LSF Research

South African Sorghum Bioethanol Study

Prepared by Blueprint Holdings (Pty) Ltd

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A Synthesis of the Evidence and the Opportunity

ABOUT THIS DOCUMENT

This synthesis document provides an accessible overview of the findings of a comprehensive research programme - the Sorghum Price Forecasting and Bioethanol Market Study - commissioned by the Localisation Support Fund (LSF) and prepared by Blueprint Holdings (Pty) Ltd. It is designed to be read as a standalone document and is intended for a broad audience, including government policymakers, members of the public, civil society organisations, and industry stakeholders.

The study sits squarely within the LSF's mandate to support localisation - the process of building domestic industrial capability to produce goods and services that South Africa currently imports. The LSF was established to identify opportunities where South Africa's existing assets and capabilities can be deployed to reduce import dependence, grow local industries, and create sustainable employment. Biofuels - and sorghum ethanol in particular - represent one of the most compelling localisation opportunities in South Africa's agricultural and energy sectors: a pathway to producing domestically, from a locally grown crop, a fuel that the country currently imports entirely from international markets.

The synthesis draws on the LSF Integrated Report, a detailed technical document running to several hundred pages, which includes value chain analysis, risk assessments, economic modelling, international benchmarking, and an interactive scenario and price forecasting model. Readers seeking the full technical detail - including the financial modelling assumptions, the full risk register, the international case studies in depth, and the detailed policy recommendations - are referred to the LSF Integrated Report. Where headline figures and projections are cited in this document, they are drawn from the Integrated Report and its associated models. They reflect modelled estimates rather than guarantees and are intended to provide a sense of scale and direction rather than precise forecasts.

ABOUT LSF

The Localisation Support Fund NPC (“LSF”) was established as a non-profit company in 2021, funded by private sector contributors committed to localising manufacturing in South Africa. The LSF is a network orchestrator within the localisation ecosystem facilitating the connection between supply and demand participants, enhancing the value of the interactions by funding industry research and the deployment of technical expert resources to accelerate or unblock opportunities for localisation and growth in the manufacturing sector.

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Blueprint Holdings (Pty) Ltd is a bespoke specialist consulting firm focused on industrial development, strategy, policy, planning and implementation. It was founded in 2004 and has been working successfully in industrial development for over 20 years. It has delivered over 400 accepted assignments since then, with none rejected. It undertakes work with International Agencies, Universities, Governments, and the private sector in the industrial development arena. It has been appointed to various Government and industry association based South African panels to provide research and strategy development and planning services. Skills and competencies include all those required to deliver on assignments and range from policy analysis to detailed modelling and scenario planning. It is 100% black owned and 100% female managed.

DISCLAIMER

This report has been prepared in part fulfilment of a study to prepare a Sorghum Price Forecasting and Bio Ethanol Study. This is the final sub report and focuses on Corn modelling as an upstream basis for the independent standalone Sorghum Price Forecasting model supplied separately.

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Section 1: Introduction

South Africa is at a strategic crossroads, having transitioned from a refiner to a primary importer of finished fuels, a shift that has doubled petrol prices over the last decade and deepened systemic vulnerability.

Petrol prices are shaped by global oil markets over which the country has no control. A number of the country's last major coastal oil refineries closed in 2022 and 2023. South Africa now imports approximately 75% of its liquid fuel requirements in already-refined form - a fundamental shift from refiner to refined product importer that has deepened the country's exposure to global supply chains, Gulf region geopolitics, and the volatility of the rand-dollar exchange rate. Over the past decade, the coastal retail price of 95 Unleaded Petrol has risen from around R10.83 per litre in January 2015 to a peak of R26.09 per litre in July 2022, before settling at around R20 to R22 per litre through 2025 and into 2026. Every South African household and business has felt the consequences of that exposure. There is no indication that the structural vulnerability driving it is diminishing.

At the same time, South Africa's energy transition is not only about vulnerability - it is about opportunity. The Just Energy Transition (JET) framework recognises that decarbonisation must be achieved in a way that is socially inclusive, economically viable, and aligned with the country's development priorities. Biofuels align with this narrative. They offer a pathway to reduce emissions in the transport sector - one of the hardest sectors to decarbonise - while simultaneously offering localisation pathways that create and sustain rural jobs, support farmers, and retain value within the domestic economy. Unlike imported fuels, biofuels can be produced locally, from crops that sustain communities and ecosystems, ensuring that the transition is not only green, but also just.

South Africa has something that many fuel-importing nations do not: vast area of agricultural land, a capable commercial farming sector, an established agro-industrial processing industry, and a crop - sorghum - that has quietly sustained communities across the African continent for more than five thousand years. The question at the heart of this study is fundamentally one of localisation: can South Africa's agricultural assets be converted into energy assets? Can a fuel that is currently imported entirely from international markets be produced domestically, from a locally grown crop, through a value chain that creates jobs, supports rural communities, retains economic value within the country, and reduces exposure to the global supply shocks that have pushed petrol prices to record levels? The answer this study provides - grounded in detailed financial modelling, value chain analysis, and international benchmarking - is that the opportunity is real, the gap to viability is smaller than commonly assumed, and the case for acting on it is stronger than it has ever been. These conclusions are derived from a calibrated financial model that reflects South African capital costs, operating conditions, and regulatory pricing structures, and that has been benchmarked against international bioethanol production experience.

That opportunity is real, but the qualification matters. Sorghum-based biofuels production in South Africa is strategically attractive and technically feasible - and it is closer to commercial viability than is commonly assumed. Under the model assumptions used in this study - an exchange rate of R16.50 to the dollar, a Brent crude price of USD80 per barrel, a 15% cost of capital, and feedstock prices set at the level farmers need to break even - a grain sorghum ethanol plant falls short of breakeven by R0.82 per litre of ethanol produced. That gap is real. But it is also the narrowest of any feedstock configuration modelled, and it is within reach of closure through a combination of yield improvement, by-product optimisation, and modest, targeted policy support. A 1.5% improvement in average dryland sorghum yields would reduce the farmer's cost per tonne by more than the gap. By-product revenues from Distillers Dried Grains with Solubles and capturable CO_2 already contribute R6.60 per litre to the economics - more than half the value of the ethanol itself.

Grain sorghum is not merely close to viable. It is the best-performing feedstock of the six configurations the model assesses. Sweet sorghum runs a deficit of R6.09 per litre. A new-build sugar plant runs R1.63 per litre in deficit. A converted sugar plant runs R3.22 per litre. Off-specification maize runs R2.92 per litre. Grain sorghum, at R0.82 per litre, stands apart from all of them. And when that deficit is distributed across the entire blended fuel pool - since bioethanol under an E2 mandate represents only 2% of total petrol consumption - the cost of supporting grain sorghum ethanol amounts to approximately less than 2 cents per litre of fuel at the pump. That is two cents per litre for the motorist, in exchange for a domestic fuel supply component, rural employment, reduced import dependency, and a measurable contribution to South Africa's climate commitments under its Just Energy Transition Investment Plan. At a bioethanol breakeven price for a grain sorghum plant of R11.94, more than half (~55%) flows back into the South African as GDP.

The timing of this study is significant. In August 2025, the South African government gazetted a regulated transfer price for bioethanol under the Petroleum Products Act, linking it to the Basic Fuel Price. After nearly two decades of policy development - including a Biofuels Industrial Strategy in 2007, Mandatory Blending Regulations in 2012, and a comprehensive Regulatory Framework in 2020 - that single action removed the last major regulatory barrier to a domestic bioethanol market. A window has opened. But international experience is unambiguous that regulatory frameworks alone do not build industries. Brazil, the United States, India, and Kenya all demonstrate the same pattern: ethanol industries emerged where demand was mandated credibly, where first movers were de-risked by targeted public finance, where feedstock supply was organised through contract farming and aggregation infrastructure, and where governments held their nerve through the difficult early years before scale and efficiency shifted the economics.

The recommendations that emerge from this research are structured around that pattern. The first and most critical priority is the active enforcement of the blending mandate - not merely its existence on paper, but its implementation with transparent monitoring and consequences for non-compliance. The second is Viability Gap Funding for first-mover grain sorghum ethanol plants - a time-bound, targeted instrument that bridges the current commercial gap without locking the sector into permanent subsidy. The third is blended finance facilities, combining development finance institution capital with commercial lending, to reduce the cost and risk of project finance in the early years. The fourth is contract farming schemes with guaranteed offtake, translating downstream demand certainty into farm-level behavioural change. And the fifth is a carbon credit framework that rewards low-carbon-intensity ethanol production, improving long-run margin stability and aligning the sector with South Africa's decarbonisation journey.

Alongside these core priorities, a small number of enabling actions can begin immediately: extending the VAT exemption that applies to other grains to sorghum, clarifying the use of downgraded maize as a biofuels feedstock, investing in sorghum seed research and hybrid variety development, and establishing a dedicated bioethanol coordination function within government.

This document sets out the evidence behind these conclusions in full. It explains how South Africa's fuel supply works, and how vulnerable it has become. It examines the global biofuels industry and what South Africa can learn from the countries that have built it successfully. It traces the long and often frustrated journey of South Africa's own biofuels policy. It assesses sorghum's agronomic potential, its geographic fit, its economics, and its capacity to support inclusive rural development. And it presents the financial model findings in the detail that policymakers and investors need to understand both the opportunity and the specific interventions required to unlock it. The analysis does not promise easy answers. But it does define - precisely and quantitatively - the conditions under which a sorghum biofuels industry becomes viable, investable, and transformative for South Africa's Just Energy Transition.

Section 2: South Africa's Fuel Supply

To understand why biofuels matter for South Africa, one must first understand the fuel supply landscape the country faces today. It is a picture of significant and deepening vulnerability - rooted in the foundational structure of an industry that has never produced its own crude oil.

No crude oil of its own

South Africa has no crude oil reserves. Every barrel of crude oil that feeds the country's refineries is imported, principally from the Middle East and the Rest of Africa (principally, Nigeria and Angola). This has been true since the industry's beginnings, and it is the foundational reality that has shaped the liquid fuels economy since its inception. It determines the price motorists pay at the pump, the foreign exchange the country must spend to secure supply, and the strategic exposure the government must manage. The downstream market reflects this dependence with the major petroleum products sold domestically including petrol, diesel, jet fuel, illuminating paraffin, fuel oil, bitumen, and liquefied petroleum gas (LPG). Of these, petrol and diesel dominate by volume, underscoring the scale of South Africa's reliance on imported crude and refined fuels.

How South Africa produces fuel: three routes

Refined petroleum products in South Africa are produced through three distinct methods. The first and most conventional is crude oil refining, where imported crude is processed at coastal or inland refineries into the full range of petroleum products that are sold domestically. The second is coal-to-liquids (CTL) and gas-to-liquids technology (GTL) - a uniquely South African capability operated by Sasol at its Secunda plant in Mpumalanga which converts coal and gas into synthetic fuels at a throughput equivalent of around 150,000 barrels per day. The third is natural gas-to-liquids processing, operated by PetroSA at its Mossel Bay facility. Together, these three routes historically gave South Africa meaningful domestic production capacity, which reduced but never eliminated its dependence on imported crude and refined product.

Historically, South Africa operated six refineries in total — four on the coast and two inland. The coastal refineries were located in Durban (Sapref, jointly owned by Shell and BP, at 180,000 barrels per day; and Enref, operated by Engen, at 120,000 barrels per day) and Cape Town (Calref, operated by Chevron and later Astron Energy, at 100,000 barrels per day). The two inland plants were Natref in Sasolburg, jointly owned by Sasol and TotalEnergies at 108,000 barrels per day, and Sasol Secunda. This six-refinery configuration, together with an extensive pipeline network connecting coastal ports to inland distribution hubs, formed the backbone of South Africa's fuel supply system for several decades.

A refinery fleet in decline - and a fundamental shift in how South Africa sources its fuel

As aforementioned, that six-refinery configuration no longer exists. The South African refinery landscape has contracted dramatically over the past several years, and trade data published by the International Trade Centre reveals the full scale of that transformation. In 2016, South Africa imported approximately 20.7 million tonnes of crude oil (HS 2709) - its primary feedstock for domestic refining - alongside around 6.8 million cubic metres of already-refined petroleum products. Crude was overwhelmingly dominant. By 2025, crude imports had fallen to around 7.3 million tonnes, while imports of refined petroleum products (HS 2710) had risen to almost 20 million cubic metres.

To put both figures on a comparable footing - since crude is measured in tonnes and refined products in cubic metres, reflecting different stages of the supply chain - crude oil has a density of approximately 0.85 tonnes per cubic metre, meaning a tonne of crude is roughly equivalent to 1.18 cubic metres of liquid. On this basis, South Africa's crude imports in 2016 represented the equivalent of approximately 24.4 million cubic metres of liquid feedstock, against 6.8 million cubic metres of finished product imports. By 2025, those positions had almost exactly reversed: around 8.6 million cubic metres of crude equivalent, against nearly 20 million cubic metres of refined product. South Africa went from being a country that primarily imported crude and refined it domestically, to one that primarily imports finished fuel and stores and distributes it.

The turning point is visible in the data with striking clarity. Between 2021 and 2022, crude imports fell sharply - from the equivalent of around 13.7 million cubic metres to just 7.2 million cubic metres - as Sapref closed, removing 180,000 barrels per day of refining capacity at a stroke. In the same year, refined product imports surged from 16.1 million to 20.7 million cubic metres, as the market moved to fill the gap. Enref's closure in 2023 reinforced this structural shift. The two largest crude oil refineries in sub-Saharan Africa ceased operations within 18 months of each other, and the gap has been filled almost entirely by imported refined product rather than by new domestic capacity.

The origins of South Africa's crude imports have also shifted. Nigeria has historically been the largest supplier, but volumes from that source roughly halved between 2016 and 2025. Saudi Arabia, Angola, the United States, and - more recently - Brazil and the UAE have all featured in the supply mix. The trade data reveals, however, that Gulf producers - Saudi Arabia, the UAE, Oman, Bahrain, and Kuwait - collectively account for a substantial share of both crude and refined product supply. This concentration carries strategic risk. The conflicts that have affected the Gulf region in 2026 have served as a sharp reminder that geopolitical instability in or around the Persian Gulf can rapidly disrupt shipping lanes, raise insurance and freight costs, and threaten the continuity of supply for countries, like South Africa, that have no domestic refining buffer to fall back on. A country that once processed imported crude into finished fuel at home had at least some operational insulation from short-term market disruptions; one that relies on finished product arriving by ship from increasingly concentrated and geopolitically exposed origins does not. This is precisely the context in which the case for domestic biofuels production - reducing, even marginally, the volume of imported fuel required - deserves to be taken seriously.

The practical consequence of this structural shift is significant, and directly relevant to the biofuels opportunity. South Africa is now a refined product importer rather than a refiner. This means blending of domestically produced bioethanol happens not at large integrated refineries - most of which are gone - but at import terminals and fuel depots that receive finished product from overseas and must inject ethanol at the point of storage and distribution. That is a workable model, and one that functions in many countries, but it requires deliberate investment in dedicated ethanol tankage, handling equipment, and logistics at terminal sites that were not originally designed with blending in mind.

How fuel reaches the consumer

Petroleum products move from refineries and import terminals through an integrated distribution network involving pipelines, rail, coastal shipping, and road transport to reach approximately 200 depots across the country, around 4,000 service stations, and more than 100,000 direct consumers - the majority of them commercial farmers. The main wholesale players in this system include BP Southern Africa, Astron Energy, Engen Petroleum, PetroSA, Sasol Oil, Shell South Africa, and TotalEnergies

South Africa, all of which operate storage terminals and distribution facilities throughout the country. In addition to these established players, a growing number of independent, non-refining wholesalers are registered with the Department of Mineral and Petroleum Resources (DMPR), adding some competitive depth to the wholesale tier.

The retail network of approximately 4,000 service stations operates under a licensing regime introduced by the Petroleum Products Amendment Act of 2003, which covers manufacturing, wholesaling, and retailing. Manufacturers and wholesalers are generally prohibited from holding retail licences, so service stations are operated either by independent dealers under franchise or supply contracts with the major oil companies, or by fully independent operators. This separation of wholesale and retail functions is important context for understanding where bioethanol blending will occur; it takes place at the wholesale terminal and refinery level, under controlled conditions compliant with South African National Standards (SANS), rather than at the forecourt.

A pricing system tied to the world - and what that has meant for South Africans

The retail price of petrol is fully regulated by the South African government, set monthly through a formula anchored to the Basic Fuel Price (BFP). The BFP is designed to represent the realistic, market-related cost of importing a substantial portion of South Africa's liquid fuel requirements from overseas refining centres. In practical terms, this means domestic petrol and diesel prices are directly driven by the international crude oil price and the rand-dollar exchange rate - two variables entirely beyond domestic policy control. When global oil prices spike, or when the rand weakens, fuel prices rise for every South African household and business, regardless of what is happening in the local economy.

The price record of the past decade illustrates this exposure in stark terms. Data published by the Fuels Industry Association of South Africa (FIASA) shows that the coastal retail price of 95 Unleaded Petrol - the standard benchmark - stood at approximately R10.83 per litre in January 2015. By January 2020, on the eve of the COVID-19 pandemic, it had risen to R15.52 per litre. The pandemic briefly reversed the trend - in May 2020, coastal 95 ULP fell back to R11.52 per litre as global oil demand collapsed - before a powerful post-pandemic recovery, followed by Russia's invasion of Ukraine in early 2022, drove prices to levels South Africans had never experienced. By July 2022, coastal 95 ULP had reached R26.09 per litre - its highest point on record, more than double the price of seven years earlier. Motorists in Gauteng, paying the higher inland price that same month, faced R26.74 per litre.

Prices moderated after the 2022 peak as global oil markets gradually rebalanced, but they have remained at historically elevated levels. Through 2023 and 2024, coastal 95 ULP fluctuated between roughly R20 and R25 per litre, with a secondary spike to R24.96 per litre in October 2023. By January 2025, prices had eased to approximately R20.28 per litre - still close to double the 2015 baseline. The April 2026 coastal price stood at R22.49 per litre.

Taken across the decade, South Africans have experienced a nominal increase in the pump price of petrol of roughly 90 to 100%, with the most extreme episodes representing more than a doubling in the space of less than two years. The volatility has been as damaging as the absolute level: a swing of more than R6 per litre within a single calendar year, as occurred through 2022, makes household budgeting, agricultural planning, and business forecasting extremely difficult. For the many millions of South Africans who rely on taxis or spend a disproportionate share of household income on transport, fuel price shocks are not an abstraction - they are a direct constraint on living standards, food security, and economic participation.

This decade of price instability is the essential backdrop against which the biofuels opportunity should be understood. A domestic bioethanol industry cannot insulate South Africa from global oil price movements - the BFP mechanism ensures that petrol pricing remains internationally referenced - but blending domestically produced ethanol into the fuel pool reduces the volume of refined product that must be imported, retains value in the local economy, and introduces a domestic supply component into a system currently entirely exposed to international market volatility. Critically, because the regulated bioethanol transfer price is set at the BFP level, the consumer pays no more at the pump for blended fuel than for conventional petrol. The argument for biofuels is therefore not that they make petrol cheap, but that they make the fuel supply system marginally less exposed and the domestic economy marginally more self-reliant. This shift promotes greater economic sovereignty for a country that has spent the last decade navigating external geopolitical and economic pressures.

This structure has a specific and important implication for the investment case for biofuels. Since the entire fuel pricing system is built around the BFP, any domestically produced fuel entering the blending pool must be accommodated within this framework at a commercially workable price. The regulated transfer price for bioethanol - gazetted in August 2025 and set at the BFP level, plus a zone differential to cover transport costs from plant to blending point - does exactly this. It provides the mechanism by which a South African ethanol producer can sell to a blender at a transparent, regulated price, without requiring the blender to absorb a cost premium or the consumer to pay more at the pump.

The infrastructure reality for bioethanol

For a domestic bioethanol industry, the current state of South Africa's refining and distribution infrastructure creates a specific set of planning requirements. Since both of Durban's major refineries have closed, blending activity is increasingly concentrated at terminal facilities rather than at refineries - a shift that has important logistics implications. The key inland blending hubs are at Alrode and Tarlton in Gauteng and at Sasolburg, which links to Sasol's operations and the national pipeline system. On the coast, the Durban Island View Precinct remains the country's largest liquid bulk hub, while Cape Town, Gqeberha (Port Elizabeth), and KuGompo City (East London) serve regional coastal markets.

A further constraint is that bioethanol cannot be transported through South Africa's existing multi-product fuel pipelines. Ethanol is hygroscopic - it absorbs water - and must be handled in dedicated storage tanks and transported by road or rail tanker to blending terminals. This requires new investment in specialised tankage, logistics, and injection equipment at blending points. These are well-understood requirements in countries with established bioethanol industries, but they need to be planned and financed deliberately in the South African context, and they make the geographic siting of new ethanol plants relative to both feedstock production zones and blending hubs a strategic planning decision with significant cost implications.

The scale of the opportunity

South Africa consumed 8.76 billion litres of petrol in 2024 - down from over 11 billion litres pre-2019 as elevated prices, slow economic growth, and gradual efficiency improvements have suppressed demand. Even on this reduced base, the mandated blending volumes are substantial. A 2% ethanol blend (E2) - the entry point contemplated by the current regulatory framework - would require approximately 180 million litres of fuel-grade ethanol per year. An E5 blend would require around 440 million litres annually, and E10 would approach 900 million litres. South Africa currently has no domestic fuel-grade ethanol production at all; its existing non-fuel ethanol industry produces around 282 million litres per year for beverages, pharmaceuticals, and industrial uses - entirely separate from the fuel market. The gap between current domestic capacity and even the most modest blending mandate is large. That gap is also the opportunity.

Even at relatively low blending levels, domestically produced bioethanol introduces a physical volume of fuel into the national supply chain that is insulated from international shipping disruptions and foreign exchange volatility. While it does not eliminate exposure to global fuel markets, it modestly reduces dependency on imported refined products and introduces a degree of domestic resilience into a system that is currently almost entirely externally exposed.

Section 3: The Global Biofuels Opportunity and Rationale

Biofuels are liquid fuels produced from biological materials - crops, plant matter, organic waste, or other biological sources - rather than from fossil fuels. The two most commercially significant types are bioethanol, produced through the fermentation of sugars or starches and blended with petrol, and biodiesel, produced from vegetable oils or animal fats and blended with diesel. This synthesis focuses primarily on bioethanol, which is the most relevant product in the South African sorghum context.

A mature and growing global industry

The global bioethanol industry is large, established, and still growing. The United States and Brazil together account for more than 80% of global production. The US produces around 55 billion litres annually, predominantly from maize, while Brazil - the world's most efficient bioethanol producer - produces approximately 35 billion litres per year from sugarcane. Together, they have demonstrated at massive scale that biofuels can be produced cost-competitively, integrated into fuel distribution systems, and accepted by consumers without significant disruption.

Beyond these two giants, a wide range of countries have established domestic biofuels industries or blending mandates: India, now targeting a 20% ethanol blend (E20) by 2025 using sugarcane juice, molasses, and grain-based feedstocks; the European Union, which has established mandatory blending targets as part of its renewable energy framework; and a growing number of African and Asian nations including Kenya, Zimbabwe, and Indonesia, each with their own feedstock and policy configurations.

Global production of bioethanol has grown from under 20 billion litres in 2000 to over 110 billion litres today, driven by a combination of energy security concerns, climate commitments, and agricultural policy. The industry has matured from an aspirational technology into a proven industrial system.

Why biofuels? The case in brief

The case for biofuels rests on several overlapping rationales, which apply with varying degrees of force in different national contexts.

Energy security is the most immediate driver for many countries. Nations that import petroleum face exposure to global price shocks and supply disruptions. Replacing even a fraction of imported fuel with domestically produced biofuel reduces this exposure and retains spending within the local economy. For South Africa, where fuel imports represent a significant drain on foreign exchange, this argument is compelling.

Climate and environment represent a second driver. Bioethanol, when produced from appropriate feedstocks and with careful management of the production process, can achieve substantial reductions in lifecycle greenhouse gas emissions relative to fossil petrol - often in the range of 40-80% depending on the feedstock and production method. As South Africa faces increasing pressure to reduce emissions under international climate commitments, and as corporate fleets and supply chains face their own decarbonisation requirements, the low-carbon credentials of domestic bioethanol become commercially as well as environmentally relevant.

A third, and often underappreciated, rationale is the moderating effect that domestic biofuel production exerts on international oil prices. Research published in AgBioForum by Hochman, Rajagopal, and Zilberman demonstrated that biofuels, by acting as a competitive substitute to crude oil, erode the market power of oil-exporting nations. When oil-importing countries produce their own fuel from agricultural feedstocks, exporting countries face pressure to reduce their prices to defend market share. The study found that the introduction of biofuels reduced international fuel prices by between 1.07 and 1.10% and increased welfare in oil-importing countries by 2.92 to 4.10%. These may appear modest figures in isolation, but the principle they establish is significant: a country that produces even a fraction of its fuel domestically is not simply substituting one volume of fuel for another - it is participating in a global market dynamic that tends to restrain the pricing power of the OPEC cartel. For a country like South Africa, structurally exposed to oil prices set by a cartel of nations in which it has no voice and no vote, the ability to introduce even a modest domestic fuel supply is a form of economic self-defence.

Agricultural development, rural employment, and localisation form a fourth and particularly important rationale for South Africa specifically. Biofuels represent a form of industrial localisation applied to the fuel sector: replacing a product that is currently imported - refined petroleum - with one that is produced domestically from a locally grown agricultural feedstock, through a processing chain that generates employment, investment, and economic activity within South Africa rather than abroad. The Localisation Support Fund commissioned this study precisely because biofuels sit at the intersection of energy policy, agricultural development, and industrial strategy - and because few other opportunities exist to localise a commodity of such strategic and economic significance. Every litre of domestically produced bioethanol that displaces an imported litre of petrol retains value in the South African economy: it pays wages to farmers, aggregators, plant operators, and logistics workers; it generates tax revenue; and it reduces the foreign exchange outflow that fuel imports represent. In countries with high rural unemployment - and South Africa is one - this localisation dividend is not peripheral to the case for biofuels. It is central.

> **Key global figure**
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> *The United States and Brazil together produce over 90 billion litres of bioethanol annually. Brazil's industry, built on sugarcane, employs over one million people and has enabled the country to supply roughly 40% of its transport fuel needs from domestic renewable sources.*

The food versus fuel debate

Any discussion on biofuels must address the "food versus fuel" trade-off - the argument that using agricultural land and crops for fuel production competes with food production and can push up food prices. This debate has been most acute in the context of maize-based ethanol in the United States and has informed South Africa's cautious approach to its own policy choices.

South Africa's Biofuels Industrial Strategy explicitly excluded maize as a biofuels feedstock on food security grounds, reflecting the importance of maize to South African diets and the risks of using the dominant food crop for energy. This exclusion opens space for other feedstocks - notably sorghum and sugarcane - and is consistent with the international trend toward crops that are better suited to non-prime agricultural land, less central to direct human consumption, or capable of using waste products rather than primary grain. Sorghum, as this synthesis will explain, has specific characteristics that make it well-suited to this role.

Section 4: South Africa's Biofuels Regulatory Journey

South Africa has been discussing biofuels for a very long time. The gap between policy aspiration and implemented market has, until very recently, been large and persistent. Understanding that journey - its milestones, its setbacks, and where it now stands - is essential to understanding both the opportunity and the caution with which it must be approached.

Early recognition: 2003 - 2007

South Africa's formal commitment to biofuels began with the 2003 White Paper on Renewable Energy, which identified biofuels as a strategic priority within the country's broader renewable energy portfolio. In 2005, Cabinet mandated the then Department of Minerals and Energy to develop a Biofuels Task Team and an associated Biofuels Industrial Strategy. The resulting strategy was published in 2007.

The 2007 Biofuels Industrial Strategy was an important document. It set an initial target of (E2) 2% biofuels penetration of the national liquid fuel pool, proposed a government subsidy for biofuels manufacturers, and explicitly excluded maize and jatropha as feedstocks - the former on food security grounds, the latter because of insufficient local evidence of its viability. Sugarcane, sugar beet, cassava, sweet sorghum, grain sorghum, sunflowers, canola, and soybeans were all identified as potential feedstocks. The strategy also identified Cradock in the Eastern Cape as a pilot project site.

Mandatory blending regulations: 2012 - 2015

In 2012, the government gazetted Mandatory Blending Regulations under the Petroleum Products Act, requiring licensed manufacturers and wholesalers of petroleum products to blend locally produced bioethanol and biodiesel into their product at minimum rates of (E2) 2% petrol and (E5) 5% for diesel. These regulations came into effect in October 2015. On paper, this was a significant milestone - a legal obligation to blend.

In practice, however, the mandate was effectively unenforceable. The critical missing piece was a regulated transfer price: without a clear mechanism setting the price at which ethanol producers could sell to fuel blenders, no commercial ethanol plant could confidently plan production, and no blender could commit to purchase. The mandate existed in law but not in practice.

The Biofuels Regulatory Framework: 2019 - 2020

After years of consultation, the government published the Biofuels Regulatory Framework in 2019 and gazetted it in February 2020. This framework set out a comprehensive structure for the sector: a Feedstock Protocol regulating agricultural production to address food security concerns; mandatory blending regulations setting out obligations for fuel manufacturers; a licensing framework for bioethanol and biodiesel producers; sustainability requirements; and provisions for manufacturer support. Importantly, it confirmed that the transfer price would be set at the Basic Fuel Price - a commercially workable basis for investment. But the actual regulated price has not been gazetted at this point.

The 2021 amendments and the long wait

Amendments to the Mandatory Blending Regulations were promulgated in 2021, making further technical refinements. But the transfer price remained unset, and without it, no bank would lend to an ethanol plant, no blender would commit to purchase agreements, and no farmer would plant at scale for a biofuels market that existed only in regulatory text.

August 2025: the transfer price is gazetted

The pivotal moment came in August 2025, when the Department of Mineral and Petroleum Resources gazetted a regulated transfer price for bioethanol under the Petroleum Products Act (Government Gazette No. 53146). The price is linked to the Basic Fuel Price, ensuring that bioethanol can be blended without increasing the retail price of petrol to consumers. This was the last major regulatory barrier to a functional domestic bioethanol market, and its removal - after nearly two decades of policy development - has created a concrete basis for blending mandates and investment decisions.

The policy gap

Between 2015 - when mandatory blending regulations came into effect - and August 2025, South Africa had a legal blending mandate but no regulated price mechanism. For a decade, the regulatory framework was structurally incomplete. The 2025 gazette closes that gap.

The lesson of South Africa's regulatory journey is not only one of delay. It is also one of eventual institutional persistence. The policy infrastructure that now exists - the Feedstock Protocol, the Mandatory Blending Regulations, the sustainability framework, and now the transfer price - is more complete and more coherent than many comparable developing-country frameworks. The question is whether government, industry, and the financial sector will now move with sufficient urgency to translate this framework into a functioning market.

It is worth noting that the 2025 Government Gazette introducing mandatory biofuels blending requirements has also confirmed that the blending mandate will ramp up progressively - beginning at 2% (E2) and with a trajectory toward higher blend levels as domestic production capacity develops. This progressive approach is internationally consistent and reduces the risk of supply shortfalls in the early years.

Section 5: Biofuels Production Process

The viability of biofuels rests on well-established technologies, rather than experimental claims. They are the product of proven agricultural and industrial processes that have been refined over decades of commercial practice in Brazil, the United States, Europe, and many other parts of the world. Understanding the basics of how bioethanol is made is useful for appreciating both the opportunities and the constraints involved in establishing a South African industry.

From crop to fuel: the first-generation pathway

The most commercially mature route to bioethanol - known as first-generation (1G) production - converts the sugars or starches found in agricultural crops into alcohol through a process of fermentation. The basic steps are as follows:

- First, the crop is harvested and transported to a processing facility. If the feedstock is a starchy grain like sorghum or maize, it must first be milled to break the grain into a fine flour or meal. Water and enzymes are then added to convert the starch into fermentable sugars - a process called saccharification. If the feedstock is a sugar-rich crop like sugarcane or sweet sorghum, the juice is pressed or extracted directly.
- The sugar solution is then fermented using yeast, which consumes the sugars and produces ethanol and carbon dioxide. The resulting mixture - called a beer - contains roughly 8-12% ethanol. This is then distilled to separate and concentrate the ethanol, ultimately producing a product of around 95-96% purity. A final dehydration step removes remaining water to produce anhydrous (water-free) ethanol suitable for blending with petrol.

The whole process, from raw grain to fuel-grade ethanol, is well-understood, commercially proven, and supported by a global equipment and technology supply chain. A first-generation grain sorghum plant is not a technology experiment - it is an industrial plant using established technology applied to a well-characterised feedstock.

Scale and capital requirements

Commercial ethanol plants are typically sized at 100 to 400 million litres per year for first-generation production. Plants at the smaller end of this range are more common in emerging markets where feedstock supply chains are still being developed. Capital costs vary depending on size, location, technology choice, and site-specific factors - but for a 100 million litre grain sorghum plant in South Africa, capital investment is estimated in the range of R700 million to R1.25 billion (2025 values). A plant of the size proposed for the Mabele Fuels project in Bothaville, at around 162 million litres per year, has been estimated at approximately R3 billion.

The second-generation pathway and why it is not yet ready

A more technically ambitious route - second-generation (2G) production - converts the fibrous, woody parts of plants (the lignocellulosic material, including stalks, husks, and bagasse) into ethanol. This pathway holds the promise of significantly higher ethanol yields per hectare and reduces competition with food uses of the crop. However, it requires more complex chemistry (breaking down cellulose and hemicellulose requires pre-treatment and specialised enzymes), and the technology is not yet commercially mature at scale.

Integrated 1G/2G plants - which convert both the starchy grain and the fibrous biomass of the same crop - are being developed internationally but remain largely at demonstration scale, with costs substantially higher than conventional first-generation plants. For South Africa, the research is clear: the realistic near-term option is first-generation production using grain sorghum, building the industrial base, supply chains, and regulatory infrastructure on which more advanced technology pathways can later be layered. The emphasis on first-generation production in South Africa should therefore be understood as a strategic sequencing choice rather than a limitation of ambition.

From distillery to the pump: logistics and blending

Once produced, bioethanol must be transported to a blending facility, typically a fuel terminal or refinery, where it is injected into the petrol stream at the mandated blend ratio. Because ethanol cannot be transported in multi-product pipelines, this logistics challenge is material. Road and rail tankers must be used, requiring dedicated storage tanks at both the ethanol plant and the blending terminal. The concentration of South Africa's blending infrastructure in a small number of coastal and inland sites means that the geographic siting of new ethanol plants relative to both feedstock production zones and blending terminals is a strategic decision with significant cost implications.

Section 6: Sorghum as a Biofuels Feedstock

Sorghum (Sorghum bicolor) is one of the world's oldest cultivated crops, with origins in northeast Africa stretching back more than 5,000 years. It is the fifth most produced cereal crop globally, grown across approximately 40 million hectares in over 100 countries. It is drought-tolerant, heat-resistant, and capable of producing reasonable yields under conditions - low rainfall, poor soils, high temperatures - that would cause other crops to fail. These characteristics make it not only a food security crop for millions of people in Africa and Asia, but increasingly a candidate for industrial use in a world where climate change is making water-intensive agriculture harder to sustain across large areas.

Why sorghum for South Africa?

South Africa's agricultural landscape has several features that make sorghum a particularly relevant feedstock option for biofuels. The starting point is land. Analysis by the Bureau for Food and Agricultural Policy (BFAP) finds that only 9.3% of South Africa's total land area can be classified as having high agricultural potential, and 65% of that high-potential land is concentrated in just three provinces - Mpumalanga, KwaZulu-Natal, and Limpopo. When attention turns to moderate and marginal land - lower-rainfall, less fertile areas that are unsuitable for high-input crops like sugarcane or irrigated maize but viable for drought-tolerant crops like sorghum - the picture changes dramatically. Across the key sorghum-suitable provinces of the Free State, North-West, Limpopo, and Mpumalanga alone, approximately 29 million hectares of uncultivated moderate and marginal land has been identified. This is land where sorghum can grow, where maize struggles, and where sugarcane cannot grow at all.

These 29 million hectares are characterised by annual rainfall in the range of 350 to 600 millimetres and soils that are not suited to high-input crop production but that respond well to the low-input, water-efficient cultivation that sorghum requires. It is worth noting that even within this broad category, not all of the land is immediately accessible for large-scale commercial production - estimates suggest that only 20 to 40% of this moderate and marginal land has sufficient road access, electricity, and water infrastructure to support commercially viable cultivation at this stage. But even at the conservative end, this represents a feedstock land base of several million hectares - far in excess of what an initial domestic bioethanol industry would require.

Beyond the broad land category, the Integrated Report identifies three specific geographic corridors as the priority zones for grain sorghum bioethanol production in the near term, based on the intersection of agronomic suitability, existing logistics infrastructure, and proximity to ethanol blending facilities. The first and strongest priority is the northern and western Free State - specifically the Bothaville-Kroonstad-Sasolburg corridor. This area already has well-developed grain logistics including rail sidings and storage capacity, an established agro-processing ecosystem from the maize belt, and excellent proximity both to Gauteng fuel demand and to the Sasolburg, Alrode, and Tarlton blending terminals. The Mabele Fuels project, the most advanced grain sorghum ethanol proposal in South Africa, is sited in Bothaville precisely because of these advantages. The second priority zone is the central North-West Province - the Lichtenburg-Klerksdorp-Mahikeng area - which is well suited to dryland sorghum and maize rotations, has established cattle and poultry farming systems that would create ready demand for DDGS animal feed by-products, and sits at a practical distance from Gauteng terminals. The third zone, suitable as a secondary or later-stage option, is the southern Limpopo Waterberg fringe, where commercial grain sorghum is agronomically viable and rail links exist southward toward processing and blending hubs, provided reliable grain origination contracts can be secured.

The government's exclusion of maize from the biofuels feedstock list means that sorghum, alongside sugarcane, is one of the primary grain options available under the Biofuels Industrial Strategy. And while sugarcane has established large-scale processing infrastructure in KwaZulu-Natal, it is geographically and agronomically unsuited to the drier inland regions where most of South Africa's potential sorghum feedstock land lies. Sorghum fills this geographic gap precisely - and it does so in provinces that need the agro-industrial investment most. Finally, it is worth noting an additional and often overlooked land opportunity: the use of degraded land, including areas affected by historical mining activity, for sorghum production. Research has demonstrated sorghum's tolerance for heavy metals and degraded soils, with studies showing positive results for biomass production on rehabilitated mine land in both South Africa and internationally. In South Africa specifically, work by the University of Limpopo has demonstrated sweet sorghum yielding viable biomass on coal mine waste while improving soil pH and organic matter. This opens a potential link between sorghum production, land rehabilitation, and the Just Energy Transition (JET) agenda in mining-affected communities in Limpopo and Mpumalanga - a combination of benefits that would be difficult to achieve with any other crop.

Two pathways: grain and sweet sorghum

Sorghum offers two distinct routes to bioethanol. The first - grain sorghum - uses the starchy seeds of the plant, processed in the same way as maize in conventional first-generation ethanol plants. The technology is well understood, the processing is compatible with existing maize-based infrastructure, and grain sorghum can be stored and processed year-round, avoiding the seasonal processing constraints of sugar-based feedstocks. Ethanol yields from grain sorghum are typically around 380-400 litres per tonne of grain, comparable to maize.

The second pathway - sweet sorghum - uses the sugar-rich juice extracted from the stalks of specially bred sorghum varieties. Sweet sorghum can achieve high ethanol yields per hectare, and its bagasse (the fibrous residue after juice extraction) can be used for energy generation or as animal feed. However, sweet sorghum juice is highly perishable - it must be processed within 24 to 48 hours of harvest - which creates tight logistical requirements around proximity to processing facilities and precise harvest scheduling. This makes sweet sorghum a higher-potential but higher-risk option than grain sorghum at this stage of South Africa's market development.

> **Near-term focus**
>
> *The research is clear that grain sorghum - processed in first-generation starch-to-ethanol plants - represents the most commercially derisked near-term pathway for South Africa. Sweet sorghum remains a promising medium-term option, particularly in regions with existing crushing infrastructure, but requires more careful logistical design.*

The state of the South African sorghum industry

South Africa's commercial sorghum sector has contracted significantly over the past three decades. The area under sorghum cultivation fell from around 170,000 hectares in the early 1990s to approximately 41,150 hectares in the 2024/25 season, with production of around 138,000 tonnes - a 75% decline. Farmers shifted to maize, sunflowers, and soybeans as these crops offered better prices, better market access, and more commercial support in terms of improved seed, extension services, and input credit.

Average yields in South Africa hover around 2.5 to 3 tonnes per hectare for commercial dryland production, well below the 4 to 5 tonnes per hectare achievable with better seed varieties, improved agronomy, and appropriate mechanisation. A critical and often underemphasised constraint is the state of the sorghum seed industry: unlike maize, which has benefited from decades of sustained breeding programmes and well-developed hybrid seed markets, sorghum seed systems in South Africa are fragmented, rely on outdated varieties, and lack the private-sector investment that drives continuous yield improvement. This seed gap is not a minor technical detail - it is a structural barrier that will need deliberate public-private investment to address.

Existing demand for sorghum comes primarily from the traditional beer brewing industry, where companies like United National Breweries use sorghum malt as a key input. This sector provides a reliable but modest market - insufficient to sustain large-scale commercial production or to signal to farmers that sorghum is a viable cash crop at scale. Biofuels demand, if properly anchored, could transform this picture.

Understanding what drives sorghum prices

For any investor or policymaker assessing the viability of sorghum biofuels, understanding what drives the price of sorghum as a feedstock is fundamental. The research undertaken for this study includes a detailed price modelling framework that traces sorghum price formation from the ground up - and the conclusions are important.

Sorghum prices in South Africa are not set independently. They are anchored to yellow maize prices, which are the dominant reference grain in the local market. When yellow maize trades at a certain level on the South African Futures Exchange (SAFEX), sorghum prices adjust around it, reflecting the substitution relationship between the two crops in feed rations, processing, and end-use markets. A farmer or trader considering whether to sell sorghum or maize, and a feed mill deciding whether to buy one or the other, will base that decision on the relative prices of the two grains. This substitution behaviour keeps the two prices broadly in alignment, with sorghum typically trading at a discount to maize that reflects its lower digestibility in some feed applications and its thinner liquidity.

Yellow maize prices in South Africa, in turn, are strongly shaped by international maize prices - principally by US corn futures prices traded on the Chicago Board of Trade. South Africa is a meaningful participant in global grain trade, exporting surplus maize to regional neighbours in good years and importing from Brazil or Argentina in drought years. This trade exposure means that SAFEX maize prices track global benchmarks, converted through the rand-dollar exchange rate and adjusted for transport and logistics costs. A 10% weakening of the rand, all else being equal, tends to raise local maize prices by 5 to 8%, as import costs rise and export parity improves. Conversely, a stronger rand dampens local prices.

What, then, drives US corn futures? The research reviewed a range of internationally recognised forecasting frameworks - including models developed by the OECD-FAO, the US Department of Agriculture, the Bureau for Food and Agricultural Policy, and academic econometric studies - to identify the dominant factors. Across all of these, a consistent set of drivers emerges. Supply fundamentals matter enormously: the ratio of ending stocks to annual use is among the strongest predictors of corn price, with prices rising sharply and non-linearly when stocks are tight relative to demand. Production volumes and crop yields - influenced significantly by weather and climate variability - translate directly into supply outcomes. Export demand, particularly from major importers like China, Mexico, and Japan, shapes the global balance sheet. And the prices of substitute grains, particularly wheat, move in tandem with corn through feed substitution and land allocation decisions.

Among these drivers, crude oil prices occupy a particularly significant and structurally important position. Oil affects corn prices through two principal channels. First, higher crude oil prices stimulate ethanol production - since ethanol is a substitute for petroleum-based fuel - which increases demand for corn as feedstock, pushing prices up. Second, oil drives the cost of producing and transporting corn through its effect on diesel, fertiliser, and chemical input prices. Research across multiple studies finds that a sustained 10% increase in crude oil prices tends to raise US corn prices in the range of 2.5 to 4%, with some estimates finding that a USD10 per barrel rise in Brent crude adds approximately USD4 to USD4.30 per tonne to corn prices. The World Bank's long-run analysis of the 2005 to 2012 food price boom attributed more than half of the corn price surge in that period to rising crude oil prices - a finding that underscores just how tightly the energy and grain markets had become intertwined once large-scale corn ethanol production was established under the US Renewable Fuel Standard.

The full transmission chain for sorghum prices therefore runs as follows: crude oil prices influence US corn futures, which shape South African yellow maize prices through import-export parity, which in turn anchor local sorghum prices through substitution dynamics - with the rand-dollar exchange rate amplifying or dampening each step along the way. This chain is the formal basis of the price forecasting model developed as part of this study, which is designed to allow investors and policymakers to trace how global shocks - in energy markets, weather systems, trade policy, or currency markets - are likely to propagate into South African sorghum prices over different time horizons.

An important nuance is the distinction between the short run and the long run. Over longer periods - measured in years - the relationships described above are empirically robust: sorghum prices do co-move with maize, maize does track global benchmarks, and global benchmarks do respond to oil. But in the short run, these relationships can lag. A sudden oil price spike may take several months to fully transmit into corn futures, and several more months again to appear in local grain prices, as stocks, contracts, and market expectations absorb the shock first. For business planning and investment decisions, this means that the long-run price relationships provide a defensible basis for financial modelling, while short-run volatility must be managed through hedging, contract structures, and adequate working capital provisions.

Sorghum, rural development, and inclusive localisation

The geography of sorghum's potential in South Africa is not accidental. The provinces best suited to sorghum production - Limpopo, North-West, the Free State, and Mpumalanga - are also provinces with high levels of rural unemployment, significant smallholder farming communities, and a history of limited agro-industrial investment. A sorghum biofuels industry would bring localisation to parts of South Africa's agricultural economy that have seen very little of it: processing plants sited near production zones, aggregation hubs that create employment in small towns, contract farming arrangements that give smallholders a guaranteed market, and a value chain that distributes economic activity across the grain belt rather than concentrating it at ports and coastal terminals. Sorghum's suitability for dryland conditions, its lower input requirements relative to maize, and its compatibility with both commercial and smallholder farming systems give it a particular potential to anchor this form of inclusive, geographically distributed localisation.

Smallholder farmers - those farming on smaller plots, often with limited access to credit, equipment, and markets - face structural barriers to participating in commercial agricultural value chains. Contract farming models, in which an anchor buyer (such as an ethanol plant) provides farmers with certified seed, inputs, technical support, and a guaranteed price and offtake for their harvest, can substantially reduce these barriers. Several examples from Kenya, India, and other parts of Africa demonstrate that anchor-buyer models, backed by aggregation infrastructure, can successfully integrate smallholders into commercial grain value chains and lift incomes significantly.

South Africa's biofuels policy has explicitly recognised the importance of smallholder inclusion. The Feedstock Protocol contemplates support mechanisms for smallholder farmers supplying biofuels feedstocks. But the practical architecture of smallholder integration - the contracts, the aggregation hubs, the extension services, the input finance mechanisms - will need to be deliberately designed rather than assumed to emerge automatically from market forces.

Sorghum's rural development potential extends beyond direct farming income. Aggregation hubs - facilities where grain from multiple farms is collected, dried, graded, and stored - create employment in rural areas and reduce post-harvest losses. Ethanol plants, if sited in or near production zones, generate skilled and semi-skilled employment in operations, maintenance, and logistics. And the by-products of ethanol production - discussed in the next section - create additional value streams that can support local livestock farmers and energy systems.

Sorghum's contribution to rural resilience is also worth noting. As climate change makes rainfall less predictable across large parts of southern Africa, sorghum's drought tolerance makes it a more reliable crop for farmers in marginal areas than maize. Where sorghum is integrated into crop rotation systems, it also contributes to soil health, providing organic matter and, in some documented cases, assisting with soil rehabilitation on degraded or post-mining land. These are not peripheral benefits - they are part of the integrated case for treating sorghum as a strategic crop rather than simply a commodity.

Section 7: By-Product Potential of Sorghum

One of the most important economic features of grain sorghum ethanol production is that the process does not only produce ethanol. It generates a range of valuable by-products that, when properly commercialised, can substantially improve the overall economics of the biorefinery and reduce the cost of ethanol production. Understanding these by-products is essential to understanding whether and when sorghum ethanol becomes commercially viable.

Distillers Dried Grains with Solubles (DDGS)

The most commercially significant by-product of grain sorghum ethanol production is Distillers Dried Grains with Solubles - universally known as DDGS. When grain sorghum is processed for ethanol, only the starch fraction is fermented. The protein, fibre, fat, and other nutrients in the grain remain and are concentrated in the distillers' grains. After drying and blending with the liquid solubles from the distillation process, the result is DDGS: a high-protein animal feed ingredient with a protein content of roughly 26-30%, comparable to soybean meal.

DDGS is a well-established product in international feed markets. In the United States, where corn ethanol produces large volumes of DDGS annually, it is a major ingredient in poultry, swine, and cattle rations. South Africa has a large and growing commercial livestock sector, and DDGS could find a ready market as a partial substitute for soybean meal and other protein ingredients in compound feed. Revenue from DDGS sales can cover a meaningful portion of a grain sorghum ethanol plant's operating costs, significantly reducing the effective cost of ethanol production.

Modelling in the Integrated Report suggests that DDGS revenues, combined with other by-product streams, are critical to the economic viability of first-generation grain sorghum ethanol in South Africa. In some scenarios, by-product revenues shift the economics of a plant from loss-making to near-breakeven - illustrating that the business model for sorghum ethanol is not simply "sell ethanol" but "manage a biorefinery that sells ethanol and multiple co-products."

Carbon dioxide

Fermentation produces carbon dioxide (CO_2) as a direct by-product. In an ethanol plant of meaningful scale, the volume of CO_2 produced is substantial and commercially valuable. Food-grade CO_2 is used in carbonated beverages, food packaging (modified atmosphere packaging to extend shelf life), refrigeration, and fire suppression. Industrial-grade CO_2 has applications in welding, metalworking, and chemical processing.

Capturing and selling CO_2 requires investment in compression, purification, and storage equipment, but the revenue potential - and the contribution to the plant's overall greenhouse gas footprint - makes it a worthwhile consideration in plant design. As carbon markets develop and carbon credits for biogenic CO_2 capture are formalised, this by-product could also contribute to a plant's carbon credit revenue.

By-products of sweet sorghum processing

Sweet sorghum processing generates a different set of by-products. The bagasse - the fibrous residue remaining after juice extraction - can be used as a biomass fuel to generate process heat and electricity for the plant, reducing energy costs, or can be processed into animal feed or biogas. Vinasse, the liquid effluent from the distillation process, is nutrient-rich and can be applied to agricultural land as a biofertiliser. Filter cake from the pressing process has similar fertiliser value.

In an integrated sweet sorghum biorefinery, these material streams can be managed to create a largely closed-loop system where waste from one process becomes a feedstock or input for another. The environmental credentials of such a system are strong, and the economics improve with each by-product stream that is captured and sold rather than discarded.

The ISCC certification advantage

For any ethanol plant seeking to access premium export markets - particularly in the European Union - sustainability certification is increasingly important. The International Sustainability and Carbon Certification (ISCC) system verifies that bioethanol has been produced in compliance with greenhouse gas reduction requirements, land use change restrictions, and social standards. Achieving ISCC certification not only opens export market access but also strengthens the credibility of carbon credit claims and improves the plant's environmental, social, and governance profile for investors. This is not a distant consideration - it is a design and operational requirement that should be built into plant planning from the outset.

Section 8: Other Feedstock Potential

While sorghum is the primary focus of this study, South Africa's biofuels feedstock landscape is not limited to a single crop. Several other agricultural products have the potential to contribute to domestic bioethanol and biodiesel production, and understanding this broader feedstock picture is important for designing a resilient and diverse biofuels industry.

Sugarcane and molasses: the established base

South Africa's sugarcane industry, concentrated in KwaZulu-Natal with some production in Mpumalanga and the Eastern Cape, is the most immediately available source of fermentable material for bioethanol production. Sugarcane juice and molasses - the thick syrup remaining after sugar crystallisation - are both well-established ethanol feedstocks with proven processing technology. The South African industry already produces ethanol from molasses for beverages, pharmaceuticals, and industrial uses.

The sugarcane sector has faced significant structural difficulties in recent years - depressed sugar prices, competition from cheap imports, drought impacts, and civil unrest in KwaZulu-Natal in 2021, which caused widespread damage to industry infrastructure. In this context, diversifying into bioethanol represents both an opportunity and a potential lifeline for an industry under pressure. The South African Sugarcane Master Plan has further explicitly identified bioethanol as a component of the sector's recovery and growth strategy.

Import-parity analysis suggests that domestically produced sugarcane/molasses ethanol is currently cost-competitive with imported ethanol: local costs in 2025 are estimated at R12.50 - 14.30 per litre, compared with a landed import-parity price of R14 - 20 per litre for US and Brazilian ethanol. This cost competitiveness - without the need for significant policy support - makes sugarcane a strong near-term anchor for South Africa's bioethanol market, while sorghum builds its supply chain over the medium term.

It is important to emphasise that sorghum and sugarcane are better understood as complementary feedstocks rather than competitors. Sugarcane is suited to the coastal and sub-tropical zones of KwaZulu-Natal; sorghum is suited to the drier, inland semi-arid regions. Together, they can provide geographic and seasonal diversification in feedstock supply, strengthening the overall resilience of the bioethanol industry.

Maize: excluded but adjacent

Maize is the dominant grain crop in South Africa, produced at scale across the maize triangle of the Free State, Mpumalanga, and North-West. However, it is explicitly excluded as a biofuels feedstock under the Biofuels Industrial Strategy on food security grounds - and this exclusion is appropriate and should be maintained.

There is, however, a nuanced exception. Downgraded maize - grain that has failed food and feed quality standards due to mould, contamination, or other quality defects, and cannot be used for human consumption or animal feed - represents a potential feedstock that does not compete with food uses. The Integrated Report identifies this as a commercially interesting option, particularly for ethanol plants in the maize triangle that could process downgraded grain during years of good rainfall when large volumes of off-specification material enter the market. This option can reduce feedstock risk for producers without impacting food security and enabling it through policy clarification could be an early and relatively straightforward win.

Other oilseeds for biodiesel

On the biodiesel side - produced from vegetable oils and blended with diesel - South Africa has potential feedstocks including sunflowers, canola, and soybeans. Sunflowers in particular are well suited to the drier inland regions and are already produced at commercial scale. However, the economics of biodiesel in South Africa are currently less favourable than for bioethanol, partly because the diesel market is larger and more exposed to cheaper imported palm oil from Southeast Asia. The policy framework for biodiesel - including a 5% mandatory biodiesel blend (B5) in the Mandatory Blending Regulations - exists, but implementation faces similar infrastructure and pricing challenges as bioethanol.

The multi-feedstock future

International experience suggests that the most resilient bioethanol industries are those that can draw on multiple feedstocks, switching between them as relative prices, seasonal availability, and supply conditions evolve. In the United States, ethanol plants commonly process both maize and grain sorghum, adjusting their feedstock mix based on price signals. In Brazil, sugarcane mills have increasingly integrated sweet sorghum as an off-season feedstock, extending their crushing season and improving capital utilisation.

South Africa should design its biofuels policy and industrial infrastructure with this multi-feedstock flexibility in mind, even if the initial market is anchored in grain sorghum and sugarcane. The ability to integrate downgraded maize, sweet sorghum, and potentially other feedstocks over time will improve the sector's economics, reduce supply risk, and allow the industry to grow without being permanently dependent on the fortunes of a single crop.

Section 9: International Benchmarks

South Africa is not the first country to consider establishing a grain sorghum biofuels industry, and it is not building in a vacuum. A comprehensive review of the experience of the United States, Brazil, India, Kenya, and Zimbabwe - conducted as part of the Integrated Report - provides important lessons about what works, what does not, and what South Africa needs to get right.

The United States: sorghum as a flexible adjunct feedstock

The United States operates the world's largest bioethanol industry by volume, producing around 55 billion litres per year predominantly from maize. Grain sorghum plays a consistent but secondary role, functioning as a price-responsive substitute that ethanol plants blend with maize depending on relative grain prices. When maize prices rise, plants switch toward sorghum; when sorghum is pricier, they shift back to maize. This flexibility is possible because grain sorghum and maize are processed using essentially the same technology and equipment.

The US industry was built on three foundations that remain instructive: the Renewable Fuel Standard, which mandated specific volumes of renewable fuel in the transport fuel pool and provided revenue certainty for producers; substantial fiscal support in the early years, including blending tax credits and agricultural subsidies; and a large, sophisticated grain handling and logistics infrastructure that could be leveraged for ethanol feedstock supply. The lesson for South Africa is not to replicate the US scale but to recognise that mandate certainty - the guarantee of a market - was the non-negotiable precondition for private investment.

Brazil: the world's most efficient bioethanol producer

Brazil's experience with sugarcane bioethanol is the global benchmark for a successful national biofuels programme. Over several decades, Brazil built an industry that now supplies roughly 40% of the country's transport fuel requirements from sugarcane, employs over a million people, and has driven sugarcane ethanol production costs down to levels that are competitive with fossil petrol at most oil price ranges.

The Brazilian model was built on long-term policy commitment - successive governments maintained blending mandates through changing economic conditions - combined with public-private investment in infrastructure, including dedicated ethanol pipelines and storage, and a development bank (BNDES) that provided long-term concessional finance for ethanol plant construction and expansion. More recently, Brazil introduced RenovaBio, a carbon credit scheme that rewards efficient ethanol producers with tradable certificates (CBIOs), providing an additional revenue stream linked to carbon performance. South Africa would do well to study this model carefully.

Sweet sorghum has played a growing complementary role in Brazil's sugarcane ethanol industry. Because sugarcane has a defined growing and crushing season, mills stand idle for several months each year. Sweet sorghum, which can be harvested in the off-season and processed in the same crushing equipment, extends the operating season and improves capital utilisation. Brazil's experience demonstrates that sweet sorghum is not a replacement for sugarcane but a seasonal complement - a model that may have direct applicability to South Africa's KwaZulu-Natal sugar industry.

India: scaling through smallholders

India's national ethanol programme has set an ambitious target of 20% ethanol blending (E20) by 2025, drawing on sugarcane juice and molasses as primary feedstocks but also actively exploring grain-based and sweet sorghum options to diversify supply and extend the programme into drier agricultural regions. A key feature of the Indian model is the use of a Minimum Support Price (MSP) - a government-guaranteed minimum price for sugarcane delivered to mills - which provides farm-level income certainty and incentivises production. India has also experimented with decentralised sweet sorghum processing, where small-scale syrup units process cane close to the farm and transport concentrated syrup to larger distilleries, reducing the perishability problem.

For South Africa, the Indian experience is particularly relevant given the importance of smallholder farmer inclusion. The use of structured price support, tripartite contracting (farmer-aggregator-processor), and decentralised processing infrastructure to make grain and sweet sorghum viable for smaller producers offers a model that could be adapted to South African conditions.

Kenya: the power of anchor buyers

Kenya's experience with sorghum illustrates a different dimension of market development. The East African Breweries Limited (EABL), which produces Senator Keg sorghum beer, created a stable, commercial demand for sorghum that transformed smallholder farmer behaviour in western Kenya. By providing guaranteed offtake at transparent prices, along with technical support and input finance, EABL demonstrated that an anchor-buyer model - even without government subsidy - could bring large numbers of smallholder farmers into a commercial grain value chain and sustain supply at meaningful volumes.

The lesson for South Africa's biofuels programme is direct: anchor demand - whether from a brewery or an ethanol plant - changes farmer behaviour in ways that spot markets alone cannot. When farmers know they have a buyer, at a predictable price, they plant more, invest in better inputs, and adopt improved practices. This behavioural shift is the foundation of supply chain development, and it must be built into the design of South Africa's sorghum biofuels programme from the outset.

Zimbabwe: a cautionary tale

Zimbabwe's experience with ethanol blending offers important lessons about what to avoid. Zimbabwe mandated ethanol blending in its petrol supply but awarded the ethanol production licence to a single supplier with exclusive rights - creating a monopoly that faced few competitive pressures to improve efficiency or reduce costs. When the sole supplier experienced production difficulties or politically-linked disruptions, fuel shortages resulted. The blending mandate was at various points suspended, reinstated, and controversially managed, undermining industry credibility and investor confidence.

The Zimbabwean cautionary lesson for South Africa is threefold: avoid monopoly supply structures; maintain policy consistency and resist the temptation to suspend mandates when short-term supply conditions are difficult; and ensure that the pricing mechanism is transparent and rule-based rather than subject to political discretion.

Common lessons across benchmarks

Across all five countries studied, the research identifies a consistent pattern of what drives successful bioethanol industry development. Governments first stabilised demand through legally enforceable mandates and clear pricing rules, then rapidly aligned agricultural supply by anchoring ethanol demand to existing grain and sugar value chains via contract farming, aggregation infrastructure, and guaranteed offtake. In all successful cases, governments avoided attempting to push supply through subsidies alone; instead, they translated mandate certainty into structured demand signals, supported aggregation, de-risked first movers, and allowed productivity gains to follow market integration.

The universal lesson

Across the United States, Brazil, India, and Kenya, ethanol industries emerged where demand was mandated credibly and revenue rules were known in advance. Policy certainty on blending is non-negotiable. Anchor demand is essential. Farmer integration will need to be designed, not assumed.

Section 10: The Economics and Investment Case

The most important question for any policymaker or investor considering South Africa's sorghum biofuels opportunity is straightforward: does it make economic sense? The honest answer from the Integrated Report's modelling is nuanced - and it is important to set out that nuance clearly.

Figure 1 Key Outputs from LSF Integrated Biofuels Model

Key Outputs

All values per litre of ethanol produced (ZAR/L) (other than Cross-Subsidy on Remaining Petrol Pool which in ZAc, i.e. ZAR cents)

Key Assumptions		
Brent Crude	USD	80.00
Exchange Rate	ZAR/USD	16.50
Project IRR Hurdle Rate	% p.a.	15%
Plant Economic Life	Years	25.00

Plant	Unit	Grain Sorghum Biofuels Plant	Grain Sorghum & Maize Biofuels Plant	Sweet Sorghum Biofuels Plant	Sugarcane Biofuels Plant (New)	Sugarcane Biofuels Plant (Conversion)	Maize Biofuels Plant ('Off Spec')
Plant Economics (Section 4)							
Revenue	ZAR/L						
Ethanol	ZAR/L	11.13	11.13	11.13	11.13	11.13	11.13
DDGS	ZAR/L	4.68	4.66	3.18	0.00	0.00	4.68
CO_2	ZAR/L	1.91	1.91	1.91	2.34	2.34	1.92
Total revenue	ZAR/L	**17.72**	**17.70**	**16.22**	**13.47**	**13.47**	**17.73**
Less: Feedstock cost	ZAR/L	(12.20)	(13.15)	(15.97)	(11.08)	(11.08)	(14.12)
Gross profit	ZAR/L	**5.52**	**4.54**	**0.25**	**2.39**	**2.39**	**3.61**
Less: Variable opex	ZAR/L	(3.01)	(3.01)	(3.01)	(1.66)	(1.66)	(3.01)
Less: Fixed opex	ZAR/L	(0.58)	(0.58)	(0.58)	(0.41)	(0.68)	(0.61)
Operating profit (EBITDA)	ZAR/L	**1.94**	**0.96**	**(3.34)**	**0.33**	**0.05**	**(0.01)**
Less: Capital servicing	ZAR/L	(2.75)	(2.75)	(2.75)	(1.95)	(3.27)	(2.91)
Operating cash flow	ZAR/L	**(0.82)**	**(1.80)**	**(6.09)**	**(1.63)**	**(3.22)**	**(2.92)**
Farmer Economics (Section 5)							
Farmer revenue (feedstock sales)	ZAR/L	12.20	13.15	15.97	11.08	11.08	14.12
Less: Direct variable expenses	ZAR/L	(8.23)	(8.91)	(9.34)	(4.35)	(4.35)	(9.60)
Less: Fixed overheads	ZAR/L	(1.56)	(1.70)	(2.29)	(1.06)	(1.06)	(1.85)
Less: Marketing / mill deductions	ZAR/L	(0.04)	(0.14)	(0.08)	(0.00)	(0.00)	(0.24)
Farmer gross margin	ZAR/L	**2.37**	**2.40**	**4.26**	**5.67**	**5.67**	**2.43**
Gross Value Added (Section 6)							
GVA per litre ethanol	ZAR/L	**5.73**	**4.88**	**3.50**	**7.79**	**7.64**	**4.06**
Operating surplus share	%	75.2%	68.8%	26.4%	77.0%	74.9%	59.7%
Compensation of employees share	%	24.8%	31.2%	73.6%	23.0%	25.1%	40.3%
Breakeven ethanol price	ZAR/L	**11.94**	**12.93**	**17.22**	**12.75**	**14.35**	**14.04**
Breakeven feedstock price	ZAR/ton	**3,761**	**2,849**	**229**	**691**	**575**	**3,659**
Farmer surplus / (deficit) at breakeven price	ZAR/ton	513	(954)	(687)	296	180	(157)
Cross-Subsidy on Remaining Petrol Pool	ZAc / L	**1.66**	**3.67**	**12.43**	**3.32**	**6.57**	**5.95**

***Note**: All values per litre of ethanol produced. Figures recalculate live when upstream assumptions change. GVA measures the total economic value created across the biofuels value chain (GDP-equivalent via the income approach, before production taxes & subsidies) — i.e. the sum of returns to labour and capital generated by farming, feedstock processing, and ethanol production per litre. Cross-Subsidy on Remaining Petrol Pool is the levy (in ZA cents per litre) that would need to be added to the non-biofuel portion of the petrol pool (98% under a 2% blend mandate) to fund the breakeven shortfall on the bioethanol blend — i.e. how much petrol consumers would effectively cross-subsidise to make the biofuels plant cash-flow neutral.*

The core economic challenge

The profitability of a grain sorghum ethanol plant in South Africa is determined primarily by three variables: the price at which feedstock (grain sorghum) can be sourced; the price at which ethanol can be sold (linked to the Basic Fuel Price under the new regulated transfer price framework); and the revenues generated from by-products, principally DDGS.

The challenge is that the ethanol selling price is essentially fixed by the Basic Fuel Price - itself linked to the international crude oil price in US dollars, adjusted for the rand-dollar exchange rate. The feedstock price, meanwhile, is determined by domestic agricultural markets and is partly influenced by demand from competing uses (food, feed, brewing). The spread between these two - feedstock cost and ethanol revenue - is the fundamental driver of plant viability.

The Integrated Report's scenario modelling assessed six different feedstock and technology configurations: grain sorghum, grain sorghum blended with downgraded maize, sweet sorghum, new and converted sugar plants, and maize plants processing off-specification stocks. The clear finding is that under current conditions - with low scale, low average yields, and some remaining policy uncertainties - none of these configurations generates a sustainably positive margin at refinery level without some form of policy or financial support somewhere in the value chain. This is not a counsel of despair; it is a calibrated statement of the conditions that need to change, and of the targeted interventions that can change them.

Oil prices: present on both sides of the equation

A particularly striking feature of the sorghum biofuels economics - and one with direct implications for investment and policy design - is that crude oil prices appear on both sides of the equation simultaneously. On the revenue side, the price at which a bioethanol plant can sell its product is linked to the Basic Fuel Price, which is itself driven by the international crude oil price in US dollars. When oil is expensive, the BFP rises, the ethanol transfer price rises with it, and the revenue per litre of ethanol produced improves. On the cost side, however, oil prices - through the transmission chain described in the sorghum price modelling work - also push up the cost of the feedstock. Higher oil prices stimulate corn ethanol demand in the United States, raise US corn futures, transmit through to South African maize parity pricing, and ultimately lift the price that sorghum commands in the local market.

This dual exposure means the relationship between oil prices and sorghum ethanol profitability is not a simple one. Both revenues and feedstock costs move in the same direction when oil prices shift. Whether rising oil prices are good or bad for an ethanol plant depends on the relative speed and magnitude of these two effects - and on the rand-dollar exchange rate, which amplifies both. The sorghum price modelling work finds that the long-run relationship between oil, grain prices, and ethanol revenues does provide a degree of natural covariance that offers some partial offsetting effect: when revenues are higher because oil is up, costs are also higher, but the relationships are not perfectly synchronised or proportional. In the short run - during periods of sharp oil price movements - lags in the grain price transmission chain mean that the revenue effect (which flows through the BFP almost immediately each month) can temporarily outpace the cost effect (which takes time to work through from US corn futures to SAFEX maize to local sorghum procurement). For producers, these windows of positive spread represent the periods when margins are strongest, and they underscore the value of having hedging instruments and flexible procurement arrangements in place.

For policymakers, the dual oil price exposure has an important implication for how support instruments should be designed. Viability gap funding and pricing support mechanisms that are calibrated to current market conditions should anticipate that both the cost and revenue environment will shift together as oil markets move. A support mechanism that assumes a fixed ethanol price and a fixed feedstock cost will quickly become either over-generous or inadequate as oil prices fluctuate. The better design - which the research recommends - is to anchor support to the spread between the BFP-linked ethanol price and a transparent feedstock reference price, allowing the instrument to self-calibrate as market conditions evolve rather than requiring constant political renegotiation.

What the model shows: six feedstocks assessed

The financial modelling at the heart of this study assesses six distinct feedstock and technology configurations under a common set of assumptions: an exchange rate of R16.50 to the US dollar, a Brent crude oil price of USD80 per barrel, a 15% weighted average cost of capital, and a plant economic life of 25 years. The regulated ethanol transfer price under the 2025 mandate framework is set at R11.13 per litre - uniform across all configurations, since all producers sell into the same BFP-linked market. Feedstock prices are set at the level required for a farmer to break even on their production costs given current input prices - in other words, this is not a speculative or optimistic feedstock price assumption, but the minimum price a farmer would need to sustain commercial cultivation. The six configurations assessed are: pure grain sorghum; a grain sorghum and downgraded maize blend; sweet sorghum; a new-build sugar plant; a converted existing sugar plant; and a plant processing off-specification maize that cannot be used for food or feed.

The headline finding is that none of the six configurations reaches profitability under these baseline assumptions without some form of policy support. This should be read carefully. The modelling is not designed to show that a biofuels industry is impossible - it is designed to show precisely how large the viability gap is, where it sits in the value chain, and what interventions can close it. The gaps are real, but they vary substantially across configurations, and that variation is itself one of the most important findings of the analysis.

Grain sorghum: the strongest performer

Of the six configurations, pure grain sorghum — processed in a first-generation starch-to-ethanol plant — produces the smallest operating deficit and remains the closest to commercial viability under current conditions. The model shows total revenue of R17.72 per litre, combining ethanol revenue with by-product revenues from DDGS and CO_2 sales. Against this, feedstock, fixed, and operating costs produce a gross profit of R5.52 per litre, and an operating profit (EBITDA) of R1.94 per litre — a positive result at the operating level that confirms the underlying process economics are sound. However, once capital servicing is included, the operating cash flow moves into deficit at -R0.82 per litre, reflecting the weight of capital costs on a sector that remains at an early, sub-scale stage of development.

To put that in perspective: the breakeven ethanol price — the transfer price a producer would need from the mandate pricing framework to cover all costs including capital — is R11.94 per litre. The cross-subsidy on the remaining petrol pool required to support grain sorghum ethanol at current conditions is just 1.66 ZAc per litre of petrol, a figure that is strikingly small relative to the scale of the industrial and rural development opportunity it would unlock. The farmer gross margin of R2.37 per litre of ethanol produced confirms that the upstream economics are workable: farmers can participate viably in the sorghum supply chain at modelled feedstock prices. These numbers tell a consistent story — the grain sorghum configuration is not yet self-sustaining under current policy and pricing conditions, but the gap between where it is and where it needs to be is narrow enough that targeted intervention, improvements in yield, or modest adjustments to by-product pricing could close it without recourse to large-scale subsidy.

The headline number

Under the baseline model assumptions, a grain sorghum ethanol plant generates positive EBITDA of R1.94 per litre but falls short of full cost recovery — including capital — by R0.82 per litre of ethanol produced. This is the narrowest operating cash flow deficit of any feedstock configuration modelled, and the cross-subsidy required on the remaining petrol pool to bridge the gap is just 1.66 ZAc per litre of petrol blended.

The by-product advantage: why grain sorghum outperforms

A critical reason for grain sorghum's relative strength is its by-product revenue profile. When grain sorghum is processed for ethanol, the non-starch components of the grain — protein, fibre, fat — are concentrated into DDGS, which commands a strong market price as a high-protein animal feed ingredient. Combined with capturable CO_2, by-product revenues make a substantial contribution to the plant's total income of R17.72 per litre — worth considerably more than half the value of the ethanol itself. This is not a speculative revenue stream; DDGS markets are well established, and South Africa's large commercial poultry and cattle sectors provide ready local demand.

The contrast with sugar-based configurations is instructive. A new-build sugarcane plant generates total revenue of only R13.47 per litre — R4.25 per litre less than grain sorghum — reflecting the different co-product profile of sugarcane processing, where bagasse and molasses are the primary residues rather than protein-rich distillers grains. Despite sugarcane's lower feedstock cost per tonne, the operating cash flow deficit for a new sugarcane plant is -R1.63 per litre, compared to -R0.82 per litre for grain sorghum, and the cross-subsidy on the remaining petrol pool required is 3.32 ZAc per litre — exactly double the grain sorghum figure of 1.66 ZAc. The by-product revenue advantage is the single largest factor explaining why grain sorghum remains the most viable configuration across the six scenarios modelled.

How the other configurations compare

The grain sorghum and maize blend configuration — which combines sorghum with downgraded maize that cannot enter the food or feed market — produces an operating cash flow deficit of R1.80 per litre, with a cross-subsidy requirement of 3.67 ZAc per litre on the remaining petrol pool. Its total revenue of R17.70 per litre is almost identical to pure grain sorghum, and by-product income is similarly comparable, but EBITDA falls to R0.96 per litre as feedstock costs are higher because off-specification maize, while cheaper than food-grade grain, still commands a significant market price. The blend configuration is most viable in years when large volumes of downgraded maize are available — a variable that depends on seasonal weather conditions and crop quality — making it a useful but unreliable source of feedstock flexibility rather than a primary strategy.

Sweet sorghum performs the weakest of the sorghum-based configurations, with an operating cash flow deficit of R6.09 per litre and a cross-subsidy requirement of 12.43 ZAc per litre — more than seven times the grain sorghum figure. The model shows negative EBITDA of -R3.34 per litre, meaning the configuration fails to cover even operating costs before capital is considered. The primary driver remains the logistical costs and yield limitations of fresh stalk processing: sweet sorghum requires rapid processing after harvest, stalk volumes are large, and the relatively low sugar content per tonne of fresh material means more biomass must be moved, crushed, and managed for every litre of ethanol produced. Sweet sorghum's high potential per hectare is real, but the processing economics under current conditions make it the most challenging near-term configuration by a considerable margin.

The converted sugar plant configuration — repurposing existing sugarcane crushing infrastructure for ethanol production — generates an operating cash flow deficit of R3.22 per litre and a cross-subsidy requirement of 6.57 ZAc per litre, roughly double that of a new-build sugar plant. This finding suggests that while the concept of converting existing sugar mills is appealing in theory, the economics of conversion need careful scrutiny on a plant-by-plant basis, and that optimised new-build design outperforms retrofitting under the modelled assumptions. Finally, the off-specification maize plant configuration runs an operating cash flow deficit of R2.92 per litre despite achieving near-breakeven EBITDA of -R0.01 per litre — indicating that operating economics are almost viable but capital costs remain the binding constraint. Its cross-subsidy requirement of 5.95 ZAc per litre reflects the weight of feedstock cost, as even degraded grain commands a significant price given its alternative uses.

Reading the deficit in context: the fuel pool argument

It is important to understand what the producer margin deficit means — and what it does not mean. The -R0.82 per litre operating cash flow deficit for grain sorghum, or the -R1.63 per litre for a new sugarcane plant, represents the shortfall for the ethanol producer on each litre of biofuel they produce after all costs including capital are accounted for. It does not represent a cost imposed on every litre of fuel in the market.

Under an E2 blending mandate, bioethanol constitutes 2% of the total fuel pool. If the operating cash flow deficit for grain sorghum ethanol is R0.82 per litre of ethanol, the cost of that deficit distributed across the entire blended fuel pool is 2% of R0.82 — approximately R0.016 per litre of total fuel sold at the pump. For a motorist buying 50 litres of petrol, the cost of supporting grain sorghum ethanol production would be around 82 cents per fill — less than the typical monthly fuel price adjustment. The cross-subsidy lens tells the same story more directly: at 1.66 ZAc per litre of petrol, grain sorghum is the least expensive configuration to support across the entire petrol pool. Even for the weakest-performing configuration — sweet sorghum at a deficit of R6.09 per litre and a cross-subsidy of 12.43 ZAc per litre — the distributed cost across the fuel pool at E2 is modest in the context of fuel price volatility. These are not trivial sums in aggregate across all fuel sold, but they reframe the question considerably. The choice is not between a costly biofuels subsidy and a free market alternative; it is between a very modest, distributed cost and the continuation of a fuel supply system entirely exposed to geopolitical risk, currency volatility, and import dependency.

For grain sorghum specifically, the case is even more compelling when the full range of offsetting benefits is considered. A grain sorghum ethanol industry at E2 scale would generate approximately 180 million litres of ethanol per year, requiring investment of several billion rand in plant and infrastructure, creating direct and indirect employment across a value chain spanning farming, aggregation, processing, and logistics, generating DDGS that reduces South Africa's dependence on imported protein feed ingredients, and retaining fuel-related expenditure within the domestic economy rather than exporting it. The operating cash flow deficit of R0.82 per litre — equivalent to a cross-subsidy of just 1.66 ZAc on every litre of petrol blended — that currently prevents this from happening on purely commercial terms is a structural market failure in an infant industry, not evidence that the underlying economics are fundamentally broken.

What needs to change: a calibrated view

The modelling is useful precisely because it identifies not just that a gap exists, but where it sits and how sensitive it is to the key variables. For grain sorghum, the plant can afford to pay R3,761 per tonne for feedstock at current ethanol prices and cost assumptions. The farmer breakeven price is R3,247 per tonne, meaning there is a farmer surplus of R514 per tonne even at the plant's maximum affordable feedstock price — farmers can participate profitably in the sorghum biofuels value chain under current conditions. The gap is not between the farmer and the plant; it is between the plant's affordable feedstock price and the cost of capital recovery. The plant generates positive EBITDA of R1.94 per litre, confirming that the underlying process economics are commercially rational, but capital servicing tips operating cash flow to -R0.82 per litre. Closing this is therefore primarily a financing and scale challenge — concessional capital, phased investment, or a modest viability gap payment targeted at the plant level — rather than a problem requiring broad agricultural subsidy or fundamental restructuring of the farming economics.

For the sugarcane configurations, the plant-level economics remain under pressure — operating cash flow deficits of R1.63 per litre for a new build and R3.22 per litre for a conversion — but the farmer picture is more encouraging than it first appears. The sugarcane farmer breakeven price is R395 per tonne, and the plant can afford to pay R691 per tonne for a new build and R575 per tonne for a conversion. In both cases the plant's affordable feedstock price comfortably exceeds the farmer's breakeven, leaving meaningful headroom for grower participation. The constraint for sugarcane is therefore entirely on the processor and financing side, not the farming side — a distinction that matters for how policy support is designed. For sweet sorghum, the situation is more fundamental: the plant breakeven feedstock price of R229 per tonne is far below any realistic farmer supply price, and the farmer gross margin of R4.26 per litre reflects genuinely strong agronomic returns that the processing economics are simply not yet able to monetise. Near-term commercial viability would require either a substantial improvement in processing efficiency, a material reduction in logistics costs, or a higher mandated ethanol price. The research therefore reinforces the sequencing argument: start with grain sorghum and the most viable sugarcane configurations, build the market and the policy infrastructure, and allow sweet sorghum to develop as a medium-term option as technology, logistics, and dedicated variety development mature.

The import parity question

An important consideration for any domestic bioethanol industry is its cost competitiveness relative to imported ethanol. South Africa currently imports small volumes of fuel-grade ethanol at landed costs estimated at R14-20 per litre (2025 values). US and Brazilian ethanol, delivered to a South African blending terminal, sets the effective price ceiling for domestic production. Local sugarcane/molasses ethanol is currently estimated at R12.50-14.30 per litre - competitive with imports. Grain sorghum ethanol, with a breakeven price of R11.94 per litre under current modelled conditions, sits below the lower bound of the import parity range — suggesting that with targeted support to close the capital recovery gap, domestic grain sorghum ethanol could be cost-competitive with imports without requiring a high or permanent subsidy. The analysis does not suggest that imports should be blocked, but rather that domestic producers need time and targeted support to reach cost-competitive levels - as was true in every country that has successfully built a biofuels industry.

What the economics tell us

A 100 million litre grain sorghum ethanol plant in South Africa requires capital of approximately R700 million to R1.25 billion. At current feedstock costs and ethanol prices, first-mover plants cannot reach breakeven without support. The combination of mandate certainty, improved yields, full by-product valorisation, and targeted viability gap funding can make the economics work - but the sequencing and design of these interventions must be deliberate.

The broader economic case: localisation at scale

Looking beyond the individual plant's profit-and-loss account, the macroeconomic case for a domestic bioethanol industry is substantial — and it is most clearly understood as a localisation opportunity.

South Africa currently spends significant foreign exchange importing refined petroleum products from international suppliers, with no domestic value added beyond storage, blending, and distribution. A domestic bioethanol industry changes this structure. It localises the production of a fuel component that is currently entirely imported, anchoring that production in South African agriculture, processing capability, and infrastructure. Every litre of domestically produced ethanol that enters the blending pool represents a litre of imported refined product that does not need to be purchased abroad, and a litre's worth of economic activity that stays within the South African economy.

The model quantifies this directly through its Gross Value Added metric. For every litre of ethanol produced, a grain sorghum plant generates R5.73 of GVA in the South African economy — encompassing farm income, processing wages, input procurement, logistics, and associated services. A new sugarcane plant generates R7.79 per litre, and a converted sugar plant R7.64 per litre, reflecting the deeper integration of an established agricultural industry. Even the weakest configuration — sweet sorghum at R3.50 per litre — generates meaningful domestic economic activity. These are not accounting abstractions; they represent the difference between rand circulating through the South African economy and rand flowing abroad to pay for imported fuel components.

The scale of this localisation dividend is meaningful even at modest blend levels. Under an E2 mandate, the annual ethanol market would be worth approximately R2.5–R3.5 billion at current prices — money that would flow to domestic grain producers, aggregators, processors, logistics operators, and workers rather than to international fuel exporters. At E10 scale, the numbers are an order of magnitude larger. Job creation estimates from the Integrated Report suggest that a fully developed grain sorghum ethanol industry at E10 scale — requiring approximately 900 million litres per year — could support tens of thousands of jobs across the value chain, from farm to distillery to blending terminal. The fiscal benefits — from reduced import expenditure, increased tax revenues from a new industrial sector, and the multiplier effects of rural employment and investment — reinforce the case further. South Africa's industrial policy has long sought to identify sectors where domestic capability can displace imports at meaningful scale. It is difficult to identify a more compelling candidate than liquid fuels, where the import bill is large, the domestic agricultural capability is demonstrably present, and the technology to bridge the two is commercially proven across multiple countries.

Independent academic research supports these conclusions. A 2024 study by Mvelase and Ferrer, published in Energy Conversion and Management: X, used a Social Accounting Matrix model of the South African economy to quantify the macroeconomic effects of bioethanol production from sugarcane. The research found that bioethanol production generates positive economy-wide impacts across multiple dimensions simultaneously: GDP growth, employment creation, gross capital formation, a positive contribution to government revenues, improved household welfare across income categories, and a favourable balance of payments effect from reduced fuel import expenditure. Critically, the study found that expanding the scale of bioethanol plants magnifies all of these benefits — the economics of scale work in the public interest as well as the commercial one. The authors identified three principal bottlenecks standing between South Africa and these outcomes: high feedstock costs, limited investment, and the absence of a mandatory blending policy. The August 2025 gazetting of the regulated ethanol transfer price has directly addressed the third of these — and the recommendations in this synthesis are designed to address the first two. What the Mvelase and Ferrer research adds to the case is the economy-wide validation: the benefits of bioethanol production are not confined to the value chain itself but ripple outward through the broader economy in ways that make the public investment case stronger still.

Section 11: Recommendations

The research underpinning this synthesis has produced a detailed, sequenced set of recommendations for establishing a viable sorghum biofuels industry in South Africa. These recommendations are structured around a core principle drawn consistently from both the modelling work and the international benchmarks: interventions must be sequenced carefully, with demand certainty established first, before upstream supply investments can be expected to respond. The full detail of the policy and investment recommendation framework is contained in the Integrated Report; what follows is the distilled essence of the key priorities.

Priority 1: Anchor demand through credible, enforced blending mandates

The single most critical action is the active implementation and enforcement of the blending mandate enabled by the August 2025 gazette. The mandate must be enforced - not merely legislated - with transparent monitoring, clear consequences for non-compliance, and a published schedule for progressive mandate increases from E2 toward higher blend levels as domestic supply develops.

Without this, nothing else in the recommendations will work. Farmers will not plant sorghum at scale for a market that may not materialise. Banks will not lend to ethanol plants without a guaranteed offtake market. Investors will not commit capital to a sector whose regulatory future is uncertain. The mandate is the keystone - everything else depends on it.

Priority 2: Viability Gap Funding for first-mover ethanol plants

The modelling shows that first-generation grain sorghum ethanol plants face a structural viability gap in the early years of the industry - before scale, yield improvements, and supply chain efficiencies have been achieved. This gap will not correct itself through market mechanisms alone; it requires a targeted, time-bound, fiscally disciplined intervention.

Viability Gap Funding (VGF) - a payment to bridge the gap between a project's revenue under current market conditions and the revenue needed for it to be commercially viable - is the recommended instrument. VGF is preferable to open-ended subsidies because it is targeted to a quantifiable gap, can be tapered as the industry matures, and is compatible with project finance and public-private partnership structures. From a Treasury perspective, it leverages private capital rather than substituting for it.

Priority 3: Blended finance facilities with concessional risk-sharing

Capital structuring risk is a major barrier to bioethanol investment in South Africa. The high upfront capital requirements, long payback periods, and legacy of policy uncertainty inflate the cost of debt and limit commercial lender participation. Blended finance facilities - combining concessional capital from development finance institutions with commercial finance - are needed to improve debt terms, extend tenors, and crowd in private lenders.

Development finance institutions including the Industrial Development Corporation (IDC), the Development Bank of Southern Africa (DBSA), and international development finance partners have a clear catalytic role to play. Brazil's BNDES model - which financed over 200 ethanol plants through long-term soft loans - provides a precedent that South Africa can adapt to its own institutional context.

Priority 4: Contract farming schemes with guaranteed offtake

Once downstream investment is mobilised, the binding risk shifts to feedstock supply. Grain sorghum supply in South Africa is structurally inelastic - the industry is small, yields are below potential, and farmers have limited incentive to switch from maize without clear market signals. Contract farming schemes, explicitly linked to ethanol plant offtake, are essential to translating downstream demand certainty into upstream farmer behaviour change.

These schemes should be structured as tripartite agreements between farmers, aggregators, and ethanol producers, with DFI support to underwrite early-season input advance payments and with standardised, bankable contract terms. The Kenyan anchor-buyer experience demonstrates that this model works - but it must be deliberately designed, not left to emerge from market forces.

The government should also consider formal equity participation pathways for farmer groups and community cooperatives in ethanol plants they supply - not as a primary mechanism but as a long-term objective that reinforces the inclusive development dimension of the industry.

Priority 5: Carbon credit mechanisms for ethanol producers

Carbon credit revenues are not the primary driver of ethanol plant viability but can serve as an important margin stabiliser - improving resilience during periods of feedstock price volatility and providing an additional revenue stream that rewards operational efficiency. South Africa should develop a national bioethanol carbon credit protocol, consistent with ISCC and other internationally recognised frameworks, that issues tradable emission reduction units for low-carbon-intensity ethanol. Brazil's CBIO (decarbonisation credit) model, in which each litre of certified ethanol generates a certificate sold to fossil fuel distributors, provides a directly applicable precedent.

Supporting interventions that can begin immediately

Several additional interventions can be initiated in parallel with the core priorities, and some can begin without waiting for major policy reform.

First, the value-added tax (VAT) exemption that applies to other grains should be extended to sorghum, removing a policy inconsistency that disadvantages the crop relative to competitors.

Second, the use of downgraded maize - grain that cannot be used for food or feed - as a biofuels feedstock should be formally permitted and clarified in policy, providing ethanol plants with feedstock flexibility and potentially improving their economics in years of good maize harvests.

Third, investment in sorghum seed research and the development of locally adapted hybrid seed varieties should begin immediately through public-private partnerships involving the Agricultural Research Council, universities, and the private seed sector. This is a long-lead-time investment - it takes years to develop and commercialise improved varieties - and it must start now.

Fourth, the establishment of a national bioethanol coordinating agency - or the designation of an existing institution with the mandate to coordinate across the value chain - would provide the institutional architecture needed to sequence and monitor implementation, prevent duplication, and provide a single investment facilitation point for prospective industry entrants.

The road ahead: a sequenced approach

The Integrated Report presents an illustrative roadmap for sorghum biofuels development in South Africa structured across three horizons. In the near term (0 - 3 years), the focus should be on mandate implementation and enforcement, establishing the VGF and blended finance mechanisms, identifying and supporting three to five first-mover ethanol plant projects, initiating contract farming pilots in high-potential sorghum zones, and beginning the seed system reform process. In the medium term (3 - 7 years), the focus shifts to scaling supply, improving average yields, expanding contract farming reach, building aggregation infrastructure, and progressively raising the mandate level. In the longer term (7 - 15 years), the industry can be expected to reach sufficient scale and productivity for the core support instruments to be tapered as market forces take over.

This sequencing reflects a consistent finding from both the economic modelling and the international benchmarks: interventions that work in year one, do not necessarily work in year five, and vice versa. The architecture of support must evolve with the industry, not remain static.

Section 12: Conclusion: A Strategic Window That is Time-Bound

South Africa's sorghum biofuels opportunity is real. It rests on a solid foundation: a regulatory framework that is now largely complete; a crop with demonstrated potential on millions of hectares of underutilised land; established agro-industrial capability that can be adapted and scaled; a global technology base that is commercially proven; and a set of international precedents that provide clear guidance on what works and what does not.

The research does not overstate the case. Sorghum-based ethanol is not yet commercially self-sustaining in South Africa. The value chain is underdeveloped, yields are below potential, and the economics require policy support in the early years. But the gap between current conditions and commercial viability is neither vast nor unbridgeable. It is a gap that targeted, sequenced, fiscally disciplined intervention can close - as governments around the world have demonstrated.

What the research does assert with confidence is that the window opened by the August 2025 gazette is both real and time limited. Regulatory frameworks can be reversed or left to gather dust. Investors who cannot find a predictable market will find other destinations for their capital. Farmers who do not receive credible price signals will plant maize. The momentum of the current policy moment must be converted - quickly and deliberately - into the institutional, financial, and agronomic architecture of a functioning industry.

The prize, if South Africa acts effectively, is not merely a biofuels industry. It is one of the most tangible and achievable acts of localisation available to South Africa's industrial policy: taking a product that the country currently imports entirely - liquid fuel - and building the domestic agricultural, processing, and logistics capability to produce a meaningful share of it at home. It is a new axis of rural industrialisation anchored in a climate-resilient crop, supporting inclusive participation by small and commercial farmers alike. It is a source of tens of thousands of jobs in provinces that need them most. It is a reduction in the country's exposure to the imported fuel price shocks that have driven petrol from R10 to R26 per litre within a decade. And it is a contribution to South Africa's climate commitments that is grounded not in aspiration but in commercially proven technology and a clear, quantified pathway to viability. The Localisation Support Fund commissioned this research because it believes that South Africa's agricultural capability is an underutilised industrial asset. This study provides the evidence that, in the case of sorghum biofuels, that belief is well founded.

The evidence is in. The regulatory framework is in place. The international benchmarks are clear. What is required now is political will, institutional coordination, and the deliberate sequencing of a set of targeted interventions that can unlock a strategic opportunity for South Africa's agricultural and energy future.

For the full technical analysis, economic modelling, risk register, and detailed recommendations, see the published ***LSF Integrated Report: Sorghum Price Forecasting and Bioethanol Market Study (Blueprint Holdings, 2026) and LSF Integrated Biofuels Model.***

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