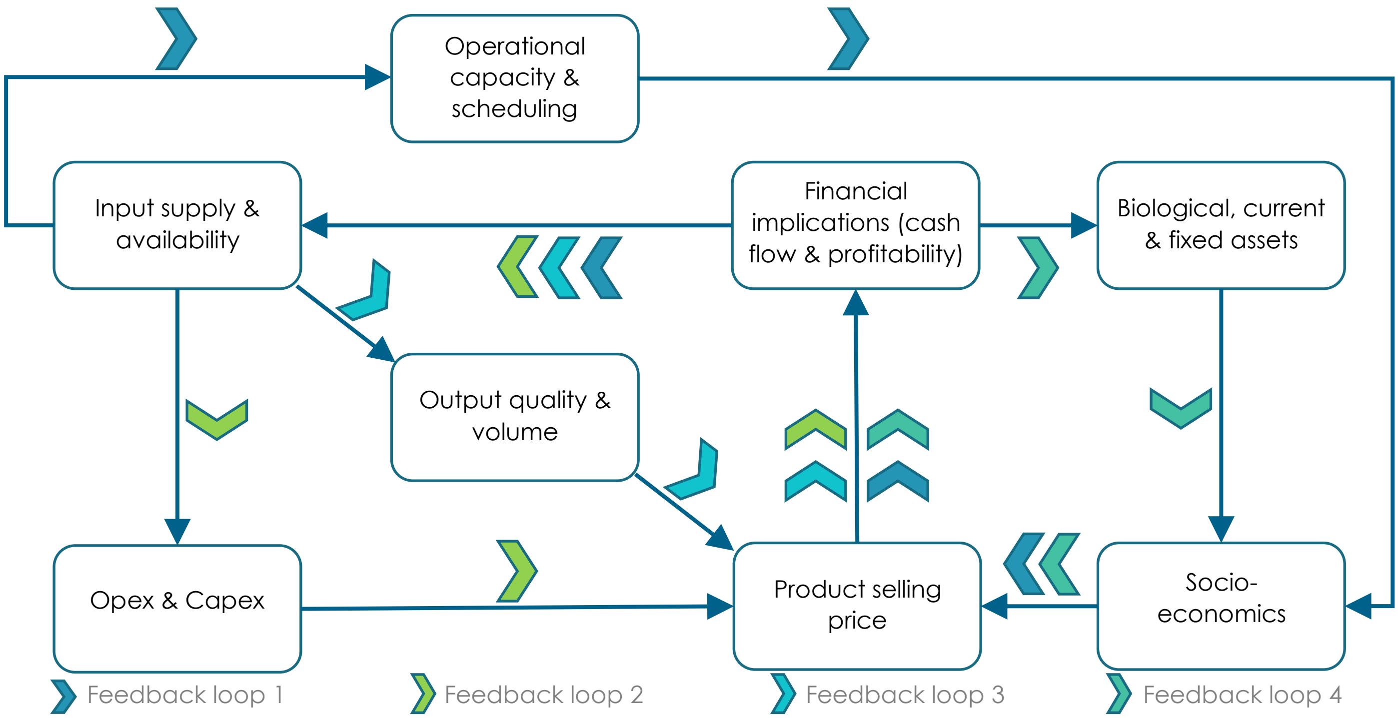


FIGURE 12: FINAL SYSTEMS INFLUENCE DIAGRAM
SOURCE: COMPILED BY BFAP, 2023

While each inter-relationships in **Table 11** can be explained as it has been described in the interviews, the emphasis of the discussion of the causal relationships falls on uncluttered SID, which explains the critical path of influence in the system. In total, 11 causal relationships form part of this critical path. A brief description of each element and each of these inter-relationships are provided in **Table 12**.

TABLE 12: DESCRIPTION OF ELEMENTS AND RELATIONSHIPS

"Cause" element	**Description of element**	**"Effect" element**	**Description of relationship (impact of "cause" on "effect")**
Operational capacity & scheduling	Level at which operations can continue under different stages of loadshedding and the extent of scheduling issues role-players have to deal with	Socio-economics	Changes in labour demand, shift schedules and work hours; changes in supply to consumers due to constraints
Socio-economics	Socio-economic impacts, including impacts on agri workers and on consumers	Product selling price	Consumer push-back (reduction in demand) on the cost passed on in the value chain
Product selling price	The price at which role-players in the value chain sell the outputs	Financial implications	Changes in product prices affecting cash flow and profit
Financial implications	Profitability of operations and the extent of cash flow interruptions and/or changes	Biological, current & fixed assets	Selling of assets/delayed replacement of assets due to financial constraints
Biological, current & fixed assets	The different assets of role-players that forms part of their operations	Socio-economics	Reduced asset structure requires smaller workforce, negatively affecting employment
Financial implications	*See above*	Input supply & availability	Inability to source inputs in a timely manner, when available
Input supply & availability	All inputs into the various value chains, the extent of supply interruptions and the extent to which role-players downstream can rely on upstream input supply availability	Opex & Capex	Changes in the supply and availability of inputs, including electricity, changes the operational budgets and capital outlay of role-players
Opex & Capex	Operational and capital expenses of role-players in value chains	Product selling price	Recovering expenditure from produce prices
Input supply & availability	*See above*	Output quality & volume	Changes in production due to reduction in quantity/quality in available/affordable inputs
Output quality & volume	The quantity and quality of outputs of role-players in value chains	Product selling price	Different prices for different quality products; equilibrium price changes due to volume changes
Input supply & availability	*See above*	Operational capacity & scheduling	Changes in timing and volume of inputs changes capacity limit and timing of operational activities

SOURCE: COMPILED BY BFAP, 2023

While the SID indicates four feedback loops, the flow of impact in the system can, of course, run concurrently through multiple loops, and it can switch between feedback loops. What this means, is that the product selling price has financial implications, which can simultaneously affect an agri-business' ability to retain assets and its ability to procure inputs, if available. Also, at any system element that forms part of multiple feedback loops, i.e., 'Input supply & availability', 'Product selling price', and 'Financial implications', the course of impact can be redirected out of one feedback loop into another.

5.2. Impact on operations

The impact of loadshedding on agricultural operations in the Western Cape can be broadly categorised as direct and indirect impacts. Throughout these integrated value chains both dependent and independent loadshedding impacts can be observed. The objective of this section is to highlight the biggest risks for businesses in these value chains – how and when operations are affected. The following section – impact of loadshedding on volume and price – will expand on the quantified impact.

A value chain is only as strong as its weakest link. Thus, the highest level of risk of operational failure lies within breakages in the value chain. Although impossible to accurately qualify breakages in value chains, it can generally be assumed that under a certain level of stress, a chain can temporarily or permanently break. An example of a temporary break could be where all operations within a vegetable packhouse cannot run during loadshedding. The results could be a backlog in delivery to the market, which, if frequent enough, could result in temporary over- and undersupplying of the market. An oversupply situation will impact farm level profitability, whilst an undersupply situation will increase the price paid by consumers. In addition, it could also affect operations at farm level – calling for a stoppage in harvesting, which, in turn, could affect quality, sizing, and waste issues. It is likely to also increase the cost of production. An example of a permanent break is when operations are ceased. This is likely to be the result of an inability to absorb or pass cost on in the chain. An example is provided in **Box 4** – which presents a case study on Apple production.

Table 13 provides a Likert scale schematic overview of the risk posed by different levels of loadshedding, as derived from surveys and interviews with industry stakeholders. It is assumed that businesses are primarily dependent on Eskom to supply energy. The colour scheme varies from green (level 1), indicating that most role-players are, on average, comfortable to manage/continue normal/close to normal operations under a certain level of loadshedding, to red (level 5), indicating that managing/continuing operations under a certain level of loadshedding is extremely difficult thus negative impacts on output would be expected. The lighter green (level 2), yellow (level 3) and orange (level 4) indicates a gradual increase in the difficulty to manage the impact of loadshedding on operations. Black indicates the ceasing of operations or severe output reduction, effectively disrupting the whole value chain and causing severe knock-on effects. The colour scheme is also indicative of the magnitude to role-players negatively affected (or unable to cope) under certain stages of loadshedding.

As stated, the table indicates the average, which implied that there is a range where some role-players are less affected, or, more able to mitigate the impact, whereas others are more exposed to the risks posed by various stages of loadshedding. From the interviews with stakeholders, it became clear that smaller role-players are more vulnerable. This holds true throughout the different value chains, but we would like to highlight emerging producers and informal processors, together with smaller commercial producers. One could, to a large extent, assume that impact of loadshedding on these role-players are typically one level higher than what is indicated in **Table 13** and operational activities of these producers and agro-processors would be disrupted at one stage of loadshedding earlier than for the average indicated in the table. There are indications that some of these smaller operators have also closed down in the last 12 months. On the other hand, large scale producers and agro-processors who have already invested extensively in alternatives can temporarily absorb more of the impact of various stages of loadshedding than indicated in the table.

Table 13: Matrix indicating the impact of different stages of loadshedding on operations

		Loadshedding stage								Black out
		1	2	3	4	5	6	7	8	
Inputs	Packaging	L1	L1	L2	L4	L4	L5	Disruption	Disruption	Disruption
	Fertiliser & chemicals	L1	L1	L2	L2	L3	L4	L5	L5	Disruption
	Water	L1	L1	L2	L4	L5	Disruption	Disruption	Disruption	Disruption
Production	Dryland field crops	L1	L1	L1	L1	L2	L2	L2	L3	Disruption
	Irrigated field crops	L1	L1	L2	L3	L4	L5	Disruption	Disruption	Disruption
	Dryland horticulture	L1	L1	L1	L1	L2	L2	L2	L3	Disruption
	Irrigated horticulture	L1	L2	L3	L4	L5	L5	Disruption	Disruption	Disruption
	Extensive livestock production	L1	L1	L1	L1	L2	L2	L2	L3	Disruption
	Intensive livestock production	L2	L3	L4	L5	L5	L5	Disruption	Disruption	Disruption
Processing/value-adding	Packing	L1	L2	L2	L3	L4	L4	L5	L5	Disruption
	Juicing	L2	L2	L3	L4	L5	L5	Disruption	Disruption	Disruption
	Canning	L2	L2	L3	L3	L5	L5	Disruption	Disruption	Disruption
	Cellars	L1	L2	L2	L3	L4	L5	L5	Disruption	Disruption
	Cold storage	L2	L2	L3	L3	L5	L5	Disruption	Disruption	Disruption
	Crushing	L1	L2	L4	L4	L4	L5	L5	Disruption	Disruption
	Milling	L1	L2	L4	L4	L4	L5	L5	Disruption	Disruption
	Meat processing[3]	L2	L3	L3	L4	L5	L5	Disruption	Disruption	Disruption
	Frozen storage	L2	L2	L2	L3	L4	L5	L5	Disruption	Disruption
Distribution & marketing	Distribution centres	L1	L1	L2	L3	L4	L5	L5	Disruption	Disruption
	Fresh produce markets	L1	L1	L1	L2	L2	L3	L5	L5	Disruption
	Ports	L1	L1	L1	L1	L1	L1	L5	L5	Disruption

Scale:	Level 1	Level 2	Level 3	Level 4	Level 5	Disruption of value chain

Source: Compiled by BFAP from various sources, 2023

Box 2: Impact of loadshedding on the livestock industry – Broiler chicken case study

Poultry production is the largest agricultural subsector in South Africa and its controlled production environment requires consistent electricity supply. The sector is also the single biggest consumer of animal feed and is therefore highly influential on both the animal feed sector and the production of raw materials used in the manufacture of feeds.

Given the importance of consistent electricity supply, both on farm to maintain the production environment and at meat processing level to ensure throughput, most of the larger producers and processing companies have already invested in backup power. Nevertheless, generator use is more expensive than Eskom power and loadshedding adds significantly to operational expenditure, both on farm and at meat processing level. Implementation of stage 6 loadshedding was estimated to add approximately R0.90 per kg to total production costs. This amounts to a 3% increase in total production costs, as electricity remains a small share of total costs relative to other factors such as feed and day-old chicks. It accounts only for the direct cost on poultry and does not include possible additional costs related to the manufacture of animal feeds and the raw materials to produce feed.

In order to illustrate the impact of these additional costs both on poultry production and the broader agricultural sector, an illustrative scenario was simulated using BFAP's partial equilibrium model of the South African agricultural sector. The model is dynamic and recursive in nature and maintains relationships across sectors, ensuring that any shock in livestock production also influences field crops through the derived demand for animal feed.

[3] Meat processing includes abattoir services, as well as deboning and other processing activities.

The relative impact of a stage 6 loadshedding scenario on poultry production, consumption and trade ultimately depends on the extent to which additional costs can be passed through to consumers. In the poultry sector, where imports still comprise around 20% of domestic consumption, the scope to pass additional costs on to consumers is limited, as Davids & Meyer (2017) note that the price of imported products is the most important determinant of domestic chicken prices, with input costs also found to be significant, but less elastic in its impact. The additional costs associated with the use of backup power therefore influences both the cost of production and the price of poultry products – with the effect on prices smaller than that on production costs.

FIGURE 13: IMPACT OF LOADSHEDDING RELATED COSTS ON CHICKEN PRICES IN SOUTH AFRICA – BASELINE VS. STAGE 6 LOADSHEDDING SCENARIO
SOURCE: COMPILED BY BFAP, 2023

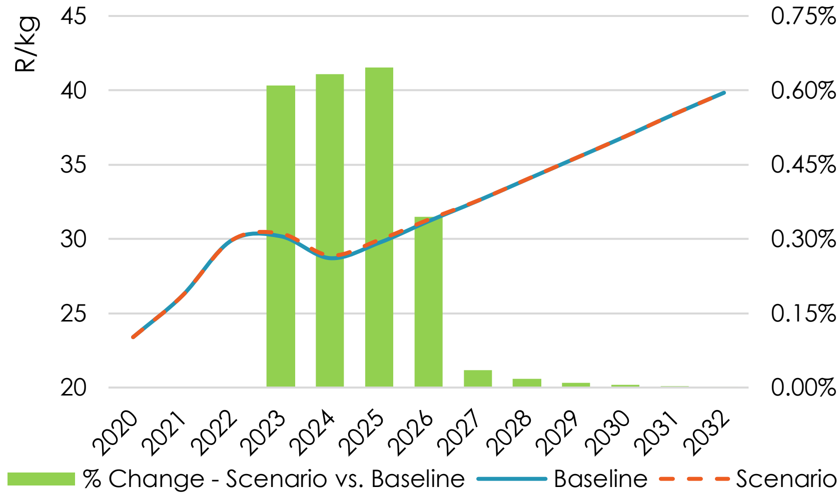


Figure 13 presents the baseline outlook for chicken prices in South Africa in the absence of further large-scale loadshedding, with the associated cost structure. This baseline outlook represents a business-as-usual scenario, that is used as a benchmark against which the impact of loadshedding can be measured and understood. The alternative scenario in the same figure reflects the additional costs associated with stage 6 loadshedding. Additional costs were introduced into the model for a 3-year period, from 2023 to 2025, with a reduced impact in 2026 and no further impact from 2027 onwards, based on the assumption that current investments into independent power production will start to bear fruit. Based on the elasticities estimated by Davids & Meyer (2017), only 20% of the estimated 3% increase in production costs, are passed through to consumers, resulting in an average increase in chicken prices of 0.6%, or 20c per kg above baseline levels from 2023 to 2025. Although seemingly minimal, an impact on production, imports and consumption are recorded as a result.

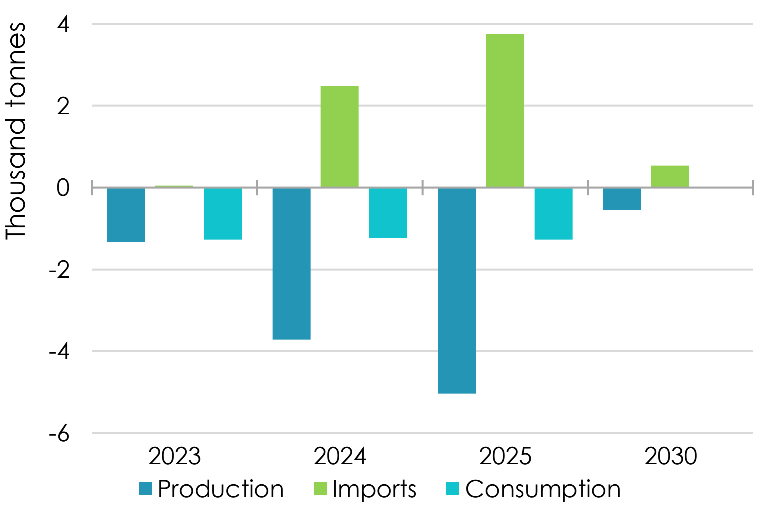


FIGURE 14: ABSOLUTE CHANGE IN PRODUCTION, CONSUMPTION AND IMPORT VOLUMES AS A RESULT OF STAGE 6 LOADSHEDDING, EXPRESSED RELATIVE TO THE BASELINE PROJECTION FROM 2023 – 2030
SOURCE: COMPILED BY BFAP, 2023

Figure 14 presents the combined impact of the price increase, and the additional cost of production on production, consumption and imports from 2023 to 2025, as well as in 2030. Given that producers have to absorb some of the additional costs, the production response to the shock exceeds that of consumption. The capital-intensive nature of production, combined with highly specific nature of production assets, implies that the supply response takes time, with the peak impact observed in 2025 through a reduction of 5 thousand tonnes per annum in production volumes. The increase in prices also results in an annual average reduction in consumption of 4.6 thousand tonnes relative to the baseline projection. Given that South African producers are less competitive relative to international counterparts as a result of the additional costs, imports are expected to rise by 3.8 thousand tonnes per annum by 2025.

The numbers presented in this case study are indicative and reflect only the impact on the poultry sector, without accounting for other agricultural sectors. Given the small share of electricity in total production costs, they may seem small, but the risk to chicken producers is immense and consistent running on backup power implies massive risk of losses if that backup power should fail. The backup equipment is neither designed to operate long hours on end nor to endure frequent stop-starts. While production volume changes may seem small, producers absorb significant additional production costs. At 90c per kg produced, the total additional cost to the broiler industry will be R1.55 billion per annum, of which only R311 million is recovered in price. This implies a loss of R1.24 billion per annum in GDP that the industry could have generated had it not been for the impact of loadshedding. For the Western Cape, the cost equates to R286 million per annum, of which of R57 million is recovered in price.

While the poultry industry is the largest subsector in agriculture, it still accounts for only 15% of total agricultural production value, hence the effect of additional costs across the agricultural sector will be larger than the simulated impacts in poultry alone.

5.3. Impact on volume and price

Several factors influence the impact of loadshedding on the volume and prices of agriculture and agro-processing products. The response from agri-businesses to the increased cost associated with producing the same unit of output, though small (1-3% of total costs), will vary considerably across the spectrum of size of business, current capacity to generate energy and value chain specific considerations. Also, the current macro-economic environment in which businesses operate is one characterised by high food inflation, sluggish economic growth and record-high unemployment levels. Although the Western Cape fares better in most of these indicators, the overall narrative stays the same for all agri-businesses in that additional costs both on the farm and down the value chain will need to be absorbed by someone, either the consumer, or somewhere within the agricultural value chain. Consequently, these impacts could affect exports, national food security and food price inflation.

From our extensive feedback from industry stakeholders a number of observations can be made as we assess the impact of loadshedding in the value chain. Most established processors in the Western Cape, and producers that export fruit and companies that provide services such as warehousing and storage, have already invested in or are busy implementing energy solutions. However, for the moment, many of these solutions are short- to medium-term, such as diesel generators, and not long-term or green alternatives, such as solar. Those that have done so already have indicated that they intend to continue with operations until it becomes economically and managerially impossible to do so. Thus, either through generating own electricity through solar, gas, generators or storage, firms are spending significantly more on energy. However, not all farms and firms are in this position. The unfortunate characteristic of the loadshedding impact on agriculture is that it will disproportionately impact smaller businesses that does not have the capital, nor the cashflow available to invest in own generation. For these agri businesses there will be an impact on the volume of output and the prices received in the market as operation are affected.

When investigating investment in renewables, consideration is given to the outline of primary agricultural energy consumption in 2022 (**Table 2** and **Table 3**) and the LCOS and PPA of alternatives (**Figure 7**). Given that LCOS accounts for all costs incurred, including the cost of replacement in the case of batteries and that PPA assumes a repayment on investment by third party in solar PV, the annual expenditure calculated on the total demand implicitly discounts the investment and running cost of such infrastructure, with the latter part a small component of the total cost. In **Table 14**, we estimated the cost per annum at current prices to supply the 2 TWh of electricity demanded by primary production and agro-processing in the Western Cape to amount to R11.1 billion, excluding additional investment in inverters, securing of infrastructure and other necessary monitoring equipment. For this calculation, a 1600 kWh/kWp/annum from 1 kw of solar PV is assumed, with additional solar PV installations to store energy in Lithium-ion batteries to supply energy during sub-optimal solar hours. Different stages of loadshedding would thus theoretically incur a proportional annual cost compared to completely operating primary production and agro-processing operations off the grid. However, given the variability in loadshedding stages throughout the year, a cost per stage of loadshedding is of little value, unless an agreement to fix the stage of loadshedding can be negotiated and implemented. This cost of alternative energy to be absorbed is not accounting for any other additional cost incurred by producers and agro-processors, e.g., infrastructure and labour cost incurred to manager changeovers and any other relevant costs.

TABLE 14: ANNUAL COST OF ALTERNATIVE ENERGY SUPPLY PER STAGE OF LOADSHEDDING: 2022 EQUIVALENT

Stage of loadshedding:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Blackout**
Loadshedding indicators									
Loadshedding	1 GW	2 GW	3 GW	4 GW	5 GW	6 GW	7 GW	8 GW	16 GW
Loadshedding hours per year	624	1 144	1 664	2 184	2 808	3 224	3 848	4 368	8 760
Total hours per year	8 760	8 760	8 760	8 760	8 760	8 760	8 760	8 760	8 760
% Eskom supply loss	7%	13%	19%	25%	32%	37%	44%	50%	100%
On-farm (1 200 GWh) – Rand billion									
Solar PV & Lithium-ion (LCOS & PPA R bn) 1 kWh = R5.42	0.46	0.85	1.24	1.62	2.09	2.39	2.86	3.24	6.50
Diesel generator (LCOS R bn) 1 kWh = R5.25	0.45	0.82	1.20	1.57	2.02	2.32	2.77	3.14	6.30
Eskom saving (R bn) 1 kWh = R2.15	-0.18	-0.34	-0.49	-0.64	-0.83	-0.95	-1.13	-1.29	-2.58
Net cost impact* R bn	**0.27**	**0.50**	**0.73**	**0.95**	**1.23**	**1.41**	**1.68**	**1.91**	**3.82**
Agro-processing (844 GWh) – Rand billion									
Solar PV & Lithium-ion (LCOS & PPA R bn) 1 kWh = R5.42	0.33	0.60	0.87	1.14	1.47	1.68	2.01	2.28	4.57
Diesel generator (LCOS R bn)1 kWh = R5.25	0.32	0.58	0.84	1.10	1.42	1.63	1.95	2.21	4.43
Eskom saving (R bn) 1 kWh = R1.50	-0.09	-0.17	-0.24	-0.32	-0.41	-0.47	-0.56	-0.63	-1.27
Net cost impact* R bn	**0.23**	**0.42**	**0.61**	**0.81**	**1.04**	**1.19**	**1.42**	**1.61**	**3.24**

SOURCE: COMPILED BY BFAP FROM VARIOUS SOURCES, 2023

NOTE: * CONSIDERS AN EVEN SPLIT BETWEEN THE TWO ALTERNATIVES (SOLAR PV & LITHIUM-ION AND DIESEL GENERATOR) FROM WHICH ESKOM SAVINGS ARE DEDUCTED

If we assume the case studies (**Box 2**, **Box 3**, and **Box 4**) are indicative of the impact on volume and price by sub-sector, the impact can be summarised as follows. For livestock, 20% of the cost incurred due to loadshedding is passed on to the consumer, with 80% absorbed in the value chain. Although production volume is marginally affected in the short run, and increased imports are triggered, it mostly reverts to baseline conditions in the long run, assuming that the energy situation normalises due to current investments in private generation capacity. Thus, while adding to food price inflation, availability should not be affected, as imports can replace the production contraction.

For field crops, it is assumed that one third of the additional cost incurred due to loadshedding can be passed onto consumers, with one third pushed to producers and one third absorbed by the agro-processors. Contraction of area and volume of 2-3% in the short run could be expected, which also curtails exports, where applicable, somewhat. Similar to livestock, a recovery to baseline levels over the latter part of the outlook is expected. Prices are well integrated in global markets and while the need to import may increase, food availability should not be affected. Since wheat is already mostly priced at import parity, price impacts will be limited, but imports will rise to ensure availability.

The horticultural sub-sector could be split into two: produce predominantly cultivated for exports, e.g., fruit, and produce cultivated primarily for local consumption, e.g., vegetables. Regarding the former, a negative impact of up to 10% GPV is projected under a "conservative" scenario modelled for loadshedding stage 6. Negative quality and volume impacts – up to a 12-15% decrease in exports – in the short run could have long run structural implications for the industry, as water limitations emanating from increased loadshedding could reduce the area under cultivation. Although not modelled, the vegetable industry would emulate grains to the extent where the cost of loadshedding is partially passed on to the consumer as volume reductions will increase the prices of fresh produce for consumers. A product like wine, which has a large domestic and international footprint is likely to experience a combination of both the fruit and vegetable impacts. The most critical component to surviving this crisis is sustained supply from water schemes and irrigation at farm level.

BOX 3: IMPACT OF LOADSHEDDING ON THE FIELD CROP INDUSTRY – CANOLA CASE STUDY

Over the past decade, canola was South Africa's fastest growing field crop with total area under production (all planted in the Western Cape) rising from around 40 000 ha in 2010 to more than 120 000 ha in 2022. Canola has also proved itself as efficient in a rotation system with other winter crops. Industry yields made a step change in the past three years despite the rapid area expansion, and South African producers have benefitted from international seed technology. Production levels have increased sharply, reaching 210 000 tonnes in 2022, which triggered further investment in local crushing and oil refining capacity. Southern Oil (SOILL) in Swellendam currently remains the main buyer and processor of canola and has established a range of premium value-added products in the market. Due to the sharp rise in production over the past two years, South Africa was able to export around 35 000 tonnes to Europe annually.

SOILL has expanded processing capacity to more than 200 000 tonnes. This additional canola processing capacity will contribute towards additional replacement of presently imported vegetable oil and the oilcake has ample offtake in dairy and pork production systems in the Western Cape.

When it comes to the impact of loadshedding, the processing industry has already incurred significant losses, estimated at more than R40 million in 2022. This equates to approximately R280 of additional costs for each tonne of canola that was processed. Furthermore, downtime due to loadshedding resulted in a reduction in processing of approximately 5%. Apart from significant waiting periods at silos to offload their crop, canola producers were not directly affected by loadshedding since the crop is grown under dryland conditions. (Note: Only a few trails of canola production under irrigation are currently conducted in Limpopo and the North-West Province).

From the survey it became evident that the strong growth momentum in the industry and overall bullish investment environment have also spilled over into the industry's response to loadshedding. Major investments in diesel generators towards the end of 2022 implies that the crushing and refining facilities can now run uninterrupted during all stages of loadshedding. However, profit margins decline sharply due to additional diesel costs as the stages of loadshedding escalate.

To quantify the likely impact of these additional costs on the industry, an illustrative scenario was simulated using BFAP's partial equilibrium model of the South African agricultural sector. The model maintains relationships across sectors, ensuring that any shock in field crops also influence livestock production. However, it must be noted that contrary to the case study on broilers that is presented in **Box 2**, the canola industry is small and consequently the knock-on effect on related industries is smaller.

For the purpose of the illustrative scenario, additional costs were introduced into the model for a 3-year period, from 2023 to 2025, with a reduced impact in 2026 and no further impact from 2027 onwards, based on the assumption that current investments into independent power production will start to bear fruit. The estimated additional costs for 2022 (R280 per tonne of canola processed) as provided by the industry, were introduced in the model. Although SOILL is currently the only main buyer and processor of canola, the products that are produced, i.e. canola oil and feed cake, are marketed into highly competitive vegetable oil complex and protein meal for the animal feed industry. In both markets, South Africa is a net importer with imports providing a natural ceiling of prices. With record soybean crops in recent years, soybean crushers in the Northern parts of the country can also offer significant discounts on soybean meal to feed mills in the Western Cape.

Consequently, for the purpose of the scenario, it was assumed that the additional costs of loadshedding will be split equally with crushers absorbing one third of the costs and pushing one third back to producers by lowering canola prices and another third to the retail market by increasing the wholesale prices of vegetable oil. The net impact of approximately R90/tonne (one third of the costs) on canola producers is relatively small. The simulated reduction in area as a result of the decline amounts to 3 000 hectares, with an associated revenue loss of approximately R20 million.

FIGURE 15: ABSOLUTE CHANGE IN CRUSH VOLUME, CAKE AND OIL PRODUCTION AS A RESULT OF STAGE 6 LOADSHEDDING, EXPRESSED RELATIVE TO THE BASELINE PROJECTION FROM 2023 – 2026
SOURCE: COMPILED BY BFAP, 2023

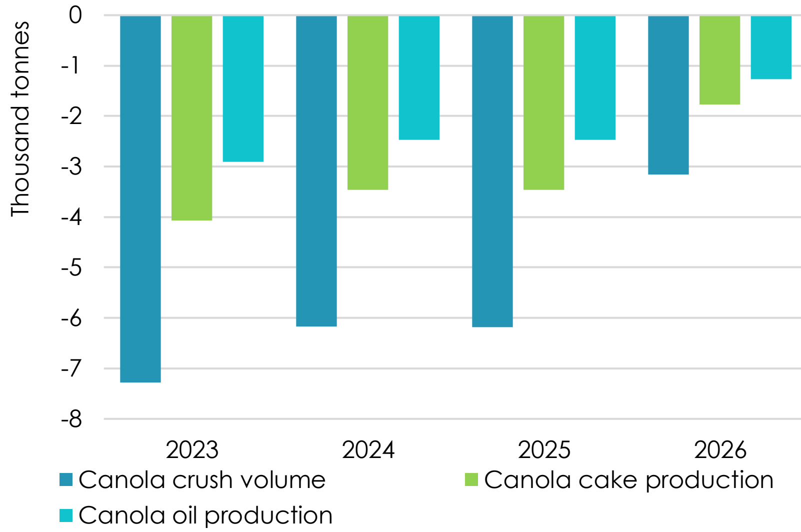


Figure 15 presents the implied drop in canola processing over the next three years. It is important to note that this presents a drop of approximately 7 000 tonnes per annum from the baseline where no loadshedding would occur. Projections still reflect additional crush volumes over the next few years from current levels, despite loadshedding. This is due to an expansion in production and local processing facilities, but this growth could have been stronger if loadshedding was not prevalent.

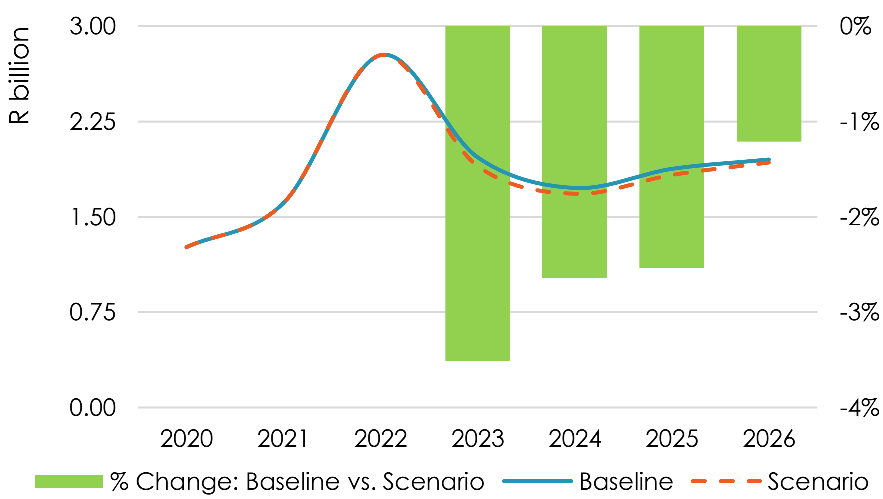


FIGURE 16: GROSS VALUE OF CANOLA PRODUCTION: BASELINE VS SCENARIO: 2023-2026
SOURCE: COMPILED BY BFAP, 2023

Figure 16 presents a drop in Gross Production Value for the industry of 3.5% in the first year and then gradually declining as alternative sources of energy are introduced or some of ESKOM's power generation is restored and less backup generation is required.

5.4. Impact on profitability

Loadshedding clearly impacts on operations, throughput volumes and prices. Consequently, the impact on profitability is undeniable, as has been highlighted in the systems influence diagram (**Figure 11**). This section focuses on highlighting the drivers and impact of loadshedding on the profitability of the Western Cape agricultural sector, which in itself is part of what drives reduced production volumes in the medium term, as producers exit the industry.

The true extent to which on-farm and off-farm profitability is affected by loadshedding is perhaps impossible to compute, given the complexity of linkages within these value chains. However, an attempt at illustrating how the impact can vary in magnitude is highlighted in the case study analyses (**Box 2**, **Box 3**, and **Box 4**). In these analyses, two models from BFAP's suite were employed, namely the multi-market Partial Equilibrium (PE) model and the whole farm financial simulation (FinSim) budgeting model.

The PE model utilised in this analysis has been developed and refined by BFAP over two decades. The PE model is a dynamic, recursive partial equilibrium framework, based on balance sheet principles to establish equilibrium, where total supply (production, imports and stocks) must equal total demand (consumption, export and ending stock). The strengths of the PE framework lie in the ability to capture intricate market and policy details and elasticities that closely mimic the real-world situation for specific commodities. This also enables detailed scenario analysis when changes occur in any of the existing variables or relationships.

Model specification is generally based on proven structures and correlations of key supply and demand drivers, with prices based on a combination of import or export parity, and domestic supply and demand dynamics, depending on the market situation for each commodity. The modelling framework ensures consistency in supply and demand relationships and is able to simulate price impacts of alternative scenarios, as well as dynamic supply and demand responses over time.

The current situation or Baseline projection assumes that current international as well as domestic agricultural policies will be maintained throughout the period under review (in this case 2023-2032). In a global setting, this implies that all countries adhere to bilateral and multilateral trade obligations, including WTO commitments. On the domestic front, current policies are assumed to be maintained. To some extent, the baseline simulations are driven by the outlook for a number of key macroeconomic indicators. Projections for these indicators are mostly, but not exclusively based on information provided by the OECD, the IMF and the BER.

The FinSim model considers the elements applicable in a whole farm budget to project a set of profitability indicators per hectare under a certain set of assumptions on variables. These variables are defined in the PE model. The base year data consist of, amongst other variables, farm size, orchard age distribution, cultivar selection and performance, establishment and production cost, and the cost and yield curves associated with non-bearing, bearing and full bearing orchards. The tool can be used to model alternative scenarios, such as changes in the macro-environment, additional cost or changes in the yields or marketing channels. The effect of these changes can then be compared to the baseline to inform decision-making.

The three case studies – one in each of the agricultural sub-sectors – shows vastly different impacts on profitability. In the case of poultry, the additional cost of broiler production was partly passed onto the consumer, with a feedback loop pushing back into the value chain, resulting in a slight decrease in production. In the case of canola, it was assumed that the additional cost at the processing node was equally spread between producers, processors and consumers. The consequence of the analysis was a slight contraction of hectares at farm level, with the processing node and consumers also expected to carry some of the burden. In the horticultural case study, where the impact of loadshedding was simulated on apples, the impact at industry and farm level are quite severe. The two main reasons for the result are that the producer remains the owner of the produce until the consumer buys it, and that apples are mostly produced for export, thus competing internationally with an extremely limited window of opportunity to pass cost onto the consumer.

The main considerations with respect to the impact on profitability can be summarised as follows:

- The first key indicator is the extent to which the value chain relies on electricity (and in particular on Eskom) to run operations.
- The second key indicator is the ability of a particular operator in the value chain to push the additional cost incurred onto other operators upstream or downstream, including consumers. It is assumed that the business will absorb the cost if unable to shift it.
- The third key indicator is the length of production cycles (monthly, annually, multiyear, etc.), which also drives the extent of short-term and longer-term impacts.
- The fourth key indicator is the availability of and ability to practically implement alternative sources of electricity. Many challenges, including access to capital, availability of equipment, affordability of equipment under current conditions and layout of operations play a role.

The main conclusions with respect to the impact on profitability can be summarised as follows:

- Profitability is negatively affected by an increase in cost in the chain, which has to be absorbed at the node where it occurs or absorbed upstream or downstream in the chain.
- Profitability is negatively affected by reduced demand for product (whether inputs or produce), resulting in facilities running below capacity, increasing the burden of overheads per unit of production.
- Negative impacts on profitability could either be short term or have long term structural impacts. From our analysis, it appears that the impact on profitability is substantially worse over the long run on perennial crops.

BOX 4: IMPACT OF LOADSHEDDING ON THE HORTICULTURE INDUSTRY – APPLE CASE STUDY

The South African apple area has incrementally expanded over the last decade, from 22 166 hectares in 2012 to 24 956 hectares in 2021. Over the same period, production volume increased by 43% (350 000 tonnes), indicating that the productivity per hectare increased substantially. The industry makes a valuable contribution to agriculture in the Western Cape, with approximately 85% of those hectares established in the province, followed by the Eastern Cape (12%), with the complement established in the Free State, Mpumalanga, and Limpopo (Hortgro, 2022).

When it comes to the impact of loadshedding, dependency on Eskom runs deep in the apple value chain. Consequently, the industry is affected at different nodes throughout the value chain, from inputs (e.g., water schemes and packaging material), to primary production (e.g., irrigation), to agro-processing (e.g., packing, canning, juicing and cold storage) to distribution and marketing (e.g., transport, ports and fresh produce markets). Since the industry is orientated towards fresh exports, competing on the international market with both Southern and Northern Hemisphere producers, since the technological advancements on the storage of apples in controlled atmosphere (CA) cold rooms allows for all year-round supply to market.

Despite only exporting 46% of production, exports contribute 78% of GPV. Consequently, the industry is exposed to both domestic and international challenges, and the impact on profitability has already filtered through to decision-making with respect to planted hectares – a small decline in planted hectares can already be observed. Since 2020, when producers came out of the drought affecting water availability and production in the Western Cape, they were exposed to market closures due to Covid-19, a global logistic crisis with port delays and freight rate hikes, the consequences of Russia's invasion of Ukraine, sharp increases in labour cost and more recently, substantial hours of loadshedding per day.

To quantify the impact stage 6 loadshedding, consideration is given to the cost of running on alternative energy, mostly diesel generators, to operate packaging material plants, irrigation pumps at farm level, packing lines at packhouses and cold storage facilities. It is expected that the additional cost in the value chain will largely have to be absorbed by the producer, since the producer remains the owner of the product until it is sold. The calculated impact equates to R19 547 per hectare (+3.13%) on total production cost, which includes off-farm activities. The calculation considers the additional cost for 2022, for which the apple production budget is an inflation adjusted 2021-budget (Hortgro, 2022).

To illustrate the likely impact of these additional costs on the industry, a scenario was simulated using BFAP's partial equilibrium model of the South African agricultural sector. The setup of the scenario is potentially conservative, as it does not account for the additional cost that could be passed to the producer from the juicing and canning industries.

For the scenario, similar to the broiler and canola examples case studies, additional costs were introduced into the model for a 3-year period, from 2023 to 2025, with a reduced impact in 2026 and no further impact from 2027 onwards, based on the assumption that current investments into independent power production will start to bear fruit. The simulated impact on the apple industry can be summarised as follows:

- Increase in the cost of production (alternative energy sources to irrigate) and upstream and downstream activities (3.13% increase in total production cost).
- Reduction in yield, especially when irrigation cycles can't be completed in critical periods (6% reduction in yield for 2023-2025, with 3% in 2026).
- Reduction in export volumes – quality and CA storage window impact (10% reduction in exports for 2023-2025, with 5% in 2026).
- Reduction in total area – accelerated removal of older, marginal orchards, due to limited water availability as a result of loadshedding.

Figure 17 presents the potential decrease in apple industry's GPV as a result of the introduction of the scenario outlined above. The impact on GPV is projected to be around 10% per annum for the period 2023-2025 and over 6% in 2026, after which is tapers off to 1.3-2.6% for the rest of the simulated period. The short-term impact reflects impact on direct and opportunity cost, whereas the longer-term impact reflects the structural impact on area, which consequently reduces volume. From 2023-2032, the total impact in absolute terms on GPV is projected to equate to R5.11 billion.

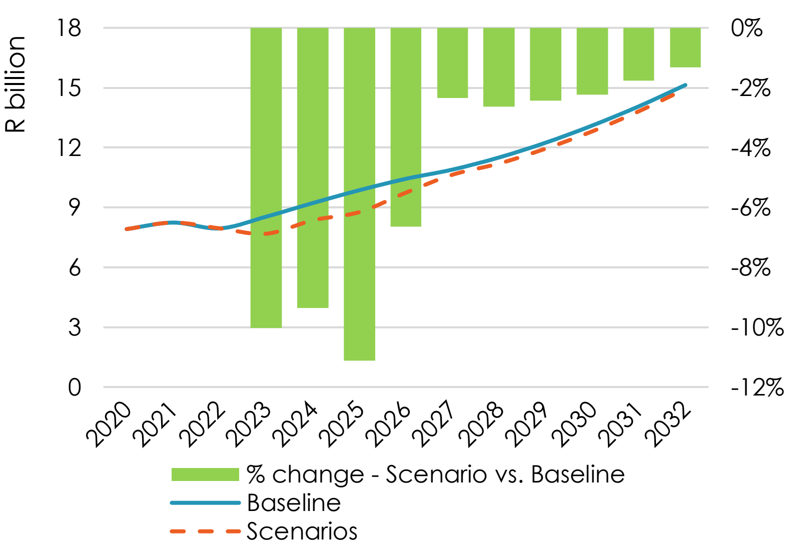


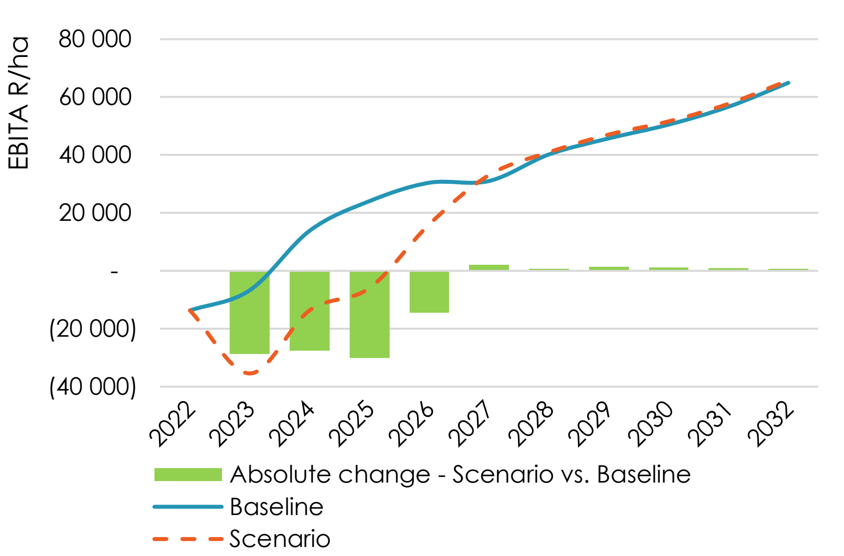
FIGURE 17: IMPACT OF DESCRIBED SCENARIO ON GPV FROM 2020 – 2032
SOURCE: COMPILED BY BFAP, 2023

Given the challenges described, the baseline already reflects a contraction in production area, resulting in a projection of 23 000 hectares in 2030. For the simulated scenario, an additional area contraction of 500 hectares is projected. With 30% of the industry's orchards older than 25 years and potentially marginal, especially when put under stress with additional cost to be covered, the contraction in area is conservative and likely could be higher (Hortgro, 2022).

Figure 18 presents the impact of the scenario compared to the baseline on the profitability of the apple component on the Witzenberg prototype farm. A normal replacement cycle is assumed, meaning that there is full bearing, bearing and non-bearing orchards on the farm. Against an already challenging baseline situation, the scenario adds additional cash flow and profitability constraints of R27 500 to R30 000 per hectare from 2023-2025, reduced to R14 400 per hectare by 2026. It is projected that these constraints are likely to result in a reduction of planted area as producers cannot sustain normal replacement under these conditions and will also remove older, less productive orchards at an accelerated tempo.

Figure 18: Impact of described scenario on Witzenberg prototype farm from 2022 – 2032
Source: Compiled by BFAP, 2023

The marginal improvement of the farm level profitability from 2027 onwards is the consequence of slightly better market prices due to lower marketable volumes, a result of area reduction. Thus, while the impact is assumed to be wholly absorbed by the producer in the short to medium term, consumers experience the delayed impact through price increases because of the impact on producers.



5.5. Socio-economic impact

There are several ways in which the escalation in loadshedding over the past few months are expected to impact Western Cape households and workers employed in the various industries in the agricultural value chain. Furthermore, a significant impact on livelihoods is anticipated on emerging producers and Small and Medium Sized Enterprises (SSMEs) particularly in the agro-processing sector. Though it falls out of the scope of this report to conduct a full socio-economic study of loadshedding, we'll briefly synthesise and discuss some of the major implications as it relates to agriculture. Important to note, is that the impact of loadshedding compounds the overarching and current macroeconomic conditions affecting especially poor households in terms of food affordability and access. The bullets below contextualise the current socio-economic landscape in the Western Cape.

- The country is currently in a monetary tightening phase in which the South Africa Reserve Bank (SARB) has been lifting interest rates in an attempt to lower overall inflation which is currently still trending at 7.1% for March 2022, compared to the same month in 2021 (StatsSA, 2023). This is still outside of the Bank's target range of 3-6% and significantly higher than the mid-point target of 4.5%. Over the medium term, the aim of lowering prices is important, but in the short term the impact of higher interest rates is affecting households, of whom a large share of lower income groups is already heavily in debt. The aggregate impact on households spending, food security and livelihoods coping strategies are significant, whilst having to cope with extreme power cuts.
- Though the Western Cape performs better than most other provinces in terms of unemployment, economic growth and a few other metrics, Western Cape households will not escape the impact of a stagnant South African economy hampered not only by loadshedding, but several other structural challenges limiting progress. The latest GDP forecast released by the IMF (2023) for South Africa is the lowest projection to date; a mere 0.1% growth for 2023. This is what several CEOs of retailers and processing firms have described as an extremely difficult trading environment, of which the agricultural value chain is dependent on to sell produce.
- The current Western Cape unemployment rate is 23% (33% in South Africa). At such high level, combined with those that earn income from wages, it will continue to weigh in consumer spending in a high inflation environment exacerbated by loadshedding (StatsSA, 2023).

- As has been observed in the apple case study (**Box 4**), the risk of losing production area due to unprofitable operations as a result of loadshedding is a real and tangible threat. Approximately 136 000 agri workers are employed on farms in the horticultural sub-sector in the province, with many more in horticulture related agro-processing facilities. Large scale uprooting of planted hectares, volume and/or quality changes are putting these jobs at risk. As indicated in **Section 5.1**, the knock-on effect reaches far wider than only the producer, the agri worker and the livelihoods of those linked to the agri worker.
- This leads us to the importance of having stable energy supply to enable food security, both in terms of access, affordability and food utilisation. **Figure 19** shows the annualised food inflation rate in the Western Cape, indicating the relative share of each food group to the overall picture. Prior to the pandemic, food inflation was trending at a modest 2%, after which food prices increased but stabilised at around 6% prior to the Russian invasion of Ukraine in March 2022. Since then, food prices have increased to around 13%, driven largely by increases in bread and cereals and meat inflation. These have such a large bearing on food inflation not only because prices for these products have risen in the past year, but also because these food items make out a relatively larger share of the weights used to calculate inflation, which in turn is based on balancing consumption levels in South Africa.

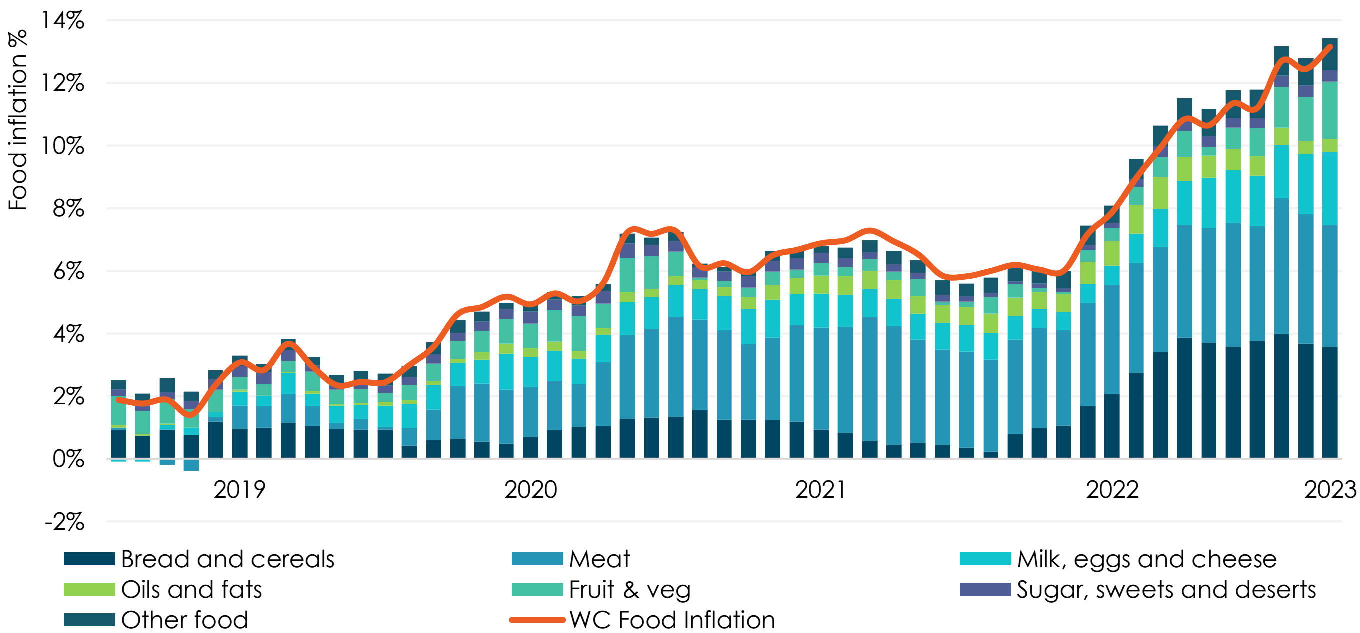


FIGURE 19: WESTERN CAPE FOOD INFLATION AND CONTRIBUTION PER FOOD GROUP
SOURCE: STATSSA, 2023

The impact of higher food prices at retail level results in a dual challenge of affording food, which, as we've pointed out is already a challenge in an economy where the level of unemployment is so high and income growth stifled by low economic growth prospects. One of the biggest challenges presented by the current energy supply constraints is that for most parts, current levels of food inflation has been caused by global factors. Our uniquely South Africa problem with loadshedding will work against the economic forces supposed to bring down food and other prices in that loadshedding adds costs to produce food. As noted earlier, it is not clear to what extent higher prices in the supply chain can be passed to the consumer, but consumers will ultimately suffer if loadshedding impacts wage rate growth or lead to job losses.

Our analysis show that there are currently around 186 000 farm workers in the Western Cape, whilst another 131 000 workers are employed in occupations directly related to agro-processing. The Western Cape has in recent years been conducting a series of Agri Worker Household Census surveys in an attempt to better understand the household profiles and livelihoods of those working on farms. The first iteration was completed in 2017 and used as the baseline, whilst a second round was concluded in 2020 (WC DoA, Agri Worker Household Census: Provincial Report Cycle 2, 2021). The last completed survey captured close to 25 000 individuals aggregated into 6 460 households, which allows us to get a better understanding of the access to electricity and other services. Around 95% of all participants reported to have electricity in their homes, of which the bulk (93%) of those residing on farms stayed in brick houses. Agri workers had either piped tap water in their homes (83%) or piped tap water on their dwelling site (12%).

One can get a sense of the impact of loadshedding on these households by means of assessing to what extent workers own assets powered by electricity. Around 80% had refrigerators, 82% electrical stoves and 51% microwave ovens. This suggest that rural workers on farms are fairly dependent on electricity for activities such as cooking and keeping food preserved using cooling. An important finding from the census as it relates the impact of electricity disruption and the cost increases over time is given in **Figure 20.** Respondents were asked who provides and pays for services to households for electricity and water services. The households with access to electricity stated that 59% received access to electricity through paying producers, which implies that these households are serviced indirectly by Eskom's provision of electricity to the farming enterprise but pays for the electricity to the producers, who then pays Eskom. A further 19% of farm workers received electricity as an in-kind payment from producers that supply worker houses with electricity at no charge. Another 19% receives electricity by buying directly from the municipality, whilst around 3% received free electricity from municipalities.

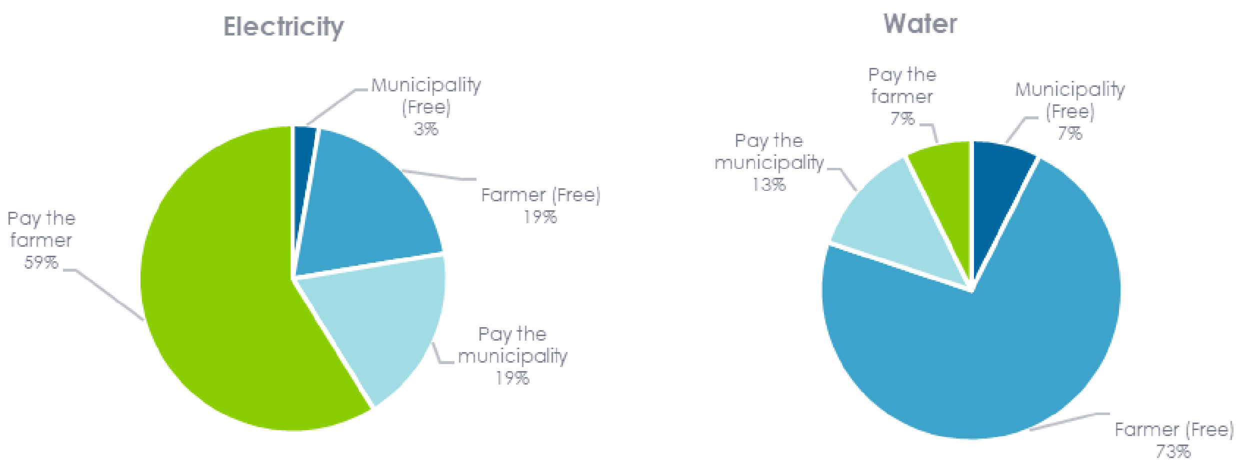


FIGURE 20: WESTERN CAPE AGRI WORKER HOUSEHOLD PROVISION OF SERVICES
SOURCE: WC DOA, 2017

The provision of water to households was mainly done by producers, of which 73% were distributed for free, whilst another 7% needed to pay producers for this service. Though slightly more indirect, the provision of water to farm worker households are impacted by loadshedding in cases where water needs to be delivered to households using electric pumps.

5.6. Impact on government objectives

The wide-ranging impacts of loadshedding, not only value chain partners, but also stakeholders such as government and civil society operating within the agricultural economy in the Western Cape, will be severe. This is particularly true for the provincial government, which needs plan and mitigate (reallocation of resources) to deal with the energy shortages to ensure the continued delivery of services. If loadshedding persist well into 2024 at current high levels, some of the overarching government objectives might not be met due to the combined impact of loadshedding on the economy. Though such causal inferences are difficult to predict, we briefly touch on the impact of loadshedding on the WCG's objectives and that of the WC DoA.

In aiming to realise their vision of a safe Western Cape where everyone prospers will be made much more difficult under current levels of loadshedding. The same applies to the Vision-inspired Priorities (VIP) of growth and jobs, empowering people, mobility and spatial transformation and innovation and culture, as well as some of the cross-cutting themes as mentioned in the WCG's Strategic Plan 2019-2024 (WCG, 2019). The main problem areas identified back when the Strategic Plan was drafted are now significantly worse than back in 2019, largely attributed by the onset of global instability caused by the Covid-19 pandemic and the subsequent impact of the Russian invasion of Ukraine. The significant and additional threat posed by loadshedding will severely hamper service delivery by government. The WC DoA mainly supports the provincial government mandate through the VIP 2 (economy and jobs) through which agriculture and agro-processing aims to grow exports, ensure rural safety and providing support to producers to name a few. As identified in the Theory of Change adopted by the WC DoA to guide the strategic direction of service delivery, the impact of loadshedding will impact several of the outcome indicators the Department are aiming to achieve. Areas in which loadshedding will impact the ability of the agricultural sector to optimally perform at the primary level includes the ability to irrigate crops and the available capital gearing to invest in alternative energy sources. Once loadshedding interrupts producers in terms of their ability to produce at the same scale and quality of produce the downstream sectors are affected. All additional costs, both on the farm and in the agro-processing firm, if not accompanied by higher prices in the market will lead to lower Gross Value Added, which is something the WC DoA aims to grow. **Table 15** represents a short description of the anticipated impact of loadshedding on the WC DoAs main outcome indicators.

TABLE 15: WC DOA IMPACT OF LOADSHEDDING ON KEY OUTCOME INDICATORS

Outcome	Indicators	Potential impact of persistent loadshedding
Increased agricultural production in a sustainable manner	Increase agricultural exports by at least 5% over the next 5 year; Enhance agri-processing capacity at both primary and secondary level	As one moves to different stage of loadshedding, the cost at each node of the value chain will scale proportionately to the number of hours of downtime. The impact on production, as we've explained in this report depends largely on the ability of producers and firms to generate their own power, or the nature of the economic activity will determine to what extent production can proceed, albeit at higher costs. Given other economic realities and factors currently affecting the Western Cape export performance it is likely that export volumes be affected by loadshedding as irrigation and cold chain logistics are disrupted. A larger share of fruit is expected to be diverted to local markets and processing capacity is likely to be subdued as costs per unit scales with each level of loadshedding.
Improved food security and safety	Increase GVA through sustainable agricultural production	Increase GVA will be constrained as the WC DoA move towards concluding the strategic plan implementation in 2024. Loadshedding will impact sustainable production in two ways- higher costs to produce the same level of output and the farm-cost squeeze will dampen farm-gate price support in the market. There is already anecdotal evidence of increased crime in South Africa related to loadshedding since security services and technologies are often reliant on electricity to function (camera's, electrical fences, lighting, alarms etc), whilst the higher risk of total grid collapse poses a significant risk of looting and social unrest.

Transformed & inclusive agricultural sectors	Success of supported land reform projects	Continued success on land reform will be severely negatively affected by loadshedding, largely due to the reality that absorbing additional costs of production for smaller producers will be constrained, or having no access to additional generation will likely reduce the volume and quality of produce. Similar to commercial producers, the biggest risk of loadshedding will be felt on the more than 800 emerging poultry producers and another 2 100 emerging irrigation producers in the Western Cape. Continued success for projects will depend on access to energy finance by existing and upcoming land reform beneficiaries.
Innovative and resilient rural economies	Develop an enabling environment to increase agricultural and related jobs	Potential opportunity presented to introduce renewable energy and other technologies to mitigate the impact of loadshedding, which should present new employment opportunities. Also presents an opportunity to reduce the energy dependence on government and potential provide income streams to farming and agro-processors. However, we anticipate that jobs growth throughout the agriculture value chain will be constrained and likely even see jobs lost due to the accumulation of impacts at the weakest points in the chain.

SOURCE: COMPILED BY BFAP FROM WC DOA, 2017

6. POTENTIAL INTERVENTIONS

Before delving into the potential implementable interventions to mitigate the impact of loadshedding on the Western Cape agricultural sector, it is worthwhile to consider the global environment in which many of these value chain role-players operate. Europe is one of South Africa's key trading partners and the pressure to comply with carbon standards and net zero targets in future, is mounting. Thus, despite the extent to which the current levels of loadshedding are challenging the agricultural sector in the Western Cape, it does provide some opportunities to gain momentum towards carbon commitments. According to PwC (2022), "private business is one of the fastest and most effective agents of change in the world". When allowed by the regulatory environment and forced to adapt to remain operational under loadshedding, businesses can rise to the challenge of decarbonising operations and/or the supply chain. New opportunities and challenges in the energy sector can broadly be categorised as follows:

- Participation in peer-to-peer electricity trading, enabled by an electricity trading platform, which allows for the commercialisation of opportunities for private businesses to generate and/or trade electricity.
- Improvements in the ease of access to clean energy while transitioning away from energy generated by fossil-fuels.
- Despite the regulatory environment opening up to invite more private participation, more stringent regulations on the environmental side can be anticipated that will provide rules and standards regarding the circularity of materials used in energy generation.
- The environmental impact component of ethical business is expected to be expanded to include renewable energy projects are part of corporate social responsibility requirements (PwC, 2022).

With this in mind, a set of potential interventions categorised according to the level of implementation is drafted in **Table 16**. Differentiation by category is incorporated by grouping various forms of businesses, industry, and government (e.g., local, provincial, national). To identify the mandates and competencies for interventions at different nodes in the value chains of the Western Cape agricultural sector, a non-exhaustive output matrix by category is provided. Where applicable, differentiation by industry (horticulture, field crops and livestock) and sub-industry will be provided. These potential interventions are supplementary to the initiatives already publicly available (GreenCape, 2022a; GreenCape, 2022b; GreenCape, 2023a; GreenCape, 2023b; GreenCape, 2023c) and initiatives coordinated and implemented by the Western Cape government. Learnings from other industries should also be considered. Implementable interventions for the season on hand, the rest of 2023 and over a 10-year period are considered. Given WC DoA preferred method of identifying a limited number of purposively selected outcomes to drive strategically, quality rather than quantity was the focal point in the construction of this matrix output.

TABLE 16: POTENTIAL INTERVENTIONS TO MITIGATE THE IMPACT OF LOADSHEDDING

Period	Input suppliers	Primary production	Agri-processing / value adding	Distribution & marketing
Businesses (input suppliers, producers, processors, value-adders, etc.)				
This season	Just in case vs. Just in time (carry more stock)	Store additional water when possible	Schedule / operational management adjustments	Schedule / operational management adjustments
	• Business Continuity Plans (BCPs) to plan and prioritise actions to minimise operational impact			
Rest of 2023	• Investigate opportunities to improve energy efficiency to reduce total energy expenditure • Hire or invest in generators • Investigate alternatives that aligns with future green energy requirements posed by market • Investigate options to operate under curtailment (e.g., different irrigation schedules)			
2024 - 2032	• Invest in alternatives, unless Western Cape can ensure more sustainable energy supply			
Industry (industry bodies, producer and processor organisations, associations, etc.)				
This season Rest of 2023	Prioritise discussions with irrigation boards	Investigate curtailment options and potential for flexi loadshedding schedules	Investigate curtailment or other forms of flexible loadshedding schedules	Prioritise discussions with cold stores and ports
	• Lobby for greater consistency and certainty regarding the stage of loadshedding • Approach financial institutions to provide innovative and affordable options to invest in energy supply			
	• Lobby for the agricultural value chain to be declared an essential service • Lobby for agriculture to be partially exempted from higher stages of load-shedding to reduce the likelihood of value chain breakages • Lobby for higher and broader application of rebates on fuel used for electricity generation • Conduct a feasibility study regarding the potential to trade load-shedding schedules			
2024 - 2032	• Enable funding of alternatives • Comprehensively map industries to identify potential for collaboration and reduce impact of direct and indirect impacts • Lobby for the finalisation of payback tariffs for electricity being put back into the grid			
Government (local (L), provincial (P) and national (N))				
This season	Curtailment or alternatives by line taking the temporal distribution into consideration (P)			
Rest of 2023	• Prioritise understanding, analysing and mitigation of electricity supply interruptions on water supply infrastructure (L, P, N) • Analyse and attempt to negotiate temporal distribution within the province to prioritise spatial differentiation in peak requirement periods within and outside of the agricultural sector (P) • Determine the extent of large scale, commercial investment in alternative energy in the province and the status of supply into the grid (P) • Research alternative systems, technologies, cost ranges, and risks to enable investment decisions (L, P, N)			

2024 - 2032	• Real, tangible incentives to encourage businesses and individuals to invest in renewable energy and increase electricity generation to help reduce pressure on the grid and ease loadshedding (e.g., Western Cape Enterprise Resource Planning enabler roll-out) (P, N) • Enable the subsidising and funding of alternatives (P, N) • Reduction in regulator procedures, i.e., streamline application process (N) • Enable large scale private alternative energy suppliers to feed into the grid (P, N) • Ensure sustainable sourcing for the Western Cape, ideally low carbon energy, with the potential of getting CoCT off the grid (P) • Development of new power projects (L, P, N) • Restore energy security through attracting private sector participation in the electricity market and addressing Eskom's operational and financial deficiencies (N) • Implement the Just Energy Transition Investment Plan (JET-IP) to achieve the country's ambitious climate goals while simultaneously addressing the energy supply crisis (L, P, N)

SOURCE: COMPILED BY BFAP FROM VARIOUS SOURCES, 2023, INCLUDING AGRISA, 2023, ENERGY CAPITAL POWER, 2023A, 2023B, 2023C, IMF, 2023, PWC, 2022

From the interventions outlined above, the short-term mitigation strategies are mostly structured around remaining operational while investigating, planning and rolling out longer term, green energy solutions. GreenCape (2023a) estimates that South Africa's agricultural sector market opportunity for energy efficiency investment is R66.8 billion with an identified potential energy saving of 19.4 TWh/annum. Energy efficiency refers to the "implementation of behaviour changes or technology to reduce energy consumption, while producing the same or greater outputs". While the Western Cape share of national agricultural electricity expenditure in 2017 equated to 22.4%, off-farm agricultural processes can vastly differ for the Western Cape relative to the national total. Rather than assuming that the Western Cape's energy efficiency investment can be directly derived, one can consider an average cost of R3.44/kWh.

In addition, the direct annual cost to be incurred by primary producers and agro-processors, on average, equate to R5.42/kWh for solar PV and Lithium-ion batteries and R5.25/kWh for diesel generators. Given that these alternatives are replacing energy sourced from Eskom, some savings on Eskom electricity should be realised. Unfortunately, the magnitude of investment in these alternatives does require a more consistent level of loadshedding, e.g., consistently on a specific stage, to effectively plan for the energy supply to be replaced and secure the capital to invest in alternative energy supply. It is also worth noting that the impact on the grid (energy availability) and implementation of different solutions are vastly different. **Table 17** summarises some interventions by impact on supply and the relative ease or complexity of implementation. This serves to guide decision-makers into prioritising some of the interventions outlined in **Table 16**.

TABLE 17: MATRIX OUTPUT ON SUPPLY IMPACT AND IMPLEMENTATION OF ENERGY SOLUTIONS

Impact on energy supply	High	Own generation (large scale)	Procuring from Independent Power Producers (IPPs), including large scale wheeling	
	Medium	Minimise leakage and non-technical losses	Wheeling (the process of delivering energy from a generator to an end-user located in another area)	
	Low		Own generation (small scale)	Supporting microgrids and Small-Scale Embedded Generation (SSEG)
		Low	Medium	High
		Ease of implementation (Low = complex; High = easy)		

SOURCE: ADAPTED FROM PWC, 2022

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7. CONCLUSION

The primary objective of this study was to analyse the on- and off-farm impact of the loadshedding situation on the Western Cape agricultural sector. In addition, given the findings in terms of the energy dependency and the impact of loadshedding of producers, value chains, consumers and agri workers, a set of recommendations on potential interventions that can be implemented was required. In this regard, a special focus on green energy generation options were of particular interest.

To determine the dependency on Eskom and provide an overview of the temporal and spatial distribution of the agricultural sector's electricity demand, existing literature with respect to electricity use in the Western Cape and in particular the agricultural sector (primary production and agro-processing) was consulted. While the City of Cape Town metro is responsible for approximately 70% of the 16 TWh electricity use in the province, use by primary production and agro-processing was estimated at approximately 2 TWh per annum.

An analysis of the spatial and temporal distribution revealed that most intensive livestock operations, i.e., dairies, chicken batteries, piggeries and feedlots, in the Western Cape are situated in the Swartland, Hessequa, Drakenstein, City of Cape Town, Swellendam and George municipalities. Considering the irrigated area and water demand of various field and horticultural crops, the municipalities identified to have the biggest electricity demand for irrigation purposes, are the Witzenberg, Langeberg, Breede Valley, Oudtshoorn, Theewaterskloof and Cederberg municipalities. Demand for electricity is much higher from October to March than from April to September. From the surveys conducted by industry associations and verified by stakeholder interviews, it was estimated that approximately 95% of producers are dependent on Eskom as their primary, or only, source of electricity, not accounting for the temporary solutions implemented during loadshedding. Furthermore, approximately 75% of agro-processing facilities source electricity from Eskom directly, with the complement being supplied via their local municipality.

After determining the baseline spatial and temporal distribution and energy dependency, an analysis of the impact of loadshedding on the agricultural sector of the Western Cape was conducted. IQA, a systematic, qualitative research technique was applied to determine causal relationships that exist. These cause-and-effect relationships showcase the chain of events that loadshedding causes in agricultural value chains in the Western Cape, where loadshedding initiates a chain of events, where operational capacity and scheduling, together with input supply are the biggest drivers of impact in the system. On the receiving end – the factors most affected in the chain – are product prices and the socio-economic conditions. Multiple feedback loops within the system, indicating a strengthened and accelerated impact through the various elements in the system, highlights the complexity and interconnectedness in the agricultural value chains, but it also exposes the risk continued loadshedding poses to the sector.

To illustrate the short- and longer-term impacts of loadshedding on operations, volume, price and profitability, four in-depth case studies were conducted. These were done on water management schemes, and the canola, poultry and apple value chains. Findings from these case studies, drawing on BFAP's PE and FinSim modelling, highlighted the relative risk distribution – the impact on horticultural value chains and role-players are far more severe than on livestock and field crops, with some of that risk directly related to irrigation water supply. It should be noted that the risks posed by electricity downtime in the intensive livestock production industry is severe, but, because of those risks, this industry is, on average, well-equipped to deal with intermittent bouts of loadshedding. The increase in the cost of production due to running on alternative energy sources, can be pushed at least partly onto the consumer, however, a slight reduction in demand of chicken could be expected as a result.

In addition to the case studies, an aggregated analysis was conducted to quantify the cost implication of different stages of loadshedding on primary agriculture and agro-processing. To replace each rationing of 1 000 MW at primary production and agro-processing, would equate to an annual (LCOS and/or PPA) cost of R0.79 billion in replacing with Solar PV and Lithium-ion batteries or R0.76 on diesel generators, not accounting for the savings due to reduced demand from Eskom. The operational cost equivalent for running uninterrupted for a full year at stage 6 loadshedding will therefore demand spending of R3.95 to R4.08 billion per annum when switching to diesel generators or solar PV and Lithium-ion. If we assume that the principles and outcomes of the case studies are indicative of the manner in which these costs are absorbed in the value chains – upstream, downstream, at node of incurrence or by consumers – the horticultural sector is the one most vulnerable to sustained loadshedding. On the other hand, the intensive livestock sector is most at risk should back-up energy supplies fail.

The impact of loadshedding on operations, volume, price and profitability inevitably affects the socio-economic aspects of agricultural value chains and the provincial government objectives. This report reiterates that job opportunities in the horticultural sector, which is the biggest employer of on-farm and off-farm agri workers in the Western Cape, are most vulnerable, putting those jobs at risk. The WC DoA aims to create an enabling environment for producers and processors to grow Value Added and grow jobs. It is clear that the ongoing energy supply shortage are set to influence some of the major outcome indicators that the Department has set out to achieve moving towards 2024. In this regard, growing exports, value added and ensuring continued success on land reform projects will be difficult to maintain. A high-level overview of the policy environment applicable to the study highlighted the slowly changing regulatory environment that still constraints the implementation of alternatives, especially with respect to the implementation of green energy options.

The potential implementable interventions were broken down into three categories – business, industry and government. Strategic actions, taking both a short-term and longer-term view on actionable items. While the responsibility of generating electricity can be forced upon businesses, with such a responsibility, businesses still depend on government to create an enabling environment. This environment encompasses various aspects of enablement, including regulatory, incentivisation to invest in renewable energy, access to low cost and innovative funding models to finance capital expenditure. At the same time, if any level of government strategically plans and implement alternative energy solutions to reduce/remove the impact of loadshedding, these implementations could ease the responsibility on businesses to invest in their own electricity generation. In that case, and in the current constrained economic environment with low to no profit margins and high interest rates, putting additional constraints on the cash flows and balance sheet ratios of individual agribusinesses could be avoided. Lastly industry organisations, associations and bodies can ensure the effective communication of the strategic actions taken at various levels of government with agribusinesses, while providing mandates inputs into government plans that are valuable, industry specific, and aggregated or disaggregated to the level most suited.

In conclusion, every attempt has been made to reflect the true state of energy dependency, the impact of loadshedding and the potential implementable interventions to mitigate the impact on the Western Cape agricultural sector within the timeframes provides. However, ample scope exists to refine, enrich and expand the research in collaboration with businesses, industry and government.

8. REFERENCES

AgBiz, 2023. *Load Shedding Impact Survey 2023*. Pretoria: AgBiz.

Agri SA, 2023. *Energy Crisis: Classification Of A National State Of Disaster.* Pretoria: AgriSA.

Agri Wes-Kaap [AWK], 2021. *Survey Results: Electricity In Western Cape Agriculture*. Paarl: Agri Wes-Kaap.

Berg River Main Irrigation Board, 2023. "Water schemes in the Western Cape and loadshedding" Interviewed by BFAP. 17 March 2023.

Bureau for Economic Research [BER], 2023. *Powering growth: Electricity and South Africa's economic outlook (Part 2 of 2)*. Stellenbosch: Bureau for Economic Research.

Council for Scientific and Industrial Research [CSIR], 2023. *Statistics of utility-scale power generation in South Africa.* Pretoria: Council for Scientific and Industrial Research.

DALRRD, 2021. Producer-Farmer Register: Western Cape Report. Pretoria: Western Cape Department of Agriculture Department of Agriculture, Rural Development & Land Reform.

Davids, T. and Meyer, F.H. 2017. *Price formation and competitiveness of the South African broiler industry in the international context*. Agrekon 56 (2).

Department of Economic Development and Tourism [DEDAT], 2019. Load shedding fact sheet – December 2019. Cape Town: Western Cape Government.

Department of Environmental Affairs and Development Planning [DEADP], 2011. *Western Cape IWRM Action Plan: Status Quo Report Final Draft*. Cape Town: Department of Environmental Affairs and Development Planning.

Enerdata, 2023. *South Africa Energy Information*. Available at: https://www.enerdata.net/estore/energy-market/south-africa/#:~:text=Electricity%20consumption%20rebounded%20by%202,%25)%20and%20services%20(18%25) (Accessed: 17 April 2023).

Energy Capital Power, 2023a. *Cape Town Announces 500 MW Power Purchase Tender*. Available at: https://energycapitalpower.com/cape-town-500-mw-power-purchase-tender/ (Accessed: 17 April 2023).

Energy Capital Power, 2023b. *Five Measures Adopted by South Africa to Address Loadshedding*. Available at: https://energycapitalpower.com/measures-south-africa-address-loadshedding/ (Accessed: 17 April 2023).

Energy Capital Power, 2023c. *South Africa Strengthens Solar Tax Incentives*. Available at: https://energycapitalpower.com/south-africa-tax-incentives-on-solar/ (Accessed: 17 April 2023).

Eskom, 2022. ESKOM Network November 2022. Sunninghill: Eskom.

FruitSA, 2023. *Fruit industry loadshedding impact questionnaire*. Pretoria: FruitSA.

GreenCape, 2022a. *2022 Energy Services Market Intelligence Report*. Cape Town: GreenCape.

GreenCape, 2022b. *2022 Large-Scale Renewable Energy Market Intelligence Report*. Cape Town: GreenCape.

GreenCape, 2023a. *2023 Energy Services Market Intelligence Report*. Cape Town: GreenCape.

GreenCape, 2023b. *2023 Large-Scale Renewable Energy Market Intelligence Report*. Cape Town: GreenCape.

GreenCape, 2023c. *2023 Sustainable Agriculture Market Intelligence Report.* Cape Town: GreenCape.

Hortgro, 2022. *Key deciduous fruit statistics 2021*. Paarl: Hortgro.

IMF, 2023a. *South Africa: Staff Concluding Statement of the 2023 Article IV Mission*. Available at: https://www.imf.org/en/News/Articles/2023/03/21/mcs032223-south-africa-2023-article-iv-mission (Accessed: 17 April 2023).

IMF, 2023b. World Economic Outlook Projections. Washington: International Monetary Fund.

National Treasury, 2023. *Budget 2023 – budget speech*. Pretoria: Directorate National Treasury.

Northcutt, N., & McCoy, D., 2004. *Interactive Qualitative Analysis - A Systems Method for Qualitative Research*. Thousand Oaks, California: Sage Publication, Inc.

Nova Economics, 2023. *Estimating the cost of load shedding on the South African economy*. Stellenbosch: Nova Economics.

PwC, 2022. *South Africa Economic Outlook & Sustainable options to plug the energy deficit*. Midrand: PwC South Africa Strategy& Economics.

PwC, 2023. *Budget 2023*. Midrand: PwC South Africa Economics.

Quantec. 2023. *Standardised Regional Service*. Pretoria: Quantec.

South African Reserve Bank [SARB], 2019. *Quarterly Bulletin September 2019*. Pretoria: Economic Statistics Department, South African Reserve Bank.

SARB, 2022. *Quarterly Bulletin December 2022*. Pretoria: Economic Statistics Department, South African Reserve Bank.

Scholtz, E., 2023. *Berg River farmers avoid loadshedding through pilot project with Eskom*. Available at: https://www.freshplaza.com/europe/article/9500936/berg-river-farmers-avoid-loadshedding-through-pilot-project-with-eskom/ (Accessed: 17 April 2023).

StatsSA, 2007. *Census of commercial agriculture, 2007 Western Cape*. Pretoria: Statistics South Africa.

StatsSA, 2014. *Manufacturing Industry: Financial*. Pretoria: Statistics South Africa.

StatsSA, 2020a. *Census of commercial agriculture, 2017 – Western Cape: Financial and production statistics*. Pretoria: Statistics South Africa.

StatsSA, 2020b. *Census of commercial agriculture, 2017 – Financial and production statistics*. Pretoria: Statistics South Africa.

StatsSA, 2023. *P0211 - Quarterly Labour Force Survey (QLFS) 4th Quarter 2022*. Pretoria: Statistics South Africa.

StatsSA, 2023. *P3041.2 - Manufacturing: Production and sales*. Pretoria: Statistics South Africa Statistic South Africa.

StatsSA, 2023. *Statistical Release P0141: Consumer Price Index*. Pretoria: Government of South Africa Statistics South Africa.

Western Cape Department of Agriculture [WC DoA], 2018. *Cape Farm Mapper*. Available at: https://gis.elsenburg.com/apps/cfm/ (Accessed: 15 March 2023).

WC DoA, 2022. *Department of Agriculture: About us*. Available at: https://www.westerncape.gov.za/dept/agriculture/about (Accessed: 17 April 2023).

WC DoA, 2020. *Causality of Actions over the Period 2020/21-2024/5*. Elsenburg: Western Cape Department of Agriculture.

WC DoA, 2021. *Agri Worker Household Census: Provincial Report Cycle 2*. Elsenburg: Western Cape Department of Agriculture.

WCG, 2019. *Provincial Strategic Plan: 2019-2024*. Cape Town: Department of the Premier Western Cape Government.