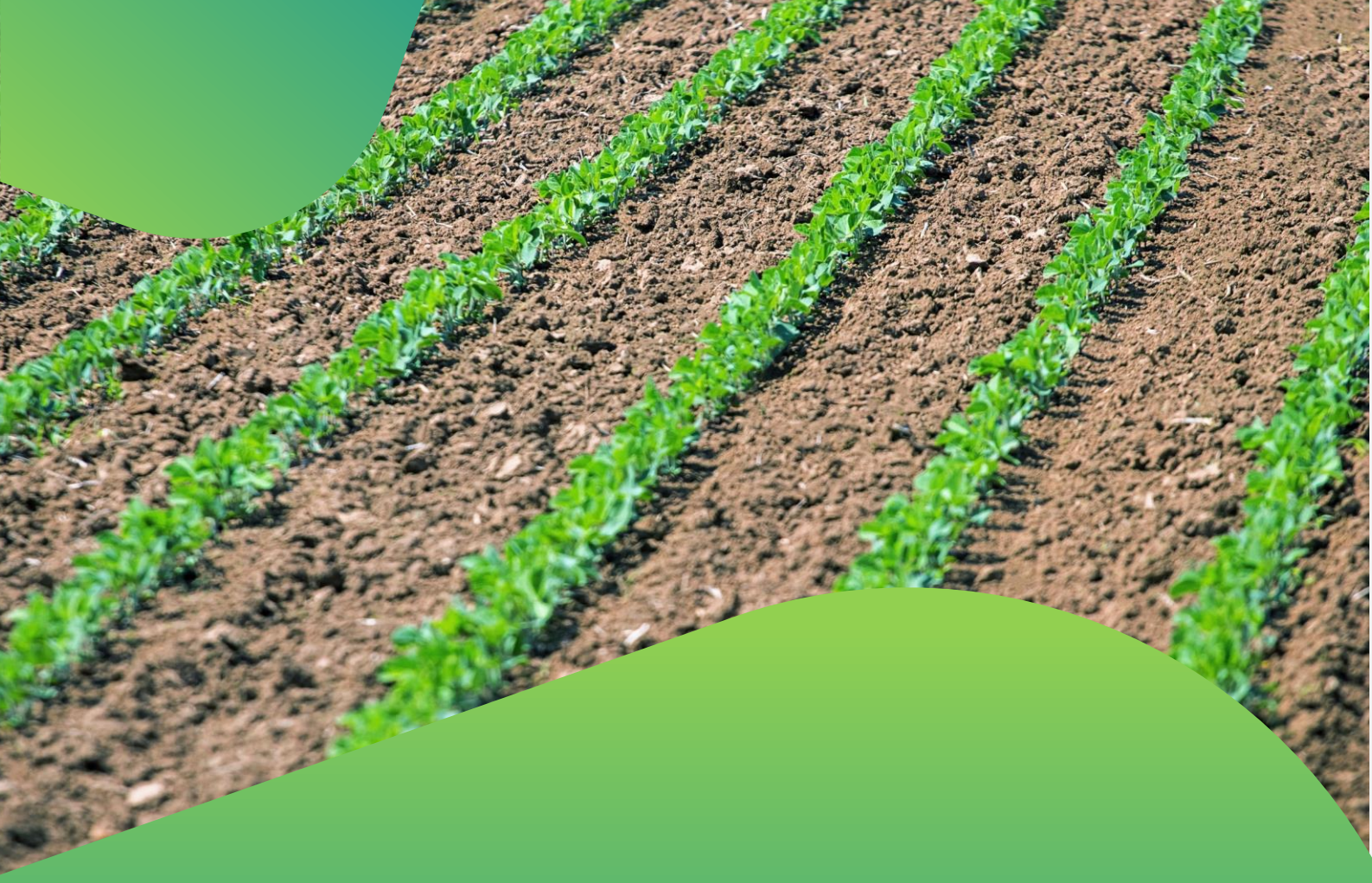

Production Potential for Soybeans and Maize in the Eastern Cape

June 2023

Contact person: Marion Delport (marion@bfap.co.za; 083 731 9698)

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Introduction

The Eastern Cape is a province located on the southeastern coast of South Africa. It is known for its diverse landscapes, ranging from rugged mountains to fertile valleys and beautiful coastlines. In recent years, there have been claims and discussions about the potential of the province to become the “breadbasket” of the country. This is an aspirational goal that highlights the province’s agricultural possibilities, but its realisation depends on various factors such as natural resource potential and limitations, infrastructure investments, the accessibility of inputs and markets, and ongoing efforts for example the improvement of extension and other advisory services.

Furthermore, the province is known to be suitable for a range of crops including maize, wheat, barley, citrus fruits, vegetables and livestock farming, and certainly has favourable climatic conditions and access to water resources. The province's field crop resource endowment can be summarised in that a high proportion (55%) of its total cultivated land (1.29 million hectares see Table 1), has fairly high land capability (Moderate to High land capability zones).

Table 1: Summary of land capability in the Eastern Cape

Land Capability (LC) Class		High	Moderate	Marginal	Non-arable	Total
Eastern Cape	Total (LC) Hectares	1 086 153	1 776 631	6 805 093	7 221 222	16 889 099
	Hectares Cultivated	340 388	371 519	473 219	106 924	1 292 050
	% of hectares cultivated	26%	29%	37%	8%	

Source: DAFF (2019), GTI (2019), BFAP (2019)

Agricultural activities comprise predominantly small-scale/subsistence agriculture including the production of crops, including maize, sorghum, beans and vegetables as well as irrigated citrus farming. Furthermore, small-scale / subsistence agriculture is involved in significant extensive livestock farming in the province (cattle, goats, sheep, including wool).

Significant commercial agriculture also takes place in the province, including the production of citrus, wool, mohair, milk and dairy products as well as cash crop production. The latter has increased from 18 550 hectares to 33 300 hectares over the past 5 seasons according to the Crop Estimates Committee (CEC) (see Table 2).

Table 2: CEC cash crop production in the Eastern Cape

Crop	Metric	2018	2019	2020	2021	2022
Maize	Area ('000 ha)	14.50	14.00	22.50	24.00	26.00
	Production ('000 tonnes)	93.20	92.16	154.20	172.20	192.75
Soybeans	Area ('000 ha)	2.40	1.15	1.50	3.10	3.00
	Production ('000 tonnes)	2.40	1.38	3.00	9.30	9.00
Wheat	Area ('000 ha)	1.65	3.10	4.00	3.80	4.30
	Production ('000 tonnes)	10.73	18.15	26.00	24.70	27.52
Canola	Area ('000 ha)	*No provincial numbers published.*				
	Production ('000 tonnes)					
Total	**Area ('000 ha)**	**18.55**	**18.25**	**28.00**	**30.90**	**33.30**

It is against this backdrop, that BFAP proposed to compile various spatial datasets in order to quantify the production potential for maize and soybeans from resource endowment, spatial land use limitations and agricultural land use perspectives.

Methodology

In order to quantify the potential for cash crop production (specifically maize and soybeans) in the Eastern Cape, BFAP quantified the production potential based on field crop boundary[1], land capability and crop suitability datasets. However, not all potential production areas may be currently available for agricultural cash crop production due to urban sprawl, livestock grazing, land degradation etc. BFAP therefore performed a spatial review/contextualisation of the province which includes collating the most recent data to quantify the following:

[1] Note, the field crop boundary/cultivated field dataset available for the Eastern Cape possibly over-estimates actual field crop area since clusters of small fields were grouped together in larger boundaries. Refinement of this dataset is listed as part of future research.

- Population density
- Built-up and populated area
- Infrastructure and transport networks
- Current land cover and crop cultivation
- Land degradation
- Ruminant-density and grazing requirements

The latest Field Crop Database (2021) from the Department of Agriculture, Land Reform, and Rural Development (DALRRD) was used to determine total agricultural field crop area under annual rainfed/dryland production (including planted pastures), irrigated fields (pivot and non-pivot irrigation) and subsistence/small-scale production. This dataset is updated periodically and quite accurately captures agricultural fields and activities, which implies alternative land use (e.g. urban sprawl, built-up areas, settlements, land degradation) would already have been accounted for when quantifying agricultural field crop area.

Various yield models were considered to quantify potential maize and soybean yields throughout the province and imposed on each field. The most relevant/accurate models were selected in the production potential calculations.

Finally, the production potential calculation was performed based on the fields and area with *some* soybean or maize production potential (i.e. yield suitability >0), but that still implied the assumption that all fields with some suitability would be planted to maize or soybeans. Therefore, a crop mix assumption was added to account for fallow fields and planted pastures (the majority of fields in the province) and to assign a proportion to maize and soybeans, based on historic cash crop area in the province.

Eastern Cape overview and contextualisation

An overview of population density, built-up and populated areas, infrastructure and transport networks as well as current landcover, crop cultivation and land degradation is presented in this section. Ultimately, these contextualising datasets will be used to qualify and possibly filter out the field crop boundaries realistically available for cash crop production.

Population density & labour

The Eastern Cape had a population density of 41.3 people per km² in 2016 and ranks 4th for the total number of people per province (Figure 1). The population density is consistently higher within the former homeland area of the Transkei and Ciskei: 60-100 people per km^2, whereas the areas towards the West of the province have less than 10 people per km^2.

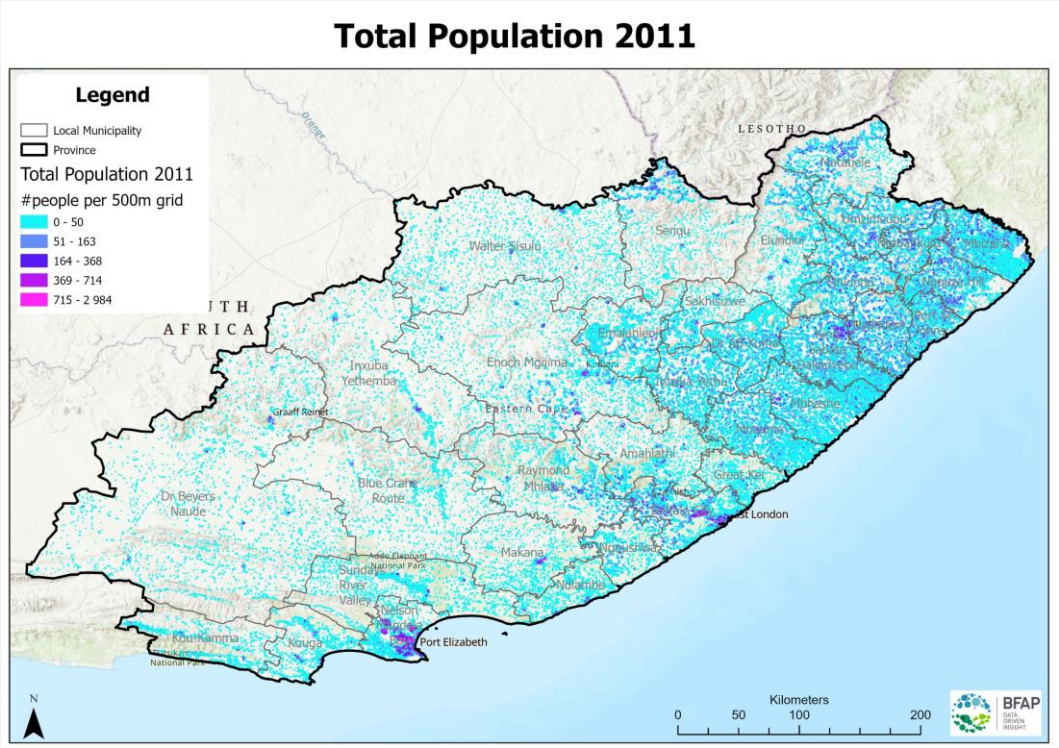


Figure 1: Population density

Total population from the 2011 census data, dasymetrically mapped to a 500m grid using the 2008 spot dwelling count.

The data provides an indication of the total number of people per 500m grid cell[2]

Infrastructure and transport networks

Figure 2 and Figure 3 present the road infrastructure and electricity grid respectively. The Eastern Cape has three ports, namely the Port of Coega (Port Ngqura, South Africa); Gqeberha (Port Elizabeth) and the Port of East London, with very few silos of which only one is in relative proximity to the former homeland areas. The road network is also very sparse in the Eastern parts of the province.

[2] Hayden Wilson. (2018). Total population by sex and age from the 2011 census [Data set]. South African Environmental Observation Network. https://doi.org/10.15493/SARVA.SDG.10000003

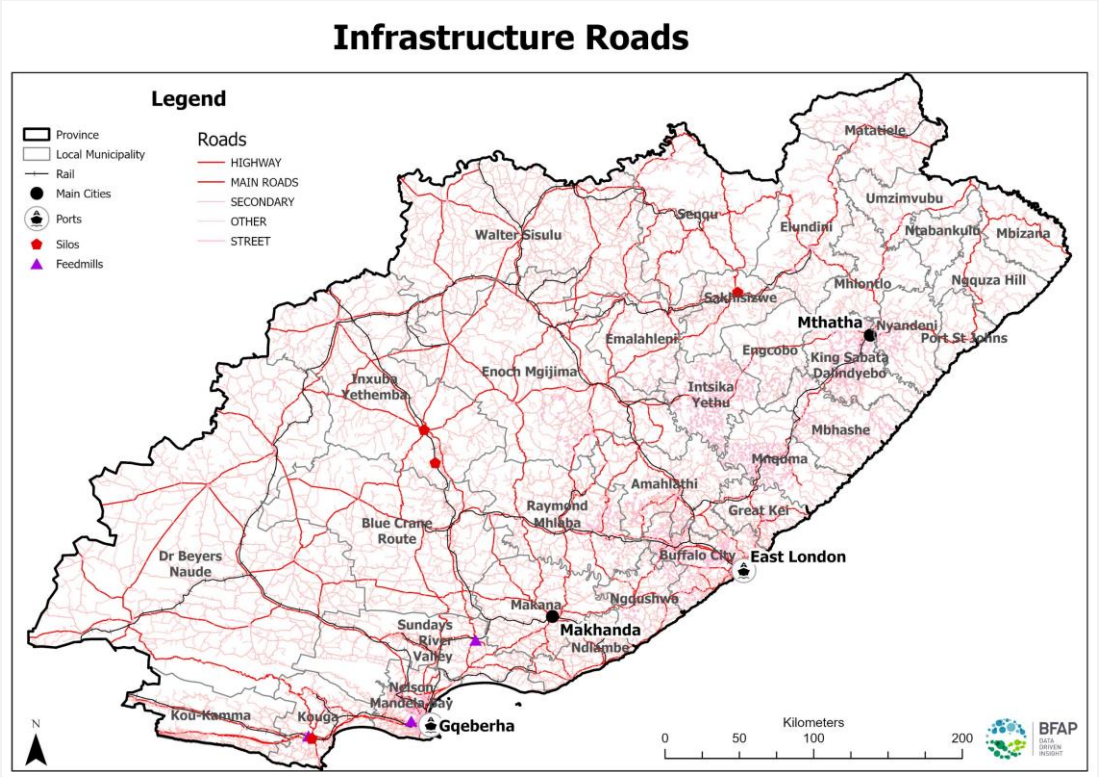


Figure 2: Road network

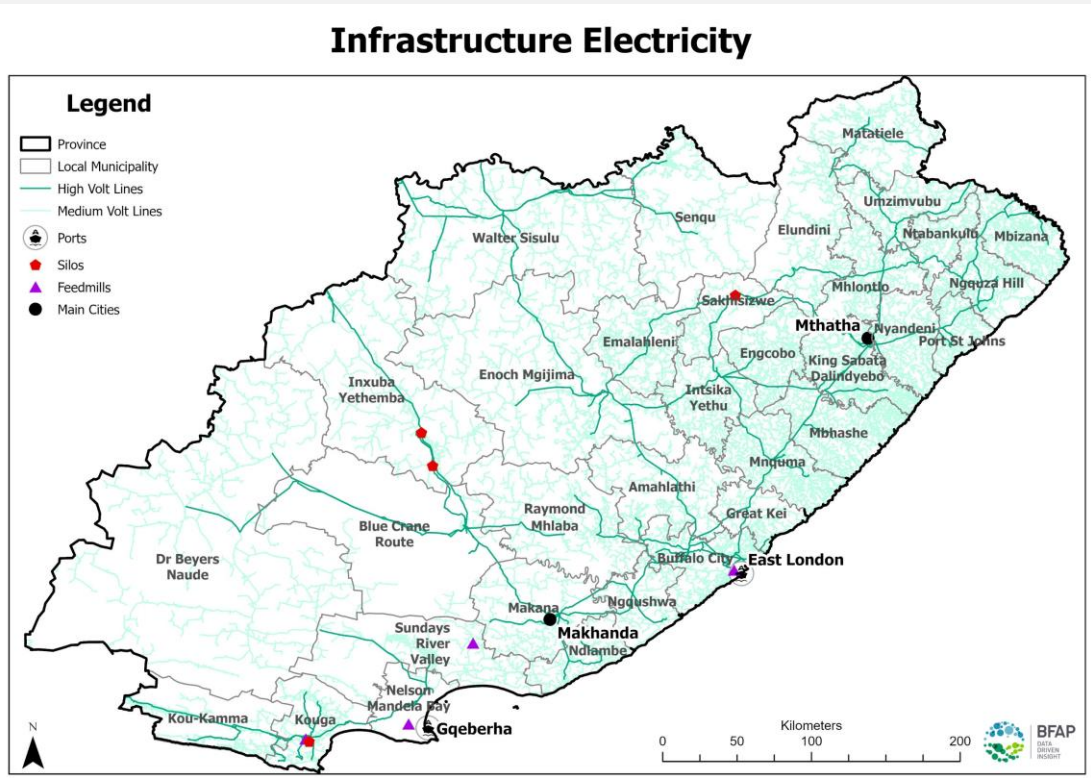


Figure 3: Electricity infrastructure

The Eastern Cape province is home to a variety of settlements, ranging from large cities to small rural villages. Different types of settlements include:

- Cities: Several major cities serve as economic and cultural centers for the province including Gqeberha, East London and Mthatha. Cities are characterized by their larger population, diverse industries, infrastructure and urban amenities.

- Towns: There are numerous towns scattered across the Eastern Cape, each with their own unique character and attractions. Towns like Makhanda (Grahamstown), Queenstown, Graaf Reinet, Hogsback, Port Alfred and Aliwal North are examples of vibrant urban centers that offer a range of services, businesses and recreational opportunities.
- Rural Villages: The Eastern Cape is predominantly rural, with rural settlements often located in more remote or agricultural areas. They tend to have smaller populations and are characterized by a close-knit community, traditional cultural practices and a slower-paced lifestyle.
- Traditional Homesteads: Traditional homesteads or so-called kraals are typically traditional dwellings and settlements of local communities adhering to cultural practices and maintaining a strong connection to their heritage. The homestead is typically surrounded by a fence or kraal, made of branches, stone, or thorny shrubs, to provide security for livestock and mark the boundaries of the family's land. Livestock such as cattle, sheep and goats are an essential part of traditional agricultural activities and are often kept within the kraal. Livestock plays a crucial role in providing food, wealth, and social status within these communities.

Figure 4 depicts various kinds of settlements in the Eastern Cape, and correlates fairly well with the population density information in Figure 1: with very high density of settlement areas in the former homeland areas, coinciding with the highest population densities. Furthermore, Figures 5 to 7 below provide examples of the types of settlements depicted in the map.

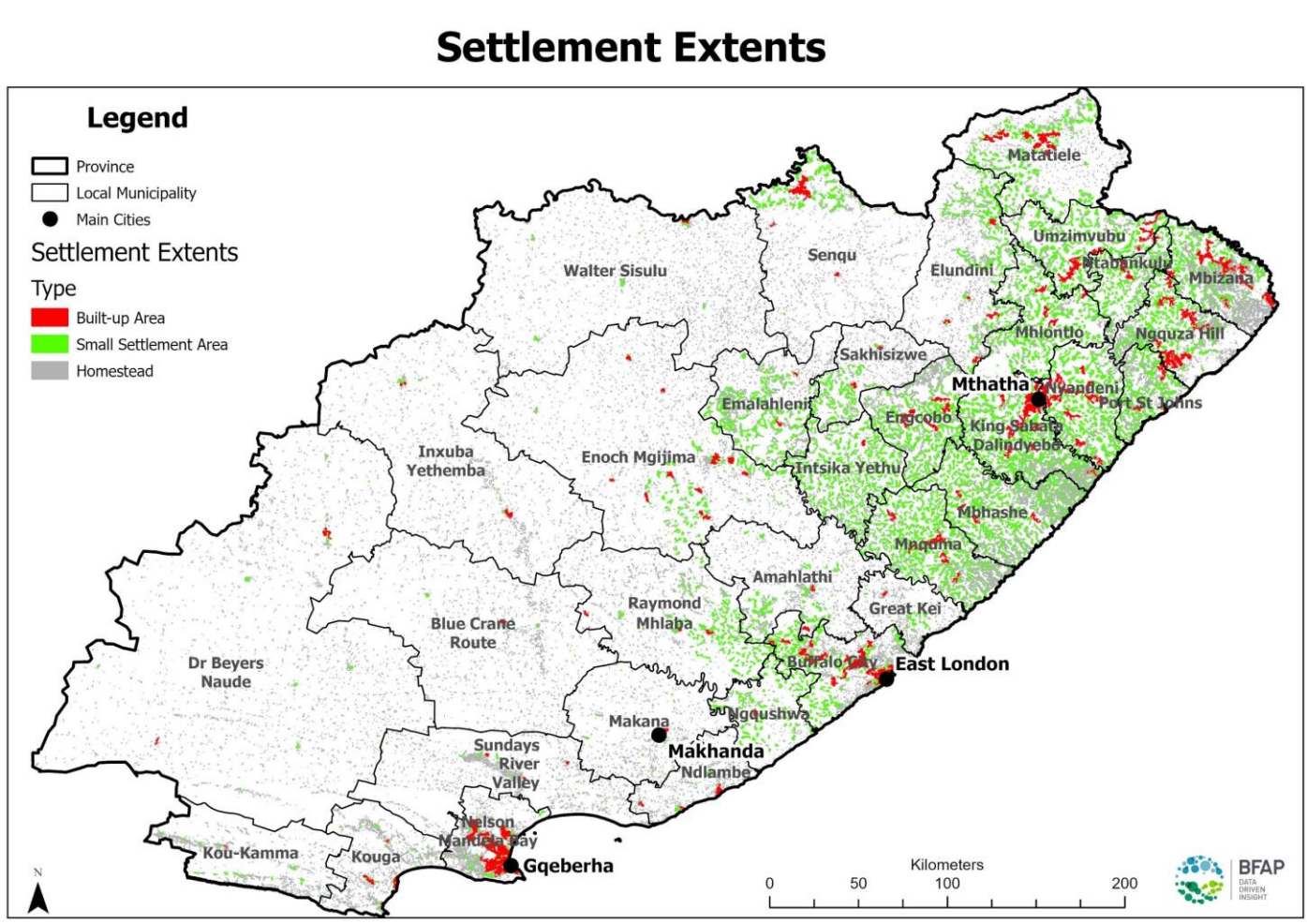


Figure 4: Settlements in the Eastern Cape

Figure 6: Examples of homesteads (black demarcations)

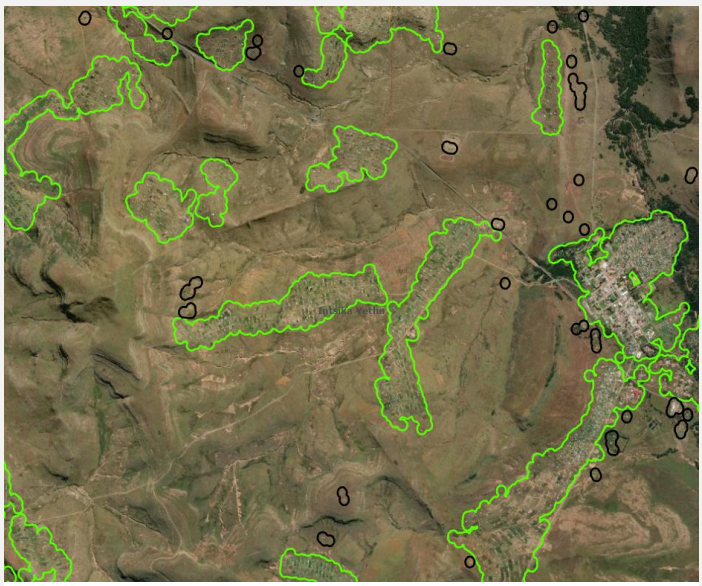


Figure 5: Examples of small settlement areas (green demarcations)

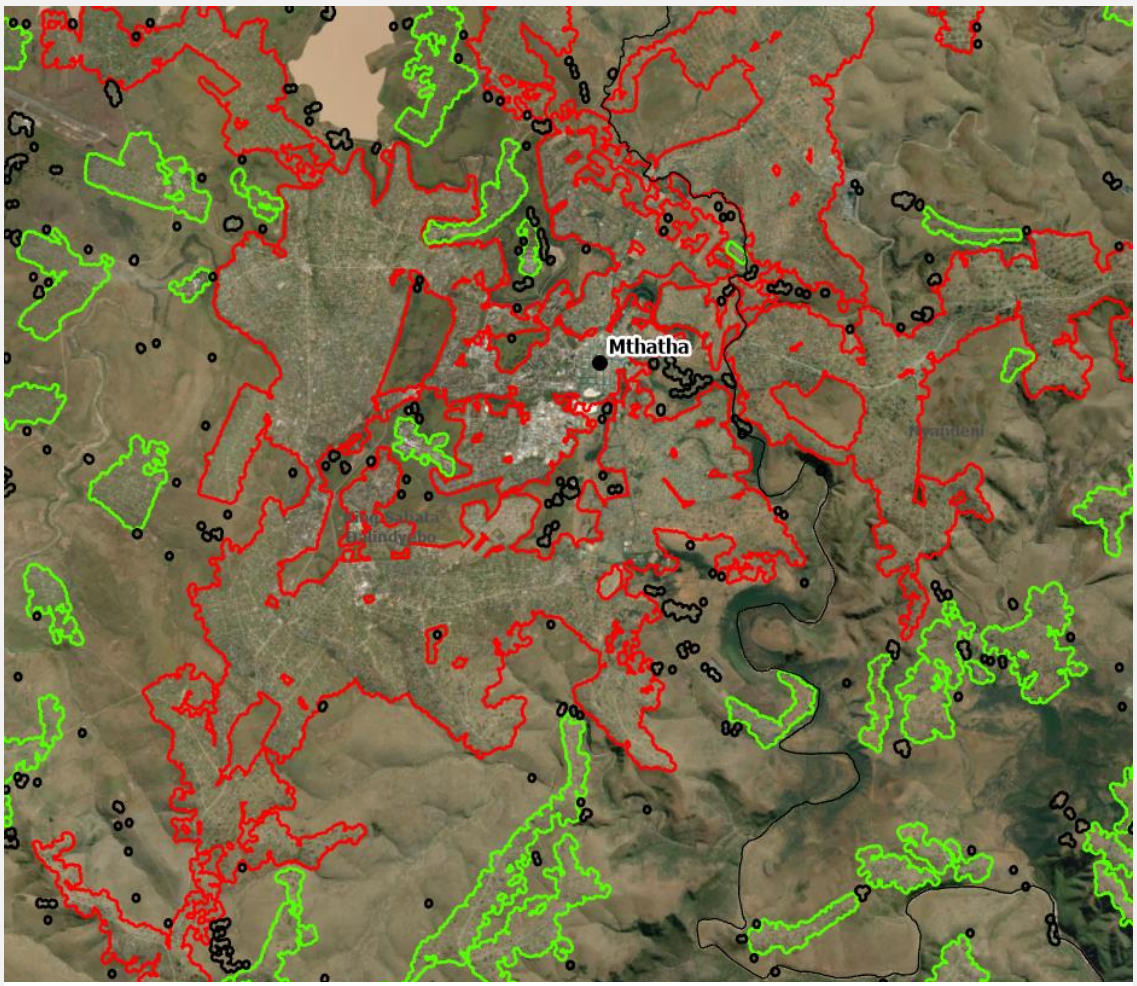


Figure 7: Mthatha settlements – built up area in red demarcations

Commercial and subsistence farming

According to the Census of commercial agriculture (StatsSA, 2017), the Eastern Cape has 25 297 farming enterprises (VAT registered farms only) earning a total of R46 971 million per annum in gross farm income. Figure 9 demonstrates the distribution of these farms across the province, while Figure 10 shows the subsistence farming activity, which highlights the prevailing dualistic nature of South Africa's agricultural sector.

Furthermore, the census indicates that yellow maize plantings contribute the highest proportion of field crops planted by commercial agriculture (Figure 8). The crop mix presented by the census indicates a prominent livestock industry in the province (i.e. grazing, lucerne, maize for silage and yellow maize (predominantly used for feed, not human use)), with cash crop production enjoying less focus overall.

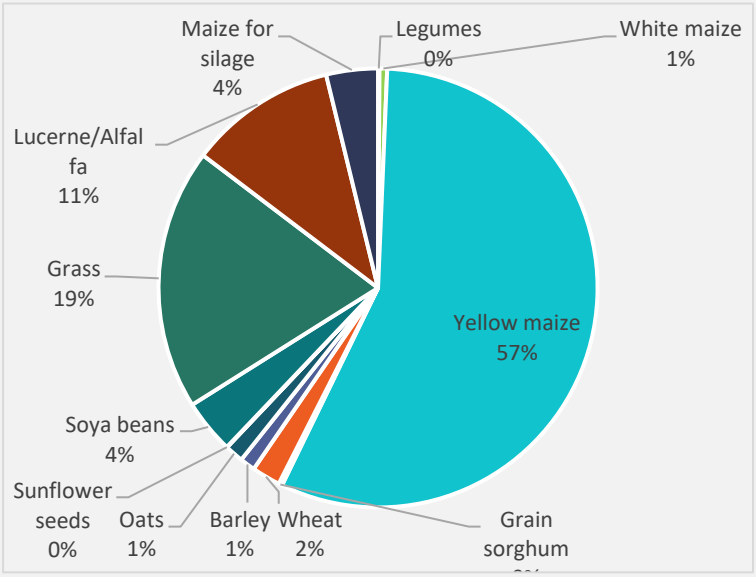


Figure 8: Dryland area planted

Source: Census of commercial agriculture, 2017

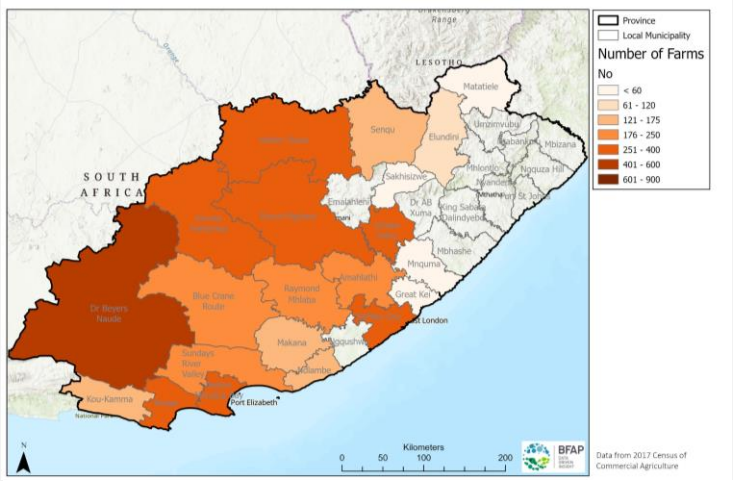


Figure 9: Number of commercial farms

Source: Census of Commercial Agriculture, 2017

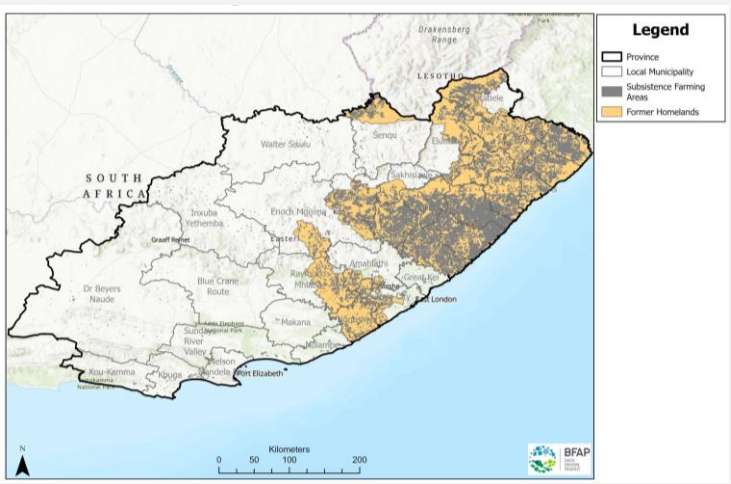


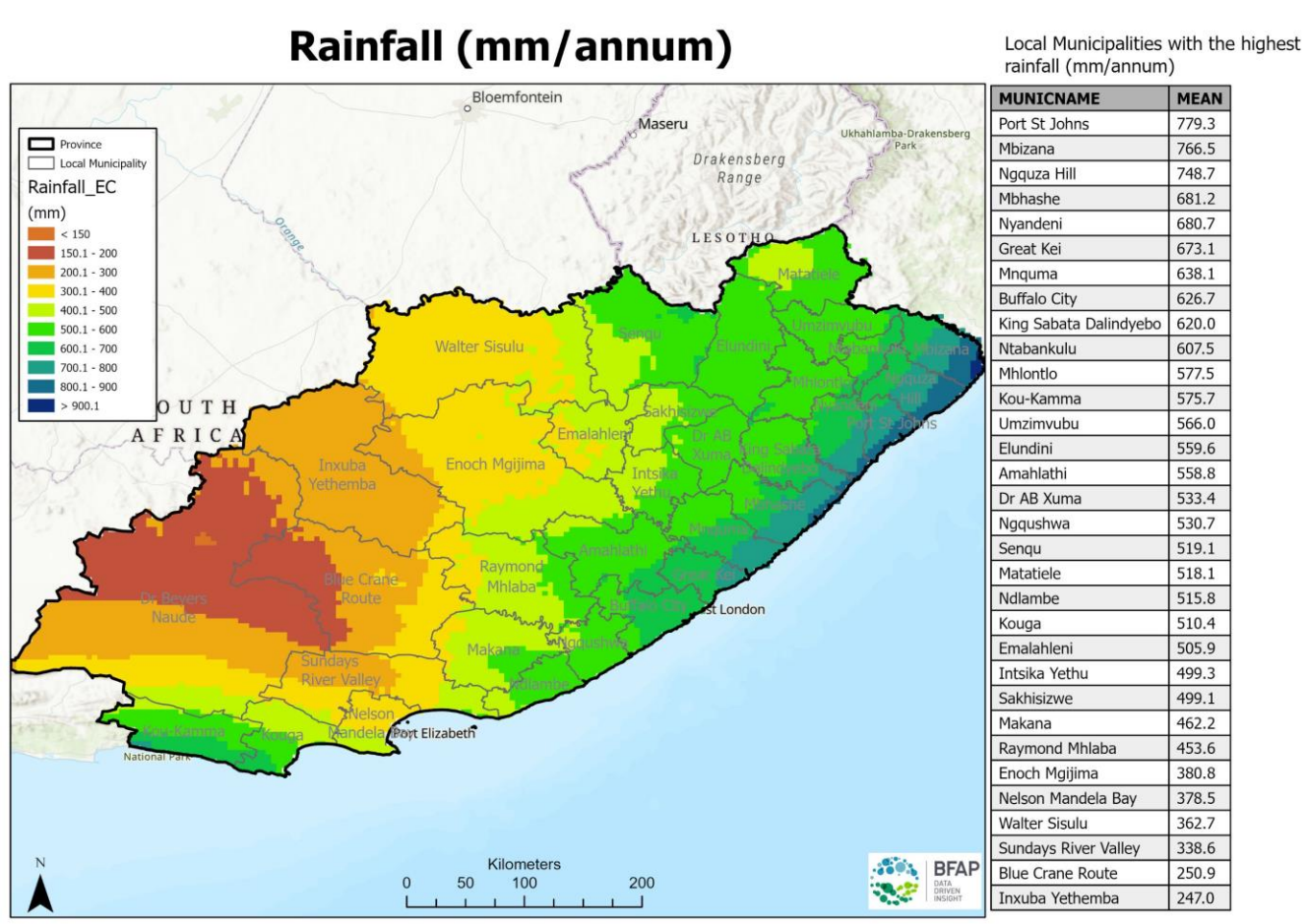
Figure 10: Subsistence farming areas and former Homelands

Source: SAEON

Natural resources

Rainfall

The province has a large variability in rainfall with totals averaging above 600mm towards the northeast down to semi-arid conditions in the west with less than 200mm/annum.



Local Municipalities with the highest rainfall (mm/annum)

MUNICNAME	MEAN
Port St Johns	779.3
Mbizana	766.5
Ngquza Hill	748.7
Mbhashe	681.2
Nyandeni	680.7
Great Kei	673.1
Mnquma	638.1
Buffalo City	626.7
King Sabata Dalindyebo	620.0
Ntabankulu	607.5
Mhlontlo	577.5
Kou-Kamma	575.7
Umzimvubu	566.0
Elundini	559.6
Amahlathi	558.8
Dr AB Xuma	533.4
Ngqushwa	530.7
Senqu	519.1
Matatiele	518.1
Ndlambe	515.8
Kouga	510.4
Emalahleni	505.9
Intsika Yethu	499.3
Sakhisizwe	499.1
Makana	462.2
Raymond Mhlaba	453.6
Enoch Mgijima	380.8
Nelson Mandela Bay	378.5
Walter Sisulu	362.7
Sundays River Valley	338.6
Blue Crane Route	250.9
Inxuba Yethemba	247.0

Figure 11: Mean annual rainfall

Source: TerraClimate data (1990-2021)[3]

Linked to these large variations in total rainfall, the province also has a diverse range of micro-climates or sub-climates due to its varied topography, proximity to the coast, and the influence of different weather patterns.

- The coastal region experiences rain almost all year round with relatively high total annual rainfall.
- On the other hand, the mountainous and highveld climate along the Drakensberg foothills (northeastern part of the province) is typically cooler and due to the higher altitude, experiences some snow and precipitation in winter as well as in summer months. Some winter grazing and or winter season crops can be grown in this region.
- The western part of the province is characterized by semi-arid climate: these interior regions have low rainfall and relatively hot summers with karoo-low-shrub vegetation exhibiting a low grazing capacity and mostly irrigated commercial agriculture.
- The southeastern part of the province is characterized by high rainfall throughout the year, lush vegetation and dense forests: Tsitsikamma and Amatola forests.

[3] TerraClimate is a dataset of monthly climate and climatic water balance for global terrestrial surfaces. It uses climatically aided interpolation, combining high-spatial resolution climatological normals from the WorldClim dataset, with coarser spatial resolution, but time-varying data from CRU Ts4.0 and the Japanese 55-year Reanalysis (JRA55). Conceptually, the procedure applies interpolated time-varying anomalies from CRU Ts4.0/JRA55 to the high-spatial resolution climatology of WorldClim to create a high-spatial resolution dataset that covers a broader temporal record.

- Lastly, the province features extensive grassland and savannah areas in the inland/central regions with hot summers, cool winters and moderate rainfall. In these regions, the mean annual precipitation is 600mm; however the distribution throughout the summer season is often not favourable for dryland cash crop production.

Land capability

Land capability is the total suitability for use, in an ecologically sustainable way, for crops, for grazing, for woodland and for wildlife. A land capability class is an interpretive grouping of land units with similar potentials and continuing limitations or hazards. It is a more general term than land suitability and is more conservation oriented. It involves consideration of (i) the risks of land damage from erosion and other causes and (ii) the difficulties in land use owing to physical land characteristics, including climate. The main datasets feeding into the land capability classification shown in Figure 12 include land type, climatic and terrain parameters. While the Eastern Cape comprises of areas with very good climatic conditions for cash crop production, they had to be down-graded in the land capability classification due to steep slopes and limited soil depth.

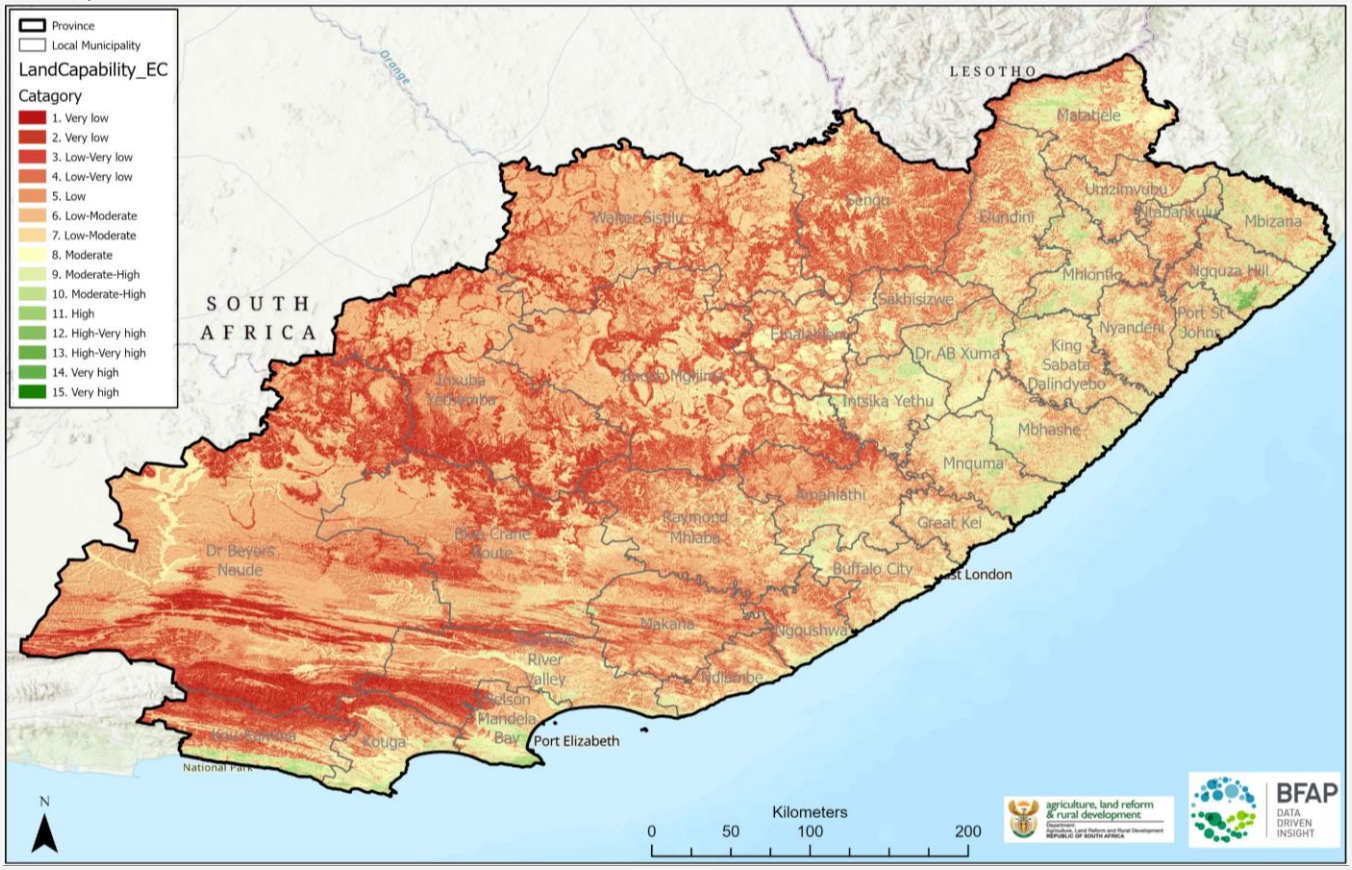


Figure 12: Land capability

Source: Land Capability, DALRRD, 2016

Land cover

The 20 m resolution, raster format South African National Land-Cover 2020 (SANLC 2020) dataset has been generated from automated mapping models (as opposed to conventional image classification procedures), using multi-seasonal 20 m resolution Sentinel 2 satellite imagery. The imagery used represents the full temporal range of available imagery acquired by Sentinel 2 during the period 01 January 2020 to 31 December 2020. The overall map accuracy for the SANLC 2020 dataset, calculated from 6835 reference points, is 85.47%. While the overwhelming share of the Eastern Cape province is natural grassland, similar to the main cash crop producing areas (North West, Free State and Mpumalanga), the remainder of the Eastern Cape is dominated by low and karoo/fynbos shrubland towards the West. Its relative share of irrigated annual crops is the same as for the main summer crop production area, whereas a very small percentage of the province is under commercial annual crop cultivation. Irrigated annual crops, therefore, play a much more prominent role in the province than in the major crop-producing region of South Africa.

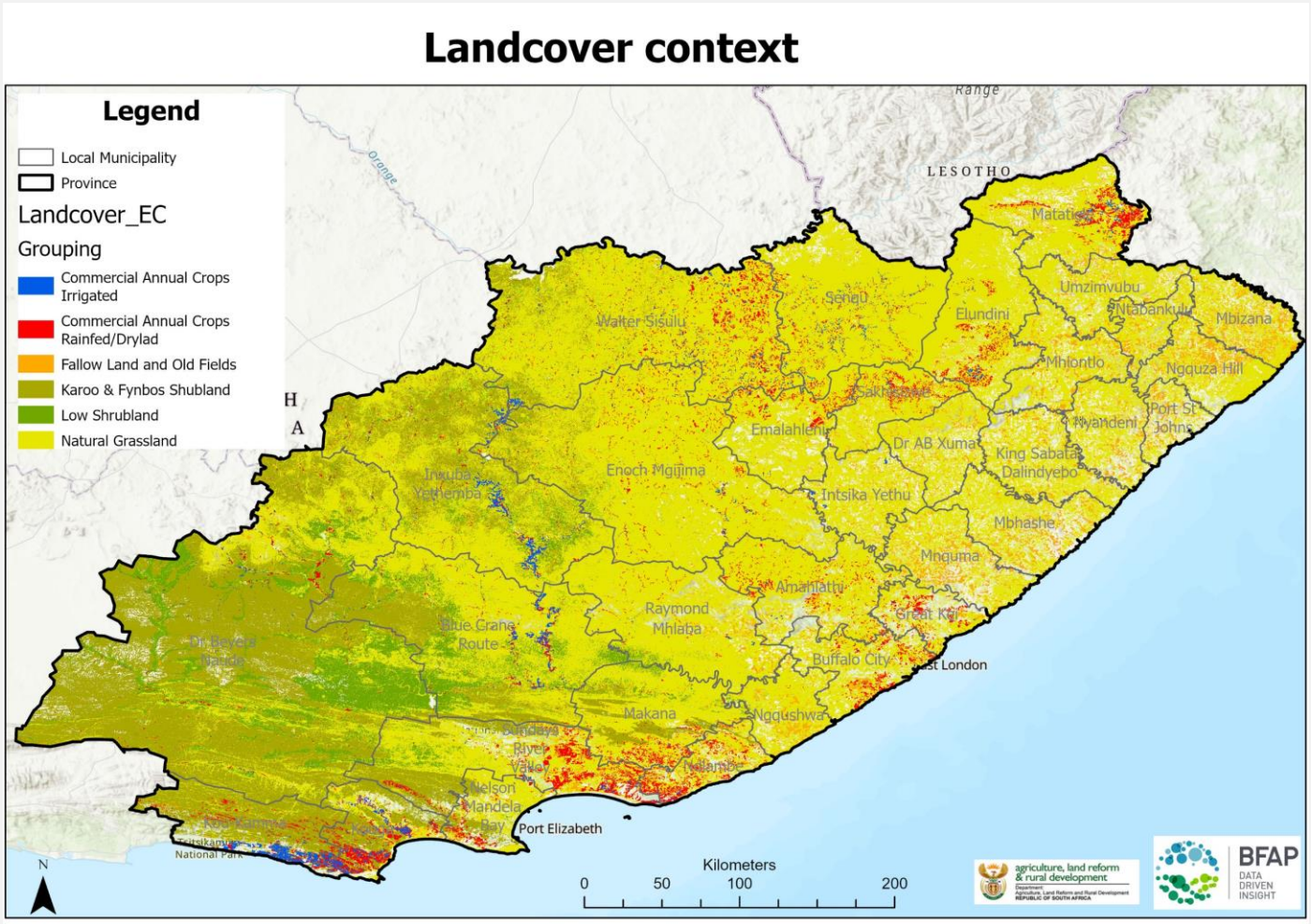
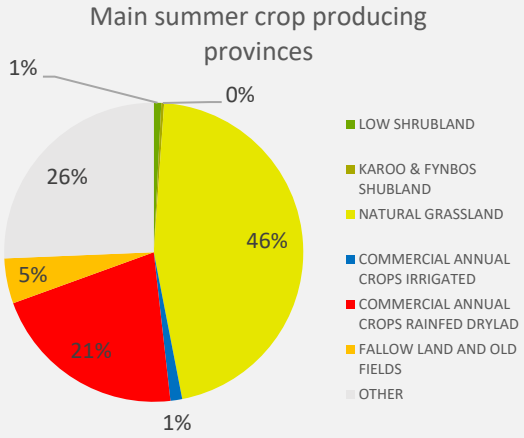
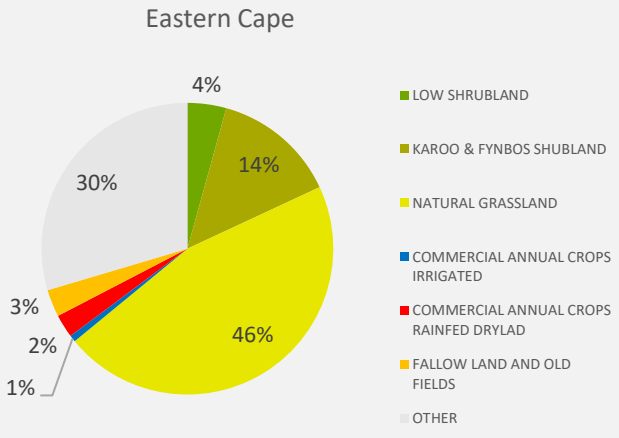


Figure 13: Landcover context

Source: Landcover 2020





Land degradation

Land degradation is a negative trend in land conditions, that can be attributed to natural landscapes and features or direct or indirect human-induced processes. Human-induced processes include anthropogenic climate change expressed as long-term reduction or loss of biological productivity, over-grazing and natural resource depletion through farming and migrating field practices – this can be largely attributed to the degraded vegetation shading of 1.53 million hectares in Figure 14. Natural features categorized as degraded land include barren rock (49 156ha) and dongas & sheet erosion (133 748ha) classifications in Figure 14.

The Eastern Cape consists of another 15.17 million hectares of “other barren land” however, this could have resulted from overgrazing or it could just be a function of low rainfall (i.e. semi-arid desert climatic conditions towards the Western parts of the Province).

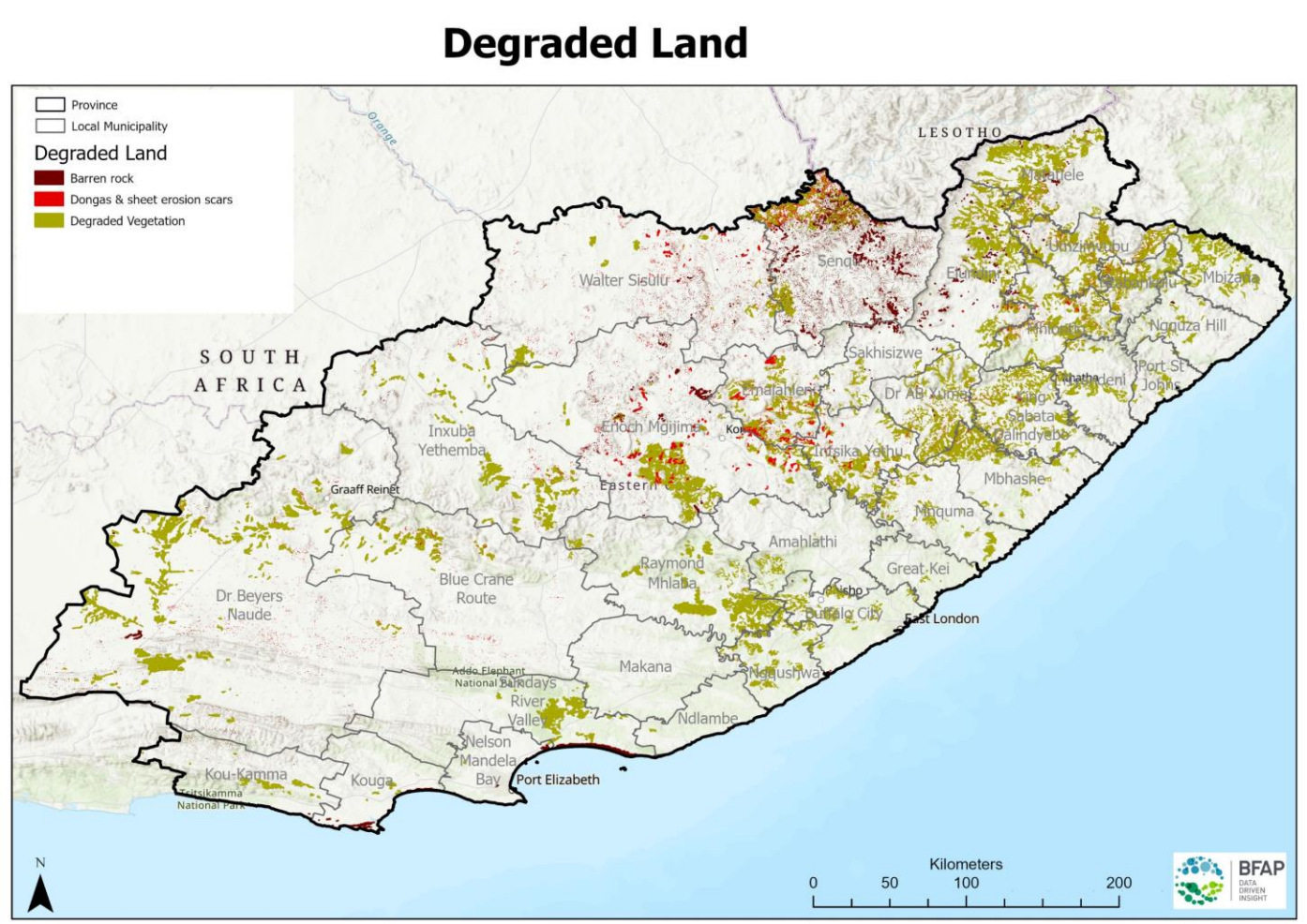


Figure 14: Degraded land in the Eastern Cape

Source: Natural Resource Atlas, ARC (2004) & Landcover 2020

Contextualising Limitations

There have been several attempts to find the most suitable areas in the Eastern Cape for the expansion of crop production, e.g., the Integrated Food and Nutrition Security Initiative (IFNSI). There remain many challenges due to, for example the topology, soil quality (pH, soil nutrients) and degradation (erosion), climate and climate change, land degradation due to over grazing and rapid urbanisation.

Although there is a perception that the Eastern Cape has the potential to be the second breadbasket of the country after the Free State due to its underdeveloped areas and largely favourable climate in terms of rainfall, the topology of the region presents many challenges. Figure 15 represents the topology and slopes of the area at a 30m resolution. The orange to red slopes indicate areas that are steep (>12% slope) and thus not suitable for cropping. Areas with steep slopes are also associated with the most degraded land (see Figure 14). Furthermore, the areas with terrain that are most suitable for cropping such as in the Dr Beyers Naude Local Municipality are the areas with the lowest rainfall (Figure 11). The most suitable areas for cropping in terms of rainfall are the northern areas of the Eastern Cape, but these have the steepest slopes and are also mostly within the more rural areas with the highest population density (Figure 1). Ultimately, despite the climatic conditions allowing for high yield potential, there are many limiting factors coinciding in these high yield potential areas.

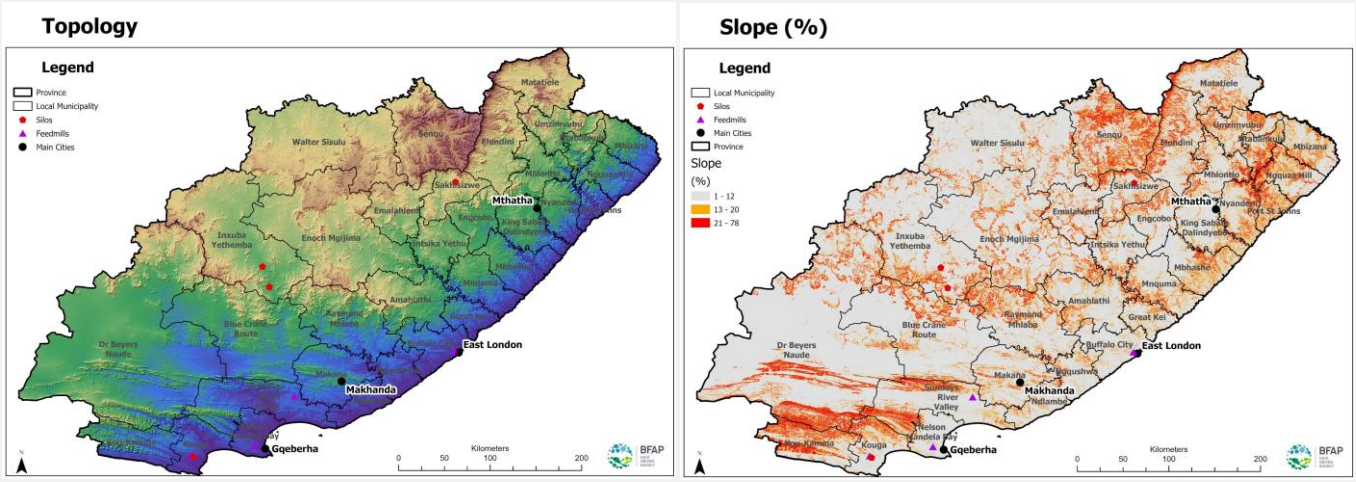


Figure 15: Topology and Slopes of the Eastern Cape

Source: NASA (2023)

The drought spells in recent years as well as the extreme flooding indicates that the Eastern Cape's weather may be influenced by changing climate patterns due to the anthropogenic effects on climate. Climate projections are indicating a positive warming trend for the Eastern Cape (see Figure 16). There are mixed signals as to precipitation for the mid-century time period with some signal of drying towards the end-of-century. These projected changes will likely also impact the agricultural yield suitability for various crops.

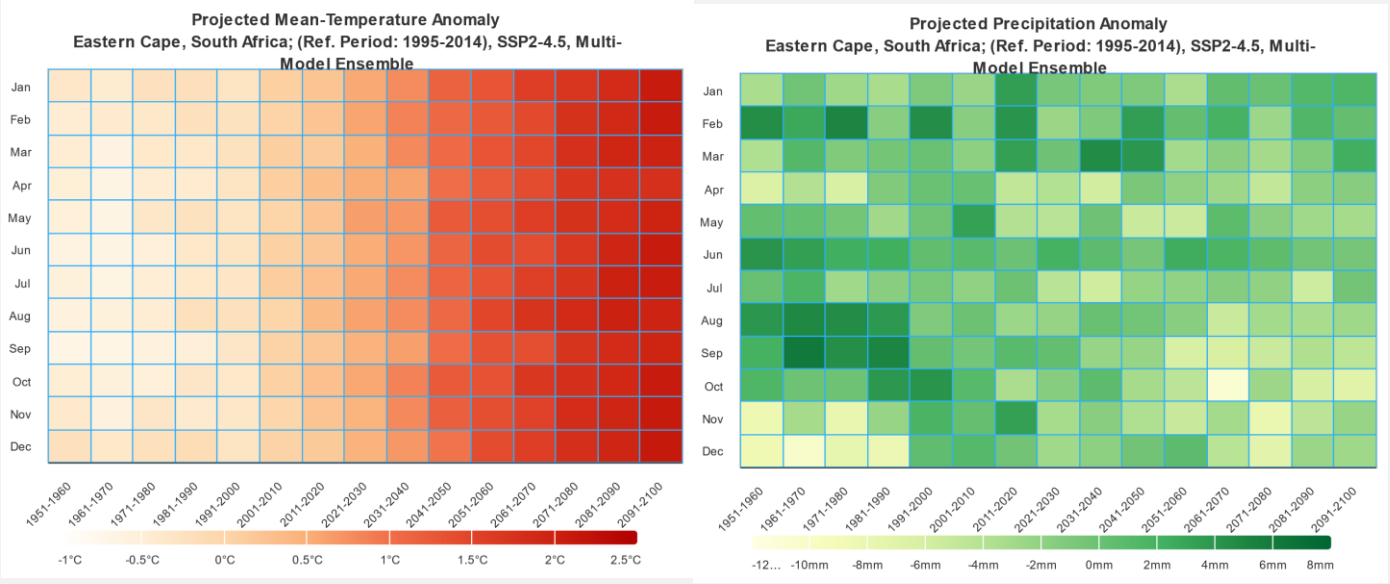
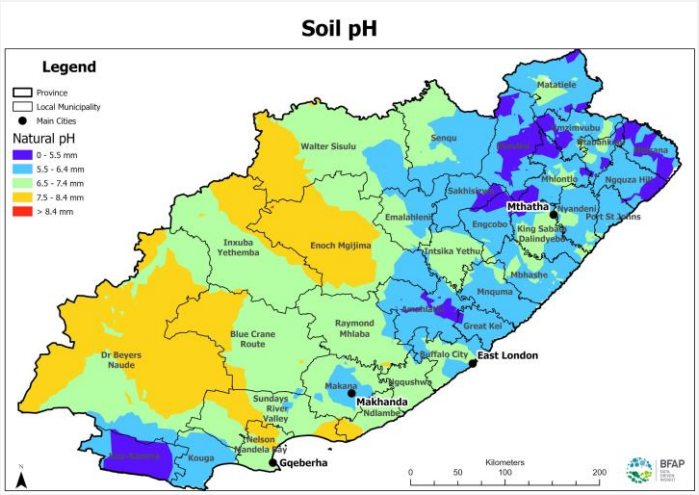


Figure 16: Projected mean temperature and precipitation anomalies

The Eastern Cape has a diverse range of soil types and conditions, each with its own limitations for crop production, i.e. low fertility due to lack of organic matter, shallow soils, or salinity. Other crop growth limiting factors in the Eastern Cape are:

Acidic Soils: Although the majority of South African soil has a pH of between 6.5 and 8.4, indicating relatively neutral soil, acidic soils are prevalent in certain areas of the Eastern Cape, with soil pH often below 5.5 (Figure 17). Low pH levels can affect nutrient availability to plants. Liming is often required to raise pH levels and reduce soil acidity.

Low Phosphate: When soils have low phosphate levels, plants may suffer from phosphorus deficiency, leading to stunted growth, reduced yield, and poor crop quality. Just as the acidic soils, largely the same parts of the Eastern Cape have low soil phosphate levels (<5 mg kg^{-1}).



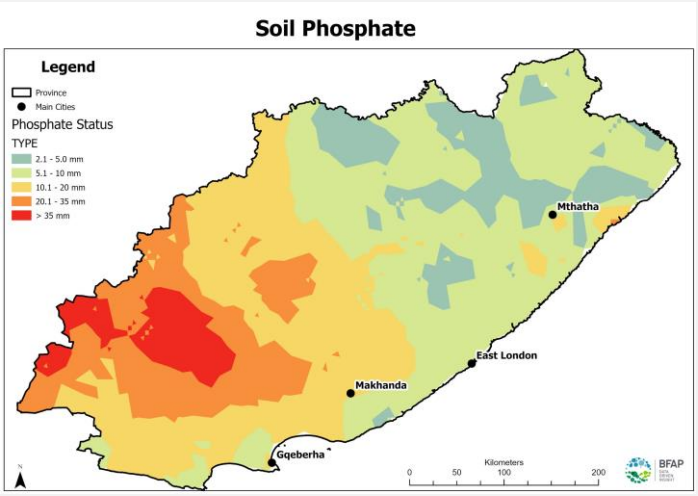


Figure 17: Soil pH and Phosphate in the Eastern Cape

Grazing requirements

Grazing capacity is defined as the long-term production potential of the herbaceous layer (grasses and forbs) of an area of vegetation that is required to maintain an animal with a weight of 450 kg (1 Large Stock Unit (LSU)) with an average fodder intake of 10 kg dry mass per day over a period that vegetation is suitable for grazing (mostly 1 year) without degrading the natural resources (vegetation and soil) and is measured in "Hectares per Large Stock Unit" (ha/LSU) (see Figure 18).

Note, that the grazing capacity map is strongly correlated with the mean annual rainfall in Figure 11 with low hectare per LSU requirement in higher rainfall regions (Eastern parts of the province) and higher hectare per LSU requirement towards the West.

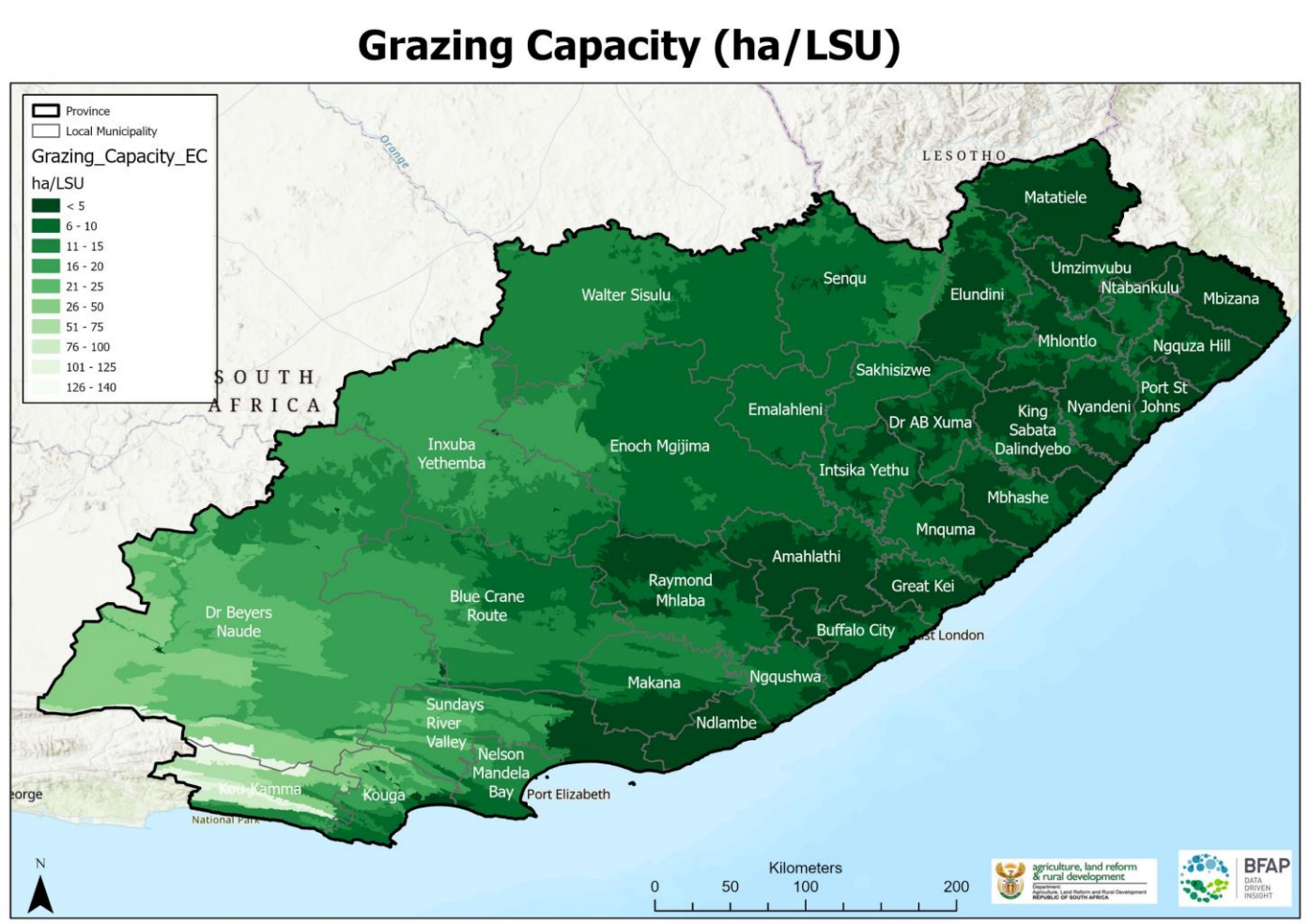


Figure 18: Grazing capacity

Source: Grazing Capacity, DALRRD, 2018

According to the Census of Commercial Agriculture 2017 financial and production statistics (Figure 19), sheep are the most numerous commercial livestock reared in the province, followed by cattle (for meat and dairy purposes), goats and pigs.

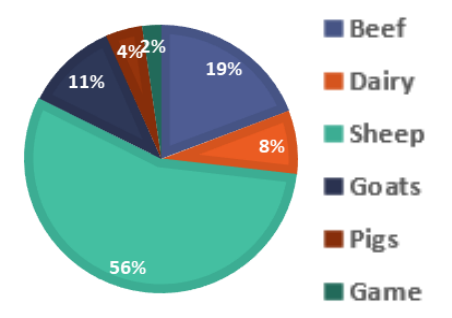


Figure 19: Livestock breakdown
Source: COCA, StatsSA 2017

Figure 21 shows both the total number of cattle and the cattle density per Local Municipality in the province in the top row. Here, the differences are not as big. If we turn to the maps in the second row: the number of households that own larger cattle herds (more than 20 heads of cattle) and compare that with the number of households that own only between 5 and 20 cattle, we see marked differences with smaller herds being concentrated in the former homeland areas and larger herds more common surrounding these areas in the Eastern part of the province, again highlighting the dualistic nature of the agricultural activities in the province.

To support this, Figure 20 depicts the total number of animals in shades of light blue overlayed with the grazing capacity expressed in Larges Stock Units (LSU) per hectare (in shades of pink). More LSU per hectare represents a higher grazing capacity: dark blue/purple shades are areas where high numbers of livestock coincide with high grazing capacity. Light blue areas indicate high livestock numbers on low grazing capacity, this typically occurs in the drier Eastern regions of the province. Pink shades indicate low livestock numbers on high grazing capacity areas which typically coincides with urban, highly populated areas, or areas with challenging topology.

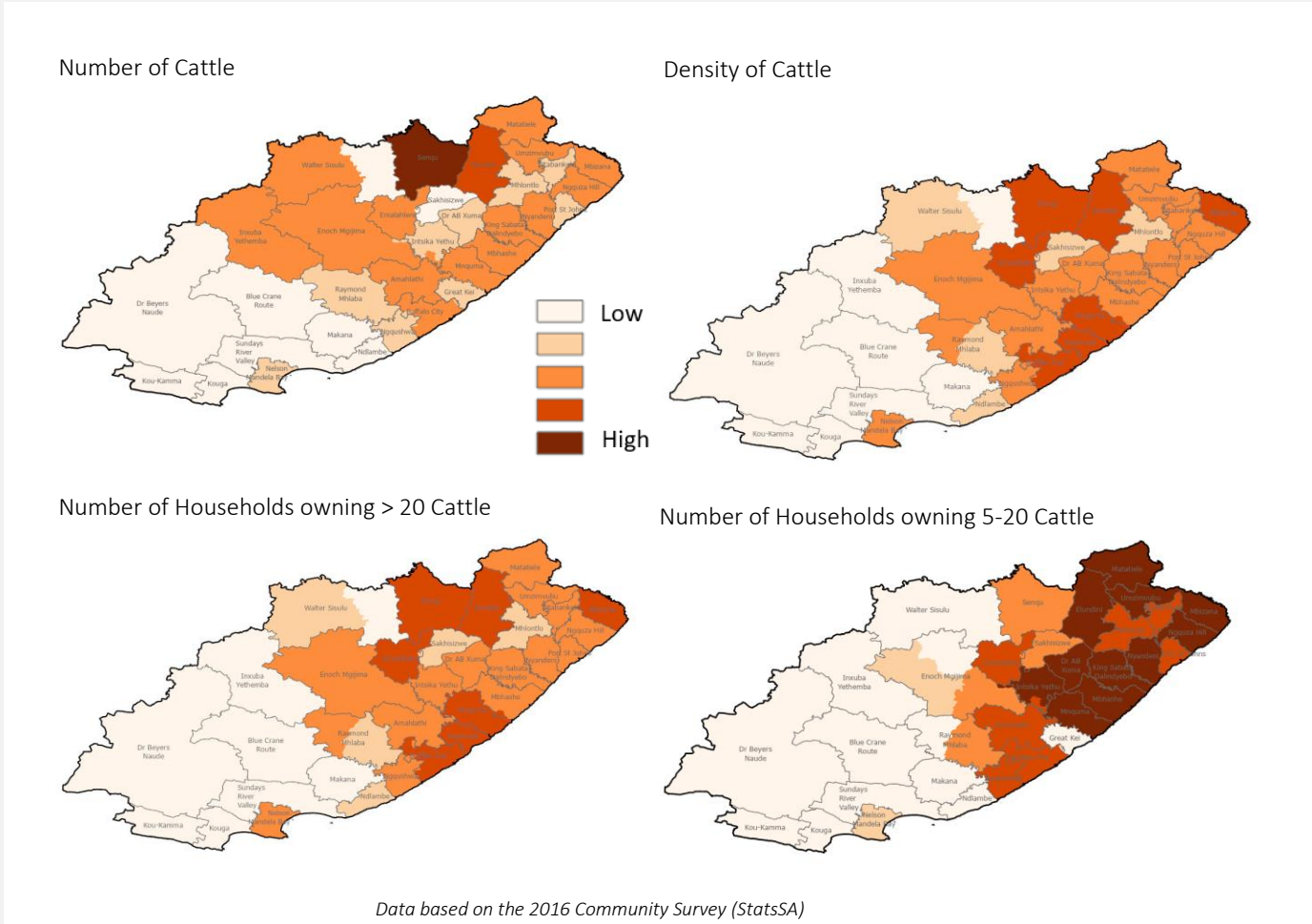


Figure 21: Cattle statistics

Source: Community Survey, StatsSA 2016

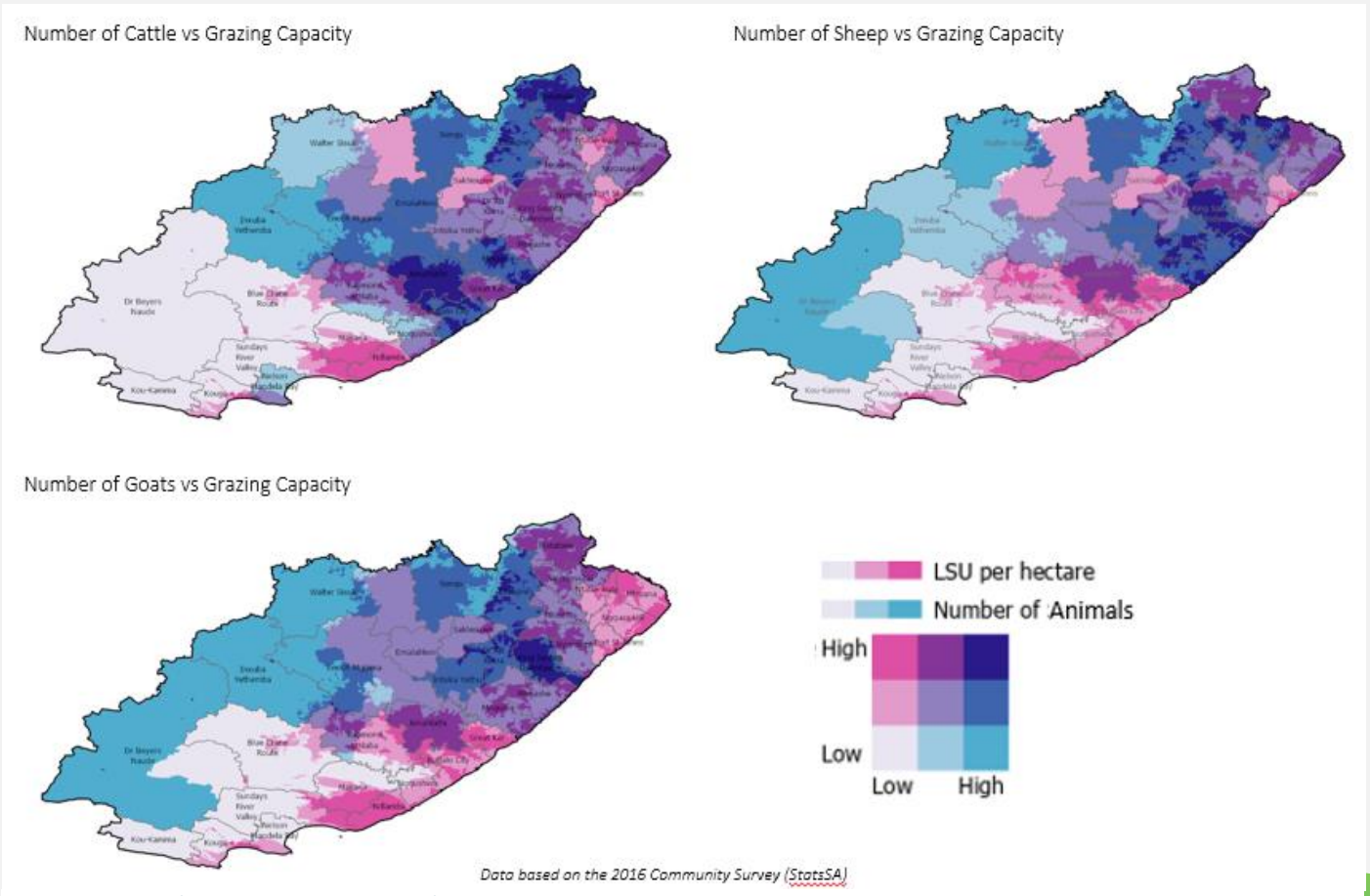


Figure 20: Livestock vs. Grazing capacity numbers

Source: DALRRD (2018), StatsSA (2016), BFAP calculations (2023)

Current land cover and crop cultivation

Agricultural activities in the Eastern Cape are primarily subsistence-based, with farming practices passed down through generations. The main crops cultivated include maize, sorghum, beans, pumpkins and various vegetables. Rainfall is the primary source of "irrigation" for crops although some communities may also utilise small-scale irrigation systems or natural water sources like rivers or dams. In addition to crop farming, livestock rearing is a significant agricultural activity among both small-scale and commercial farming systems. The province is also home to modern commercial agriculture for both cash crops like maize, soybeans and wheat as well as citrus, other fruit, vegetable and dairy farming.

The Eastern Cape landscape with respect to field crop boundaries has changed quite a bit over the last 4-6 years. Table 3 summarises the 2017 and 2021 field crop boundary datasets (by DALRRD): the total field crop boundary area increased to 1.37 million hectares in 2021, that is an increase of 14% from 2017. This is mainly driven by a large increase in rainfed annual crop or planted pasture cultivation (i.e. dryland commercial production), from 271 191 hectares in 2017 up to 432 450 hectares in 2021, the number of dryland commercial fields almost doubled in these four years. Figure 22 maps the density of 2021 dryland commercial fields in the Eastern Cape.

Figure 23 presents the density of irrigated commercial fields which are concentrated around large rivers in the province (e.g. Sundays River). The total irrigated commercial field crop area decreased from 216 946 hectares in 2017 to 189 012 hectares in 2021 (-13%).

While commercial field crop area changed quite a bit from 2017 to 2021, the subsistence field crop area remained relatively consistent, growing by only 4% from 717 371 hectares in 2017 up to 748 573 hectares in 2021. Subsistence agriculture is severely concentrated in the former homeland areas (see Figure 24).

Table 3: Agricultural field crop boundary area in the Eastern Cape

	2017	2021	% CHANGE
DRYLAND COMMERCIAL	271 191	432 450	+59%
IRRIGATION COMMERCIAL	216 946	189 012	-13%
SUBSISTENCE	717 371	748 573	+4%
TOTAL	**1 205 508**	**1 370 035**	**+14%**

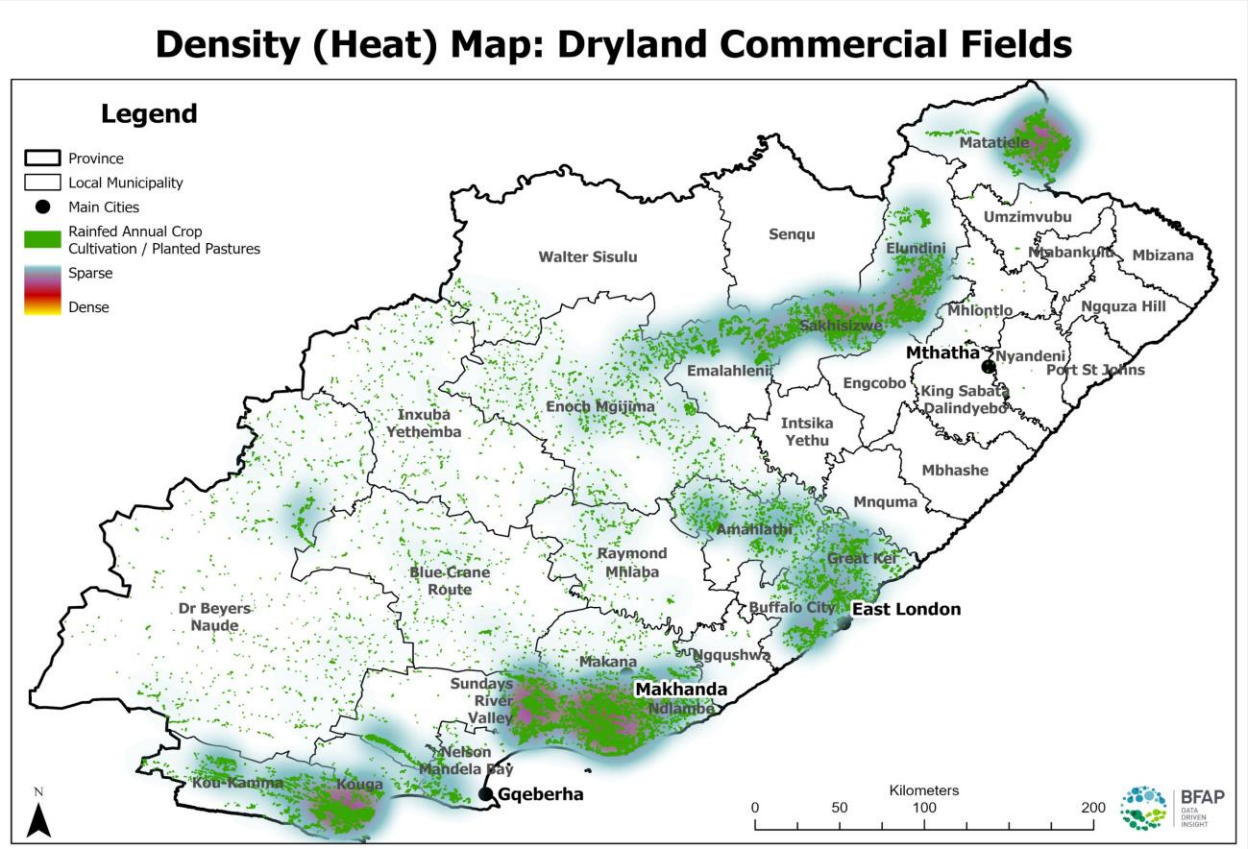


Figure 22: Density map of dryland commercial fields

Source: DALRRD, 2021

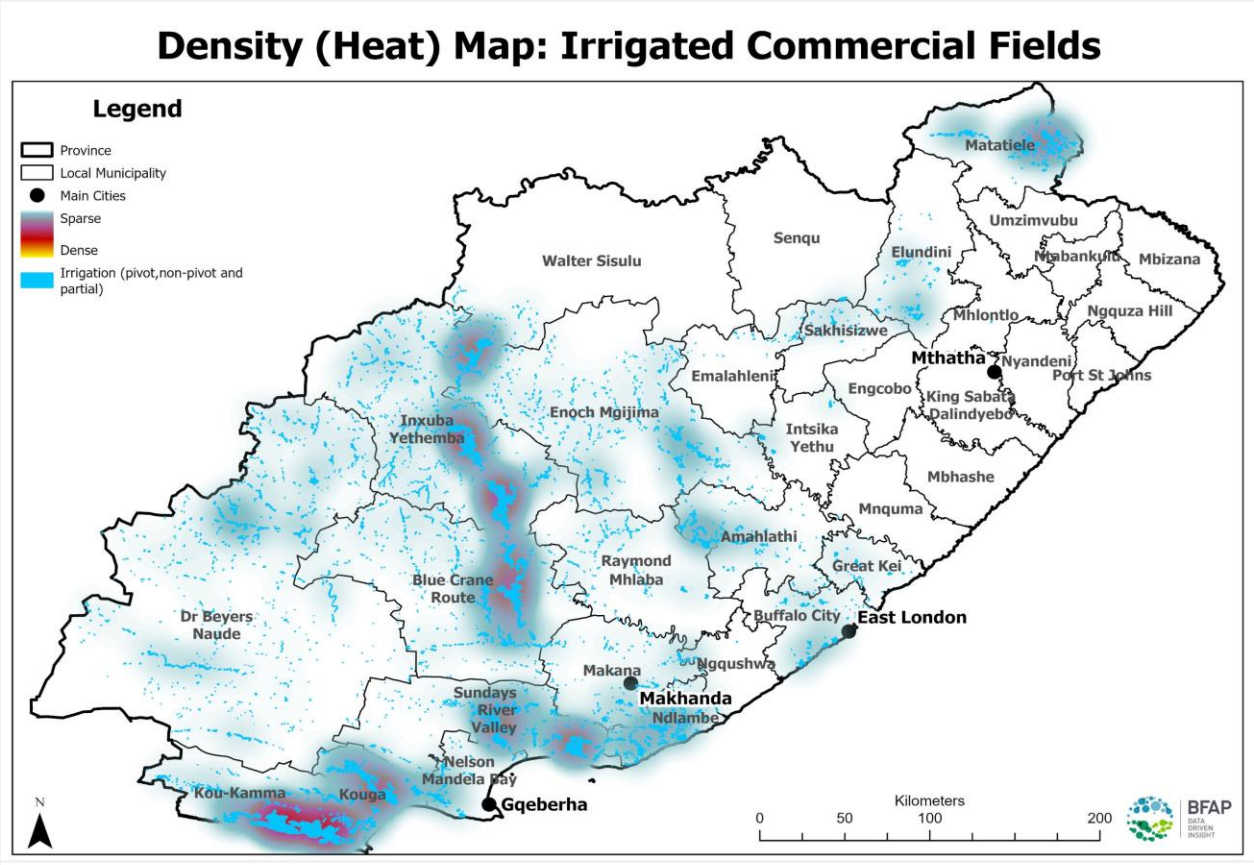


Figure 23: Density map of irrigated commercial fields

Source: DALRRD, 2021

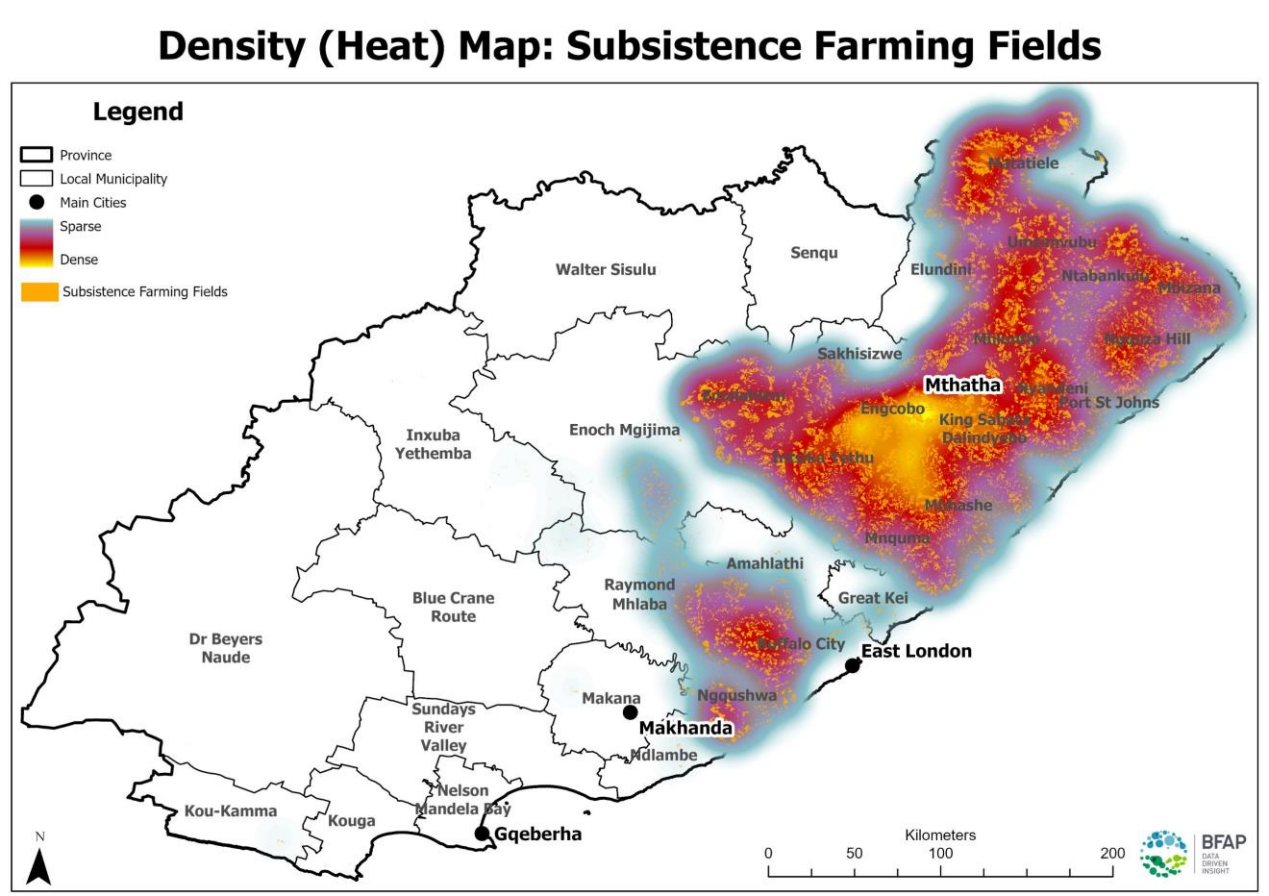


Figure 24: Density map of subsistence farming fields

Source: DALRRD, 2021

The subsistence farming fields in the Eastern Cape were delineated as large polygons (Figure 25) due to the small field sizes and often indistinguishable individual field borders. Subsistence farmers also tend not to plant their fields every year but rather rotate throughout an area or through a set of adjacent fields. For production calculations an assumption was made that only 40% of a delineated area is planted to a crop in a season. Therefore, the total area of subsistence field crop boundaries (total area contained in red and yellow boundaries in Figure 25) sums up to 748 573 hectares; it is thus assumed that only 299 429 hectares are planted to a crop in any given year.

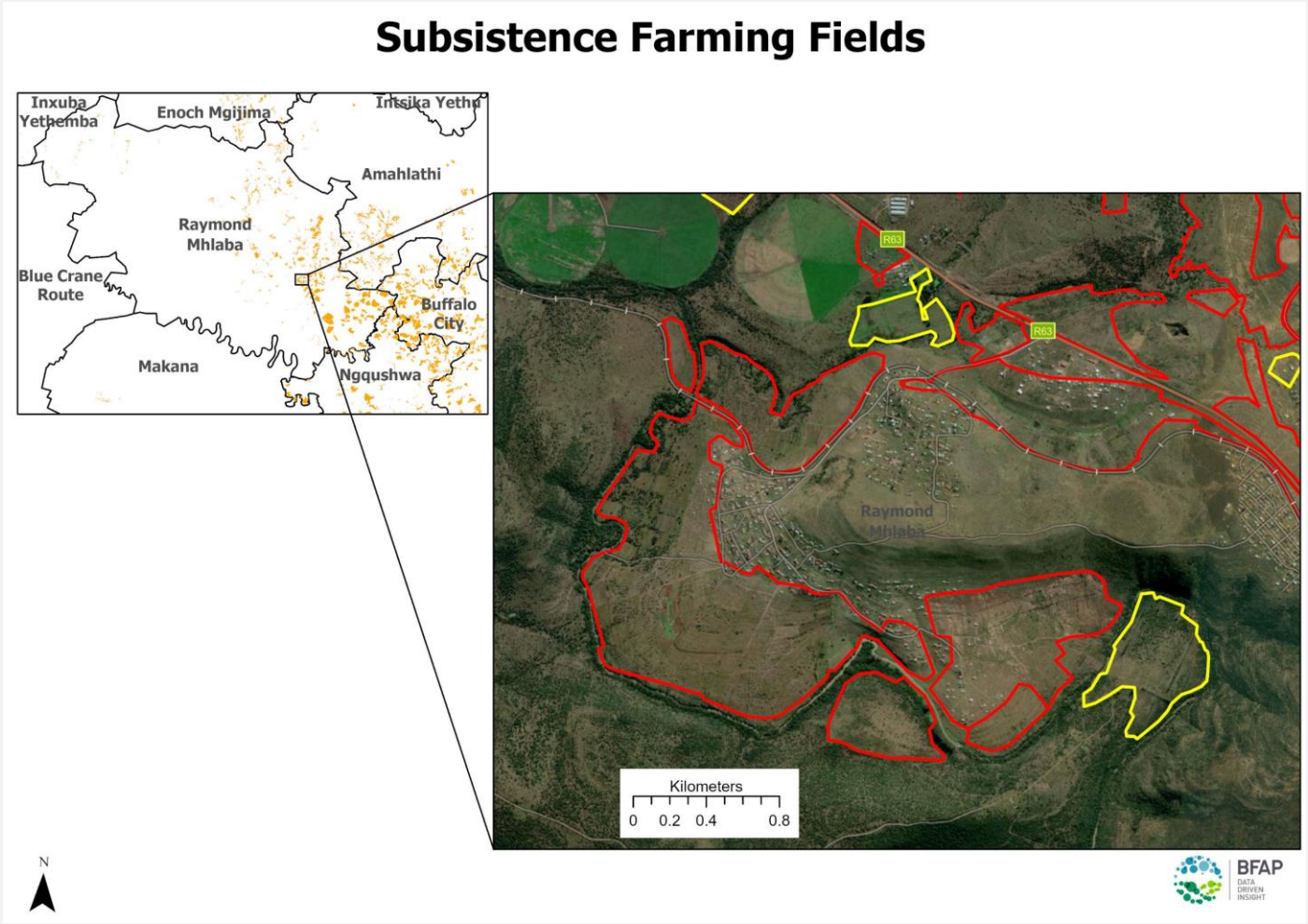


Figure 25: Illustration of subsistence farming fields

Source: DALRRD, 2021.

Potential cash crop production

Maize

Maize overview

Small-scale and subsistence maize production systems in the Eastern Cape involve agricultural practices carried out by individuals or families primarily for their own consumption or local markets. These systems typically differ from large-scale commercial maize production in terms of scale, resources, production practices and market orientation. Small-scale maize production takes place on relatively small plots of land, typically less than 10 hectares. Farmers use traditional farming methods, relying on manual labour or limited mechanization. Access to resources such as modern farming equipment, irrigation systems and improved seeds may be limited compared to larger commercial operations. Surplus production may be sold or bartered at local markets to generate additional income or to acquire goods not produced on the farm.

Small-scale farmers in the Eastern Cape often practice mixed cropping, combining maize cultivation with other crops such as beans, pumpkins or vegetables. Apart from limited national or international market access and integration, small-scale farmers face other challenges including limited access to credit, technical knowledge, and market information as well as vulnerability to climate variability and pests. Government and non-governmental organisations support these farmers by providing extension services, training programmes, access to improved seeds, and initiatives aimed at improving productivity, profitability and sustainable farming practices.

On the other hand, commercial maize production systems in the Eastern Cape involve large-scale farming operations that are focused on producing maize as a cash crop for domestic and international markets. These systems typically use modern farming techniques, advanced technology, and extensive resources to maximise productivity and profitability. These farms can range in size from hundreds to thousands of hectares and employ mechanised equipment such as tractors and combines. Land utilisation is optimised through careful planning and precision farming techniques to maximise yields. Commercial maize farmers make use of modern technology and inputs to enhance productivity which includes the use of high-yielding hybrid maize varieties, genetically modified (GM) and improved seeds and commercial fertilizers. In order to sell their maize on domestic and international markets, farmers are required to comply with quality standards and adhere to market demands in terms of grain size, moisture content and other specifications. They typically engage in forward contracting or selling their maize through commodity markets and grain market channels and have access to a range of supporting infrastructure and logistics including on-farm storage facilities, drying facilities, transport infrastructure and possibly modern grain handling equipment. Commercial maize farmers typically have access to a range of support services, including agricultural extension programmes, financial institutions, and market information systems. These resources help farmers stay updated on market trends, access to credit and insurance and obtain technical advice to optimise their production systems.

South Africa's maize market overview

While estimating the potential maize production in the Eastern Cape, the total domestic market in which this potential production will contribute needs to be understood. To that end, this subsection summarises the South African maize supply and demand dynamics.

Despite global volatility, South African maize producers have prospered in recent years. 2022 yielded the third successive record summer crop harvest, sold at unprecedented price levels derived from global dynamics. The 15.5 million ton maize crop was sufficient to keep domestic prices at export parity levels, despite firm demand as cash strapped consumers, particularly amongst lower income groups, switched to more basic food staples. Early indications from the Crop Estimates Committee (CEC) suggest that 2023 will bring another 16 million ton harvest, despite an 80 000 hectare (3%) reduction in area planted following the sharp increases in

input costs in 2022. This implies that exports could exceed 3.7 million tonnes for the third consecutive year in 2023.

The yields achieved over the past three years reflect favourable weather conditions, together with exemplary farming practices and investment into efficiency gains. Consequently, maize prices have traded well below export parity prices over the first few months of 2023 and in line with global price trends, are expected to decline by around 17% year on year, despite the weaker exchange rate. This reduction is critical to the expectation of slower food inflation over the second half of 2023, and ensures improved affordability of the most basic food staple for embattled consumers. At the same time, it implies that the gross production value of white and yellow maize could decline by 12% and 15% respectively in 2023, despite higher production volumes than in 2022.

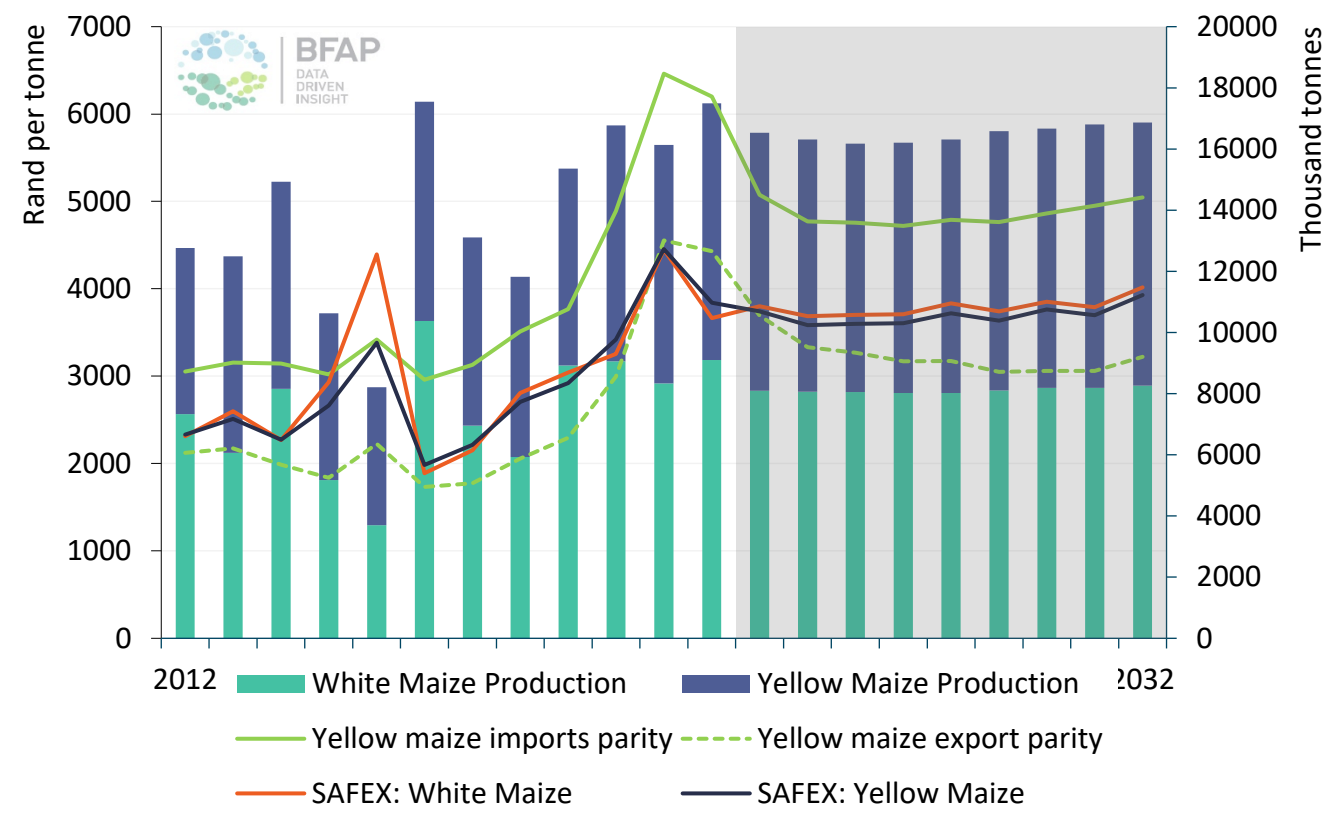


Figure 26: BFAP maize outlook

Source: BFAP, 2023

Current maize production in the Eastern Cape

Maize production in the Eastern Cape has more than doubled over the last 5 years: from 93 200 tonnes in 2018 up to 198 650 tonnes in 2022. This increase was mainly driven by area expansion (14 500 hectares up to 26 000 hectares) however, yields also steadily increased over this time period (see Table 4). Note, that the average yield in the Eastern Cape consistently exceeds the national average yield, likely due to the higher proportion of irrigated maize production in the province. The Eastern Cape only contributed an average 1% to the total Maize production in South Africa over the past 5 years.

Table 4: 5 years of maize production statistics

		2018	2019	2020	2021	2022
Eastern Cape	Area ('000 ha)	14.50	14.00	22.50	24.00	26.00
	Yield (t/ha)	6.43	6.58	6.85	7.18	7.64
	Production ('000 t)	**93.20**	**92.16**	**154.20**	**172.20**	**198.65**

South Africa	Area ('000 ha)	2 318.85	2 300.50	2 610.80	2 755.40	2 622.00
	Yield (t/ha)	5.58	4.86	5.86	5.89	5.87
	Production ('000 t)	**12 931.21**	**11 181.85**	**15 300.00**	**16 234.27**	**15 387.20**

Source: Crop Estimates Committee, 2023.

Yield potential

Various publications on crop suitability and yield potential are available, each with its own set of limitations. Crop suitability can be defined as the process of assessing the appropriateness or ability of a given type of land to support the ideal growing conditions of a particular crop. In the case of the DALRRD data, crop suitability is based on the land (pixel) adhering to a certain set criteria for temperature, slopes and soils. These limits differ per crop type. For this study only land (pixels) that adheres to all three set criteria were used to calculate production potential.

The yield potential is defined by crop limiting factors. The **potential yield** of an area is only limited by uncontrollable factors such as CO_2, radiation, temperature, day length and crop characteristics such as physiology, phenology or canopy architecture. However, in crop production there are numerous agronomic limiting factors at play such as water availability and/or nutrients such as for example nitrogen and phosphorus and other soil (i.e., pH, bulk density, organic carbon) and crop management viz. planting date, plant density and/or row width that define a crop's actual **attainable yield**. Furthermore, there are other crop limiting factors such as weeds pests, diseases and pollutants that define the **actual yield** farmers can obtain.

In most cases mathematical models (often referred to as crop models) are used to calculate the yield potential of an area given the above-mentioned growth limiting factors. These crop yield models may be of differing complexity. Some are **simple rule-based** climate driven models with yields modified for variations in soil properties and management level, such as the Smith Climatic Criteria (1994; 1998). Other models, such as the ACRU maize yield model (Schulze et al., 1995) or Aquacrop and the model used within the GAEZ framework are of intermediate complexity (**semi-empirical models**) and simulate yield by daily soil water budgeting coupled with crop phenology, approximating the crop's response to environmental conditions, while sacrificing certain details of physiological processes such as photosynthesis and respiration. Furthermore, there are complex physiology and genetics based growth models, such as DSSAT or APSIM (Jones and Kiniri, 1986; Jones et al., 1998). These are **mechanistic crop models** where productivity (crop yield) is determined by equations representing a crop's physiological responses to environmental variables. In a mechanistic model to forecast will simulate processes at organ level, like photosynthesis, respiration, and foliar expansion and abscission often on a daily time step.

To estimate the potential production a selection of yield models were used, each with their own strengths and weaknesses, scale and input data.

To estimate the maize yield potential Schulze & Walker (2007) used the DSSAT cropping system model (CERES-maize) that operates at a daily time step to simulate the main physiological processes. The model simulated yields for each Quaternary Catchment representing three plant dates, viz. 15 October, 15 November and 15 December representing early, mid and late plantings, and four cultivars, viz. an ultra-short season hybrid maturing in <115 days, a short season (115 - 130 days), medium (130 - 145 days) and a long season hybrid maturing in >145 days. *For each catchment the optimum yield which should be attained, irrespective of the combination of plant date and hybrid length was used in the study to represent potential maize yield (see* Figure 27*).*

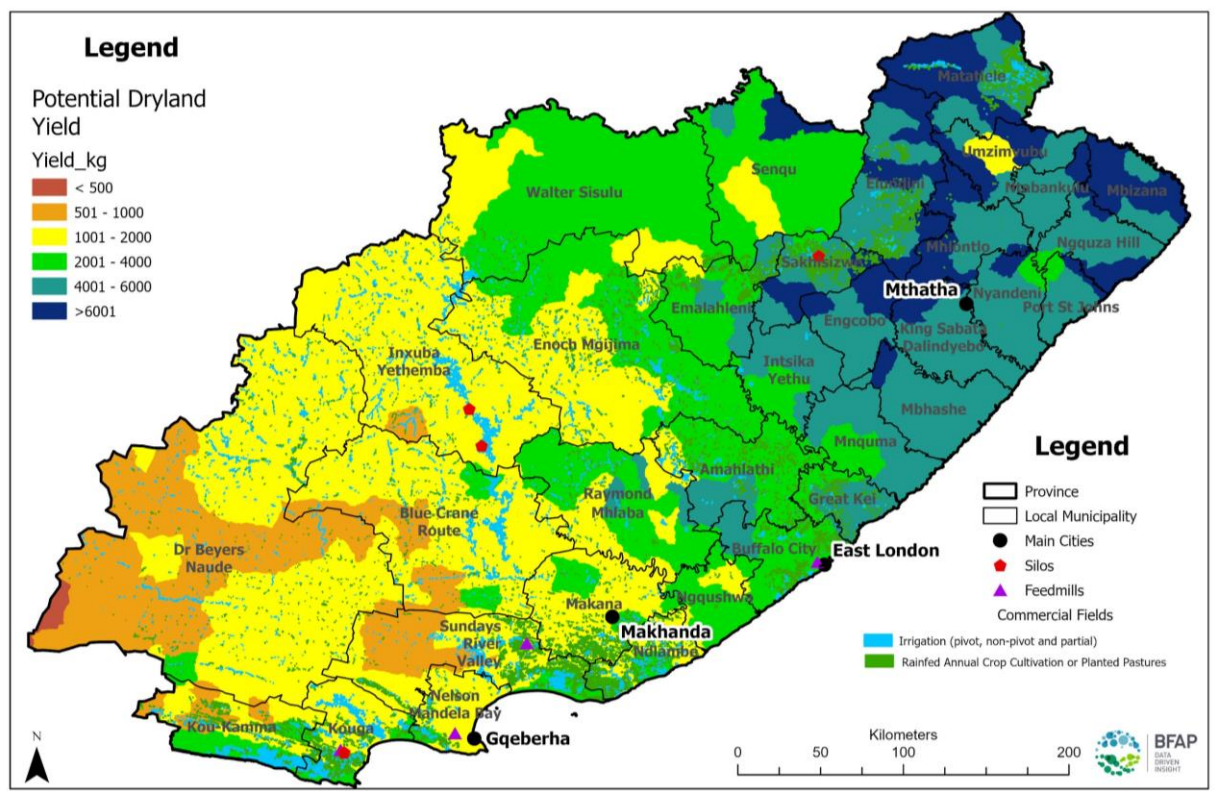


Figure 27: Maize potential dryland yield

Source: Schulze (2007)

Global Agro-Ecological Zones (GAEZ v4) project modeled yield at a 30 arc minute level (9km x 9km) at a global scale. Both potential (the agronomically possible upper limit to produce individual crops under given agro-climatic, soil and terrain conditions and applying specific management assumptions and agronomic input levels) and attainable yield (combining agro-climatic potential yields with soil/terrain evaluation results, i.e., yield reduction factors due to the constraints induced by soil limitations and prevailing terrain-slope conditions) were calculated. *For the study the attainable yield under rainfed or irrigated conditions using high level of input was used (see* Figure 28*).*

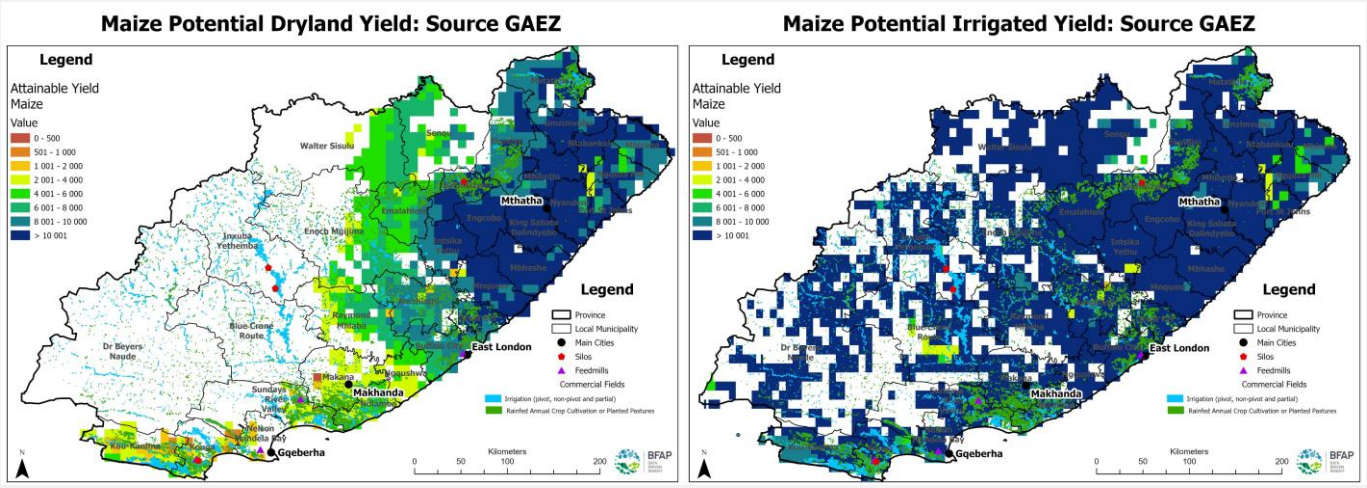


Figure 28: Maize potential dryland and irrigated yield (GAEZ)

Source: Fischer, et al., 2021

Figure 29 presents a boxplot summary of the Schulze and GAEZ Dryland and Irrigation maize yields as linked to field crop boundaries in the Eastern Cape. Evidently, the yield models and assumptions have a big influence on the ultimate production potential calculation:

- Schulze dryland maize yields range between 0.4 to 7.56 t/ha with an average of 2.51 t/ha.
- GAEZ dryland maize yields range between 0.002 and 12.3 t/ha with an average of 6.16 t/ha.
- GAEZ irrigation maize yields range between 0.01 and 15.8 t/ha with an average of 12.5 t/ha.

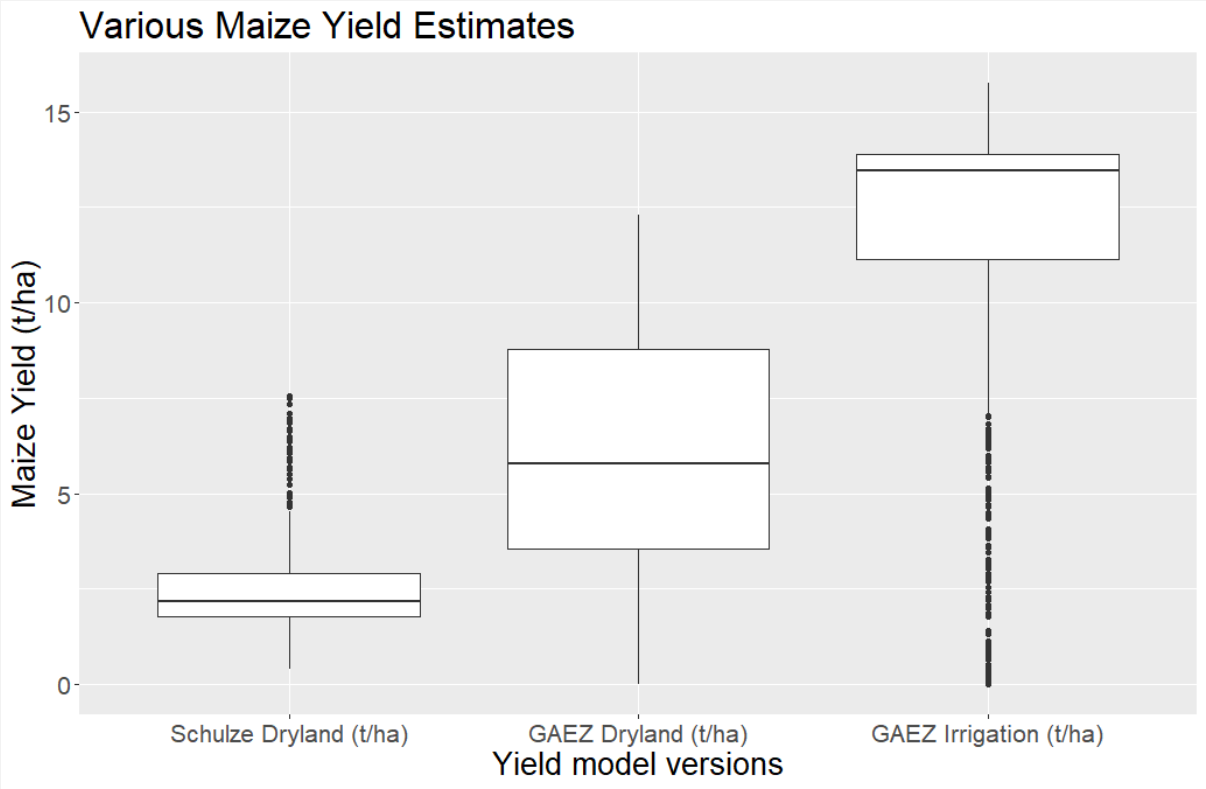


Figure 29: Boxplots of various yield model assumptions
Source: own calculations

Using field boundaries delineated for 2017 (based on 2014-2016 Landsat imagery, 30 m resolution) and 2021 (based on 2019-2021 Sentinel imagery 10m resolution, and aerial photography) a link was made between each field and the yields from the different sources using the contained per quaternary catchment in the Schulze yield data set, the mean for GAEZ and the majority DALRRD coverage. With the known area per field, and whether these are under a dryland or irrigated management system, the production potential for each field was calculated. To present the field level production in a more meaningful way the production was summarised to quaternary catchments and mapped. *In other words, the dryland managed fields were only associated with the dryland yields, with the same rules applied to irrigation production calulations.*

To derive a production estimate using only the DALRRD suitability indicators, the majority class for the field was used indicating either suitability only for irrigated production systems or suitability for both dryland (rainfed) or irrigated production systems (see Figure 30). Yields based on 5-year averages for either dryland or irrigation based as calculated by the Crop Estimated Committee's (CEC) secretariat for a split between dryland and irrigated area were used to estimate a field's production:

- Dryland potential yield of 3.6 t/ha (2018 – 2022 average)
- Irrigated potential maize yield of 8.9 t/ha (2018 – 2022 average)

For representation these were also summarised based on quaternary catchments.

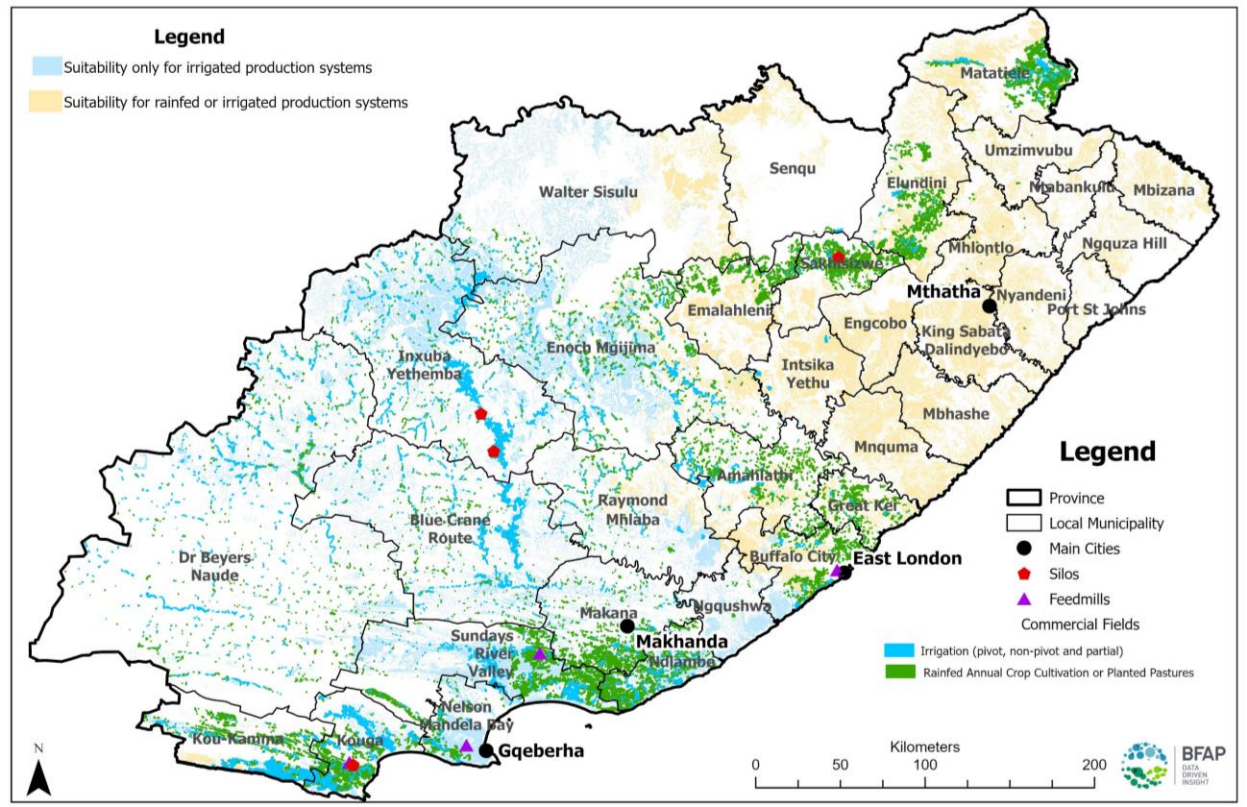


Figure 30: Indication of whether or not a field boundary is suitable or not for maize production
Source: DALRRD (2020)

To calculate the production potential of subsistence farming systems the assumption was made that only 40% of the area delineated by the field boundaries dataset is actually planted in a season. Furthermore, the average yield was taken as 2.36 t/ha, based on a 5-year average (2019 – 2023) as presented by the Crop Estimated Committee's (CEC) secretariat. Note that van der Burgh (2016) estimated the potential yield for subsistence farming at 3.7t/ha, asserting that with improvement of crop management practices like planting date, cultivar selection and weed management, the attainable yield in the former homelands of the Eastern Cape is higher than is currently achieved. Howerver, the CEC figure was maintained for the calculated production potential presented here.

Using various sources of evidence allows for triangulation of potential/attainable and actual yields for an area, taking into account changes in area under crops over years due to factors such as climate, economics and ubanisation. This forms the basis for the calculation of potential maize production in the next section.

Production potential

Figure 28 - 27 illustrate that the various yield data versions do not cover the total or the same parts of the Eastern Cape province and therefore the production potential summaries presented in Table 5 are based on not only different yield potential models, but also on varying total production areas, based on where maize production is viable according to the yield models.

Table 5: Maize production potential summary

	PRODUCTION ('000 TONNES)	AREA ('000 HA)**	OVERALL AVERAGE YIELD (T/HA)*
SCHULZE (FIGURE 31)	1 133.03	414.50 (96%)	2.51
GAEZ DRYLAND	1 851.76	293.25 (68%)	6.16
DALRRD DRYLAND	365.63	101.56 (23%)	5.98
GAEZ IRRIGATION	1 572.06	125.66 (66%)	12.47
DALRRD IRRIGATION (FIGURE 32)	728.69	84.72 (45%)	5.07
SUBSISTENCE (FIGURE 33)	703.16	297.95 (40%)	2.36

*Overall average yield is calculated from total production and area quoted in the table and differs slightly from the mean quoted in the boxplot in Figure 29.

**Percentage of total available Dryland, Irrigation and Subsistence area indicated.

Source: own calculations

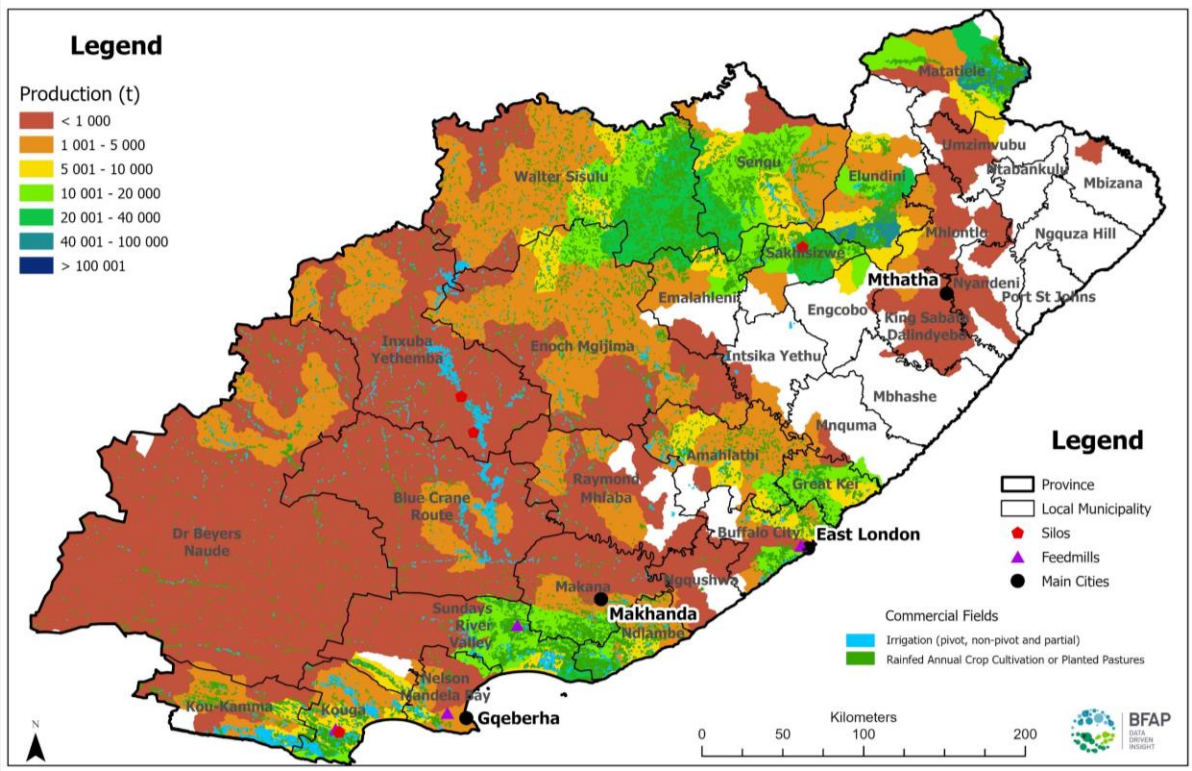


Figure 31: Maize potential dryland production

Source: Schulze, own calculations

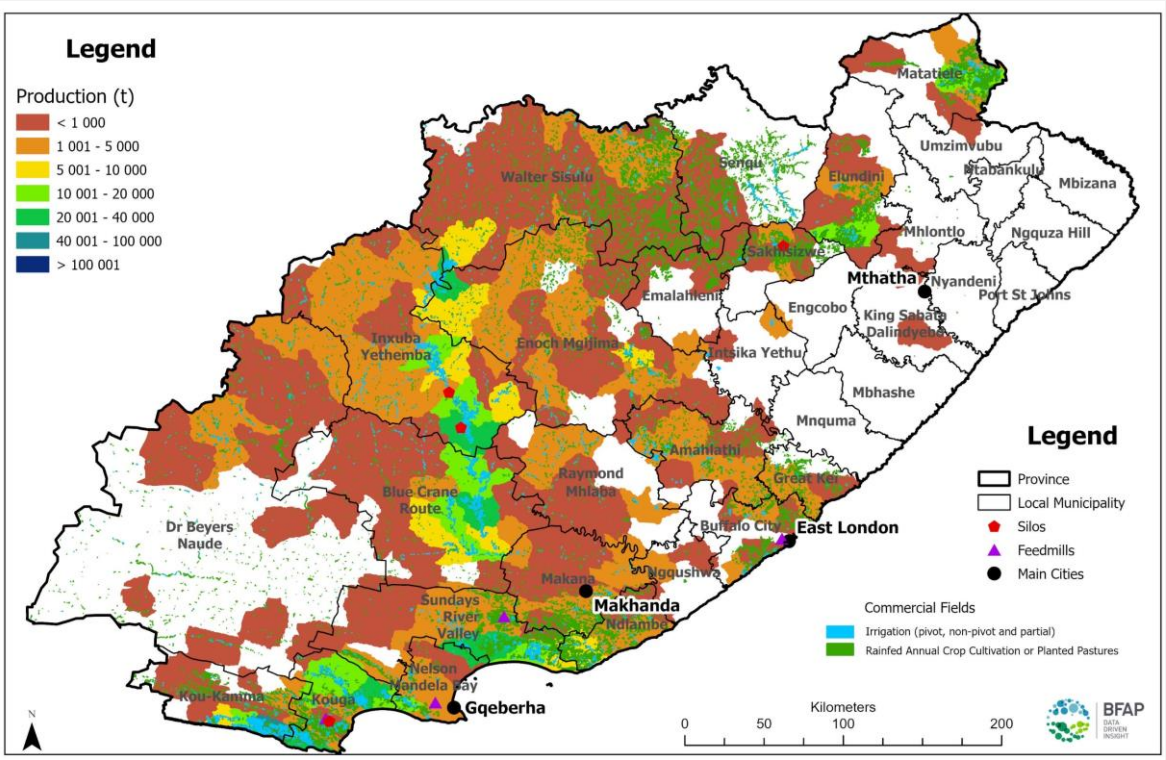


Figure 32: Maize potential irrigated maize production

Source: DALRRD (2020), own calculations

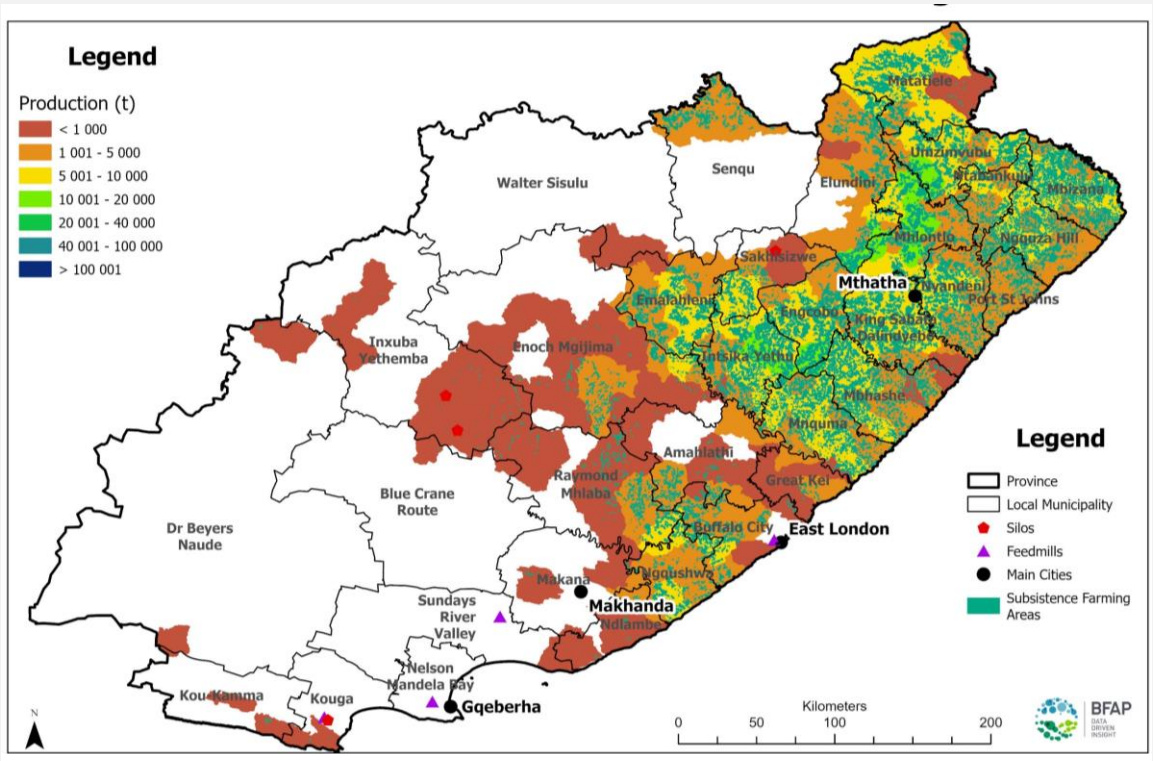


Figure 33: Maize potential subsistence farming maize production

Source: CEC (2023), own calculations

If the highlighted versions are selected as the most accurate representation of total area and attainable yield (Table 5), the total maize production potential for the Eastern Cape is as much as **2 564 880 tonnes**. This does not take crop mixes and rotations into account but assumes that all agricultural fields available are planted to maize, which is not realistic.

We assume that 10% of all agricultural fields are fallow in a given year, and as much as 55% are planted pastures that are unlikely to be converted to cash crop production given the marginal climatic and/or soil attributes[4].

The remaining 279 010 hectares of field crop area could be assumed to be planted to cash crops (this exceeds the Crop Estimates Committee total cash crop area as published by the CEC by 230%, but accounts for dryland, irrigation and subsistence agriculture, while the CEC figure captures only commercial cash crop production).

Furthermore, according to the CEC, maize typically makes up 76% of total cash crop area in the Eastern Cape (Table 6). The total area under maize production should therefore be revised as in Table 7 (each step demonstrated in subsequent columns). The revised potential maize production can be calculated as 578 040 tonnes. That is more than three times the average maize production in the Eastern Cape over the last three years (2020 – 2022) of 175 000 tonnes.

Table 6: Cash crop area in the Eastern Cape

	5-year average area (2018 – 2022)	% of total the Eastern Cape
Maize	20.30	**76%**
Sunflower	0.20	**1%**
Soybeans	2.23	**8%**
Drybeans	0.26	**1%**
Wheat	3.71	**14%**

Source: CEC, 2023

Table 7: Revised attainable maize production potential

	Total Area with some yield potential ('000 ha)	Total Area less 65% fallow & planted pasture fields ('000 ha)	Estimated Maize Area: 76% of crop mix ('000 ha)	Overall average yield (t/ha)	Production potential ('000 tonnes)
DRYLAND COMMERCIAL PRODUCTION (BASED ON SCHULZE)	414.50	145.08	110.26	2.51	276.75
IRRIGATED COMMERCIAL PRODUCTION (BASED ON DALRRD)	84.72	29.65	22.54	5.07	114.26
SUBSISTENCE PRODUCTION	297.95	104.28	79.25	2.36	187.04
Total	**797.17**	**279.01**	**212.05**		**578.04**

Source: own calculations and verified by Table 14 in Van der Burgh (2016).

[4] The proportion fallow and planted pasture fields is derived from the Crop Type Distribution data generated by GeoTerra Image. This data is essential to further understanding of crops planted in the Eastern Cape, especially given the diverse nature of sub-climates and agricultural practices in the province.

Soybeans

Soybean overview

Soybean production in the Eastern Cape has gained importance in recent years due to the crop's profitability and versatility. While soybean production in the region is not as extensive as in other parts of the country, it has been steadily increasing. The province offers favourable agroecological conditions for soybean cultivation, including a warm climate, moderate rainfall, and well-drained soils. Soybeans are often included in crop rotation systems together with maize, sunflower or other crops to optimise yield and reduce disease and pest pressures. Common pests that can affect soybeans include aphids, thrips, armyworms, and pod borers. Diseases such as soybean rust and root rot can also pose challenges. Integrated pest management (IPM) strategies, including the use of insecticides, resistant varieties and cultural practices are employed to control these threats and minimize yield losses. The Eastern Cape's soybean production is primarily aimed at meeting both local and international demand. Soybeans have diverse uses, including animal feed, edible oil extraction and food processing. Farmers may sell their soybeans to local grain merchants, processors or directly to feed mills and oilseed crushing facilities. However, the major markets are situated in the northern parts of the country, hence transport costs are high. Agricultural research institutions (e.g. the Agricultural Research Council) and extension services in the Eastern Cape provide support to soybean farmers, offering guidance on best practices, pest management strategies and crop nutrition. These institutions conduct research and trials to develop improved soybean varieties adapted to the specific conditions of the Eastern Cape.

South Africa's soybean market overview

The South African soybean supply and demand dynamics are summarised in this subsection, in order to highlight the context in which soybean production potential is estimated in subsequent sections. Oilseed production growth in South Africa as a whole has been even stronger than maize, as another almost 100 000-hectare expansion in soybean area propels expected production growth of 22% in 2023, following an 18% expansion in 2022. This implies that soybean production has more than doubled since 2020, to exceed 2.7 million tonnes by 2023. Expansion was fuelled by higher prices, in line with global dynamics, combined with exceptional yields as producers optimised seed variety choices, particularly in the Western parts of the country. The sharp rise in the exportable surplus has pushed soybean prices below export parity as well in early 2023, but despite the projected year on year decline in prices of more than 15%, the gross value from Soybean production is expected to rise for the 4th consecutive year, due to increased production volume (Figure 34).

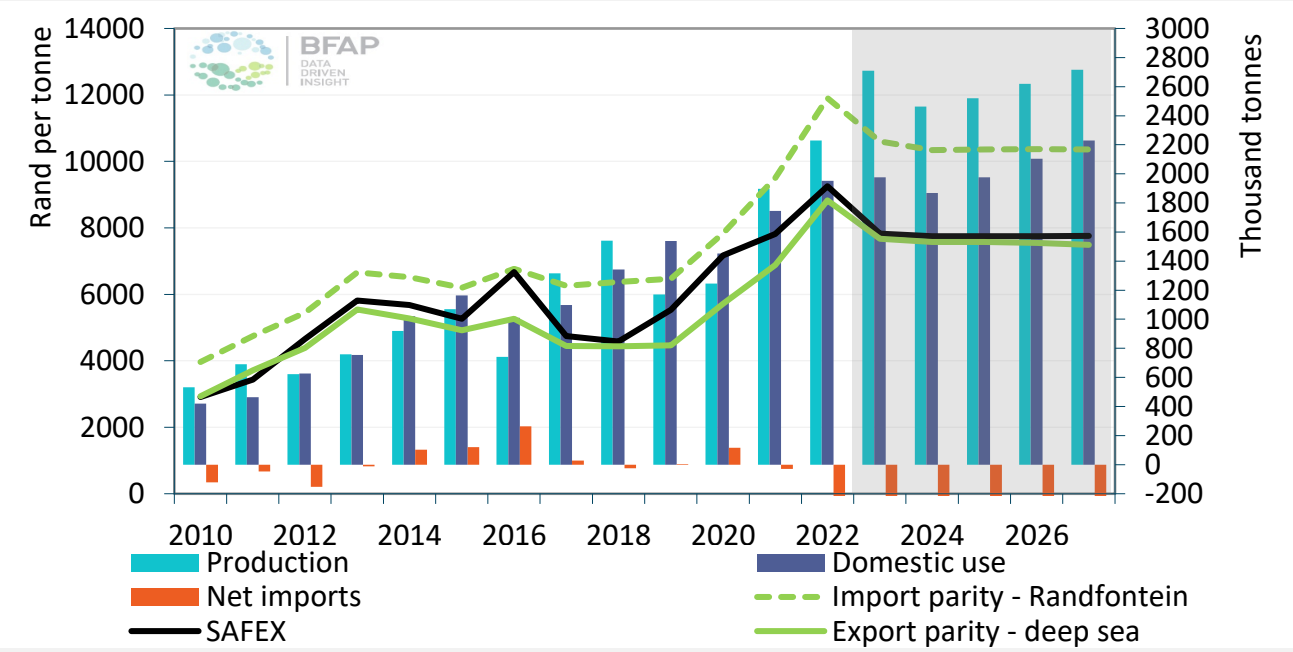


Figure 34: BFAP soybean outlook

Source: BFAP, 2023

Current Soybean Production in the Eastern Cape

Soybean production in the Eastern Cape has increased substantially over the last 5 years, from 2 400 tonnes in 2018 up to 9 000 tonnes in 2022 (see Table 8). The increase has been mainly driven by both expansion (area increases) and intensification (yield increases). During the most recent three seasons, the average Eastern Cape soybean yield was slightly higher (26%) than the national average yield according to the Crop Estimates Committee.

Table 8: 5 years of soybean production statistics

		2018	2019	2020	2021	2022
Eastern Cape	Area (ha)	2 400	1 150	1 500	3 100	3 000
	Yield (t/ha)	1.00	1.20	2.00	3.00	3.00
	Production (t)	**2 400**	**1 380**	**3 000**	**9 300**	**9 000**
South Africa	Area (ha)	787 200	730 500	705 000	827 100	925 300
	Yield (t/ha)	1.97	1.60	1.77	2.29	2.38
	Production (t)	**1 550 800**	**1 170 345**	**1 245 500**	**1 897 000**	**2 201 000**

Source: Crop Estimates Committee (2023).

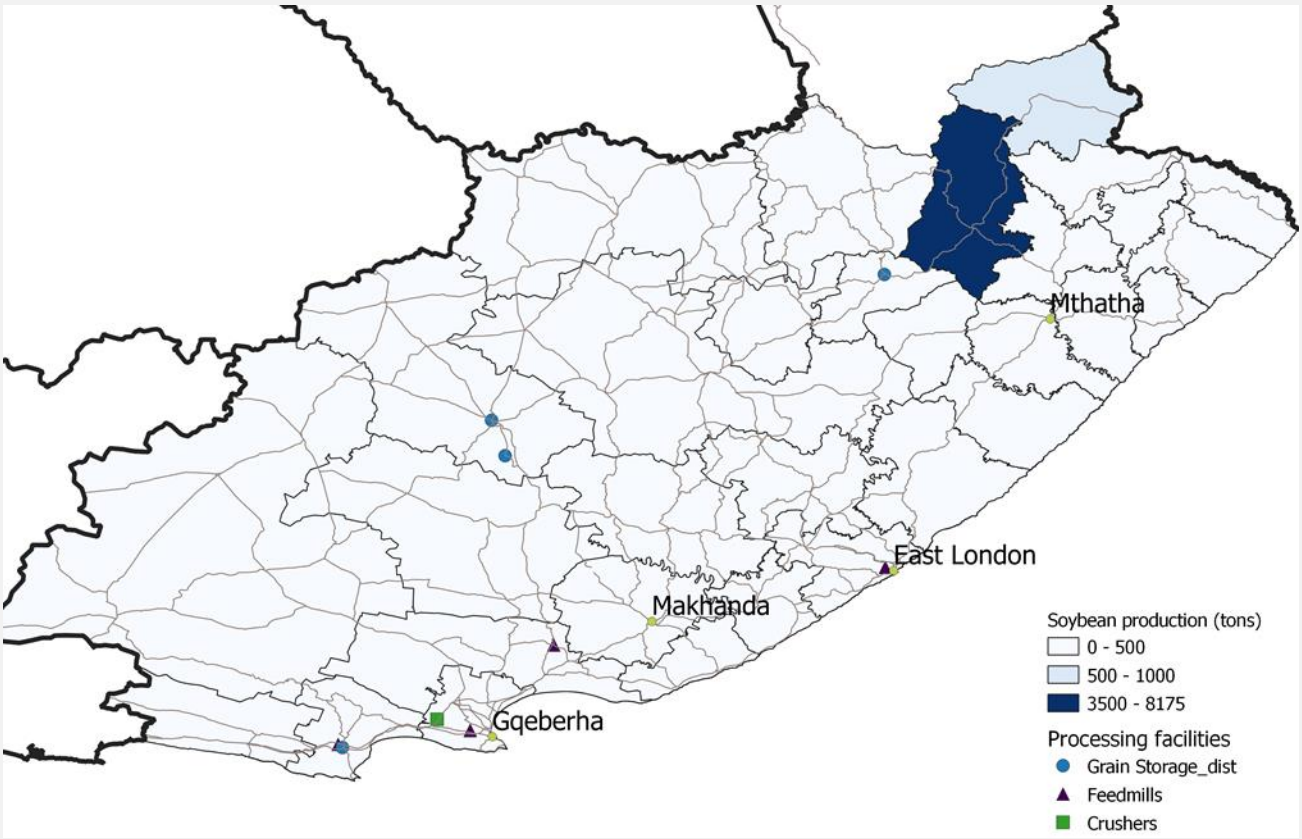


Figure 35: Current soybean production in the Eastern Cape

Source: own compilation

Yield potential

The following maps illustrate potential yields that can be achieved, or whether soybean production is suitable, across the Eastern Cape. The description below the maps explains what each map indicates.

They maps are based on a combination of environmental, climate and soil data to make modelling predictions.

The types of available yield models were discussed above, in the maize yield potential section and below, various yield models for soybeans are discussed, each with their own strengths and weaknesses, scale and input data.

For soybeans, Schulze used Smith's (1994; 1998) climatic criteria as presented in the Agrohydrological Atlas to estimate yields. These criteria included the effective rainfall for October to March and heat units (base 10°C) for the same period, with modifications to yield made for soil properties and levels of management. Rainfall values were derived from the 1 arc minute (1' x 1' latitude x longitude) median monthly rainfalls generated for South Africa by Lynch (2004), while heat units were computed from the 1 arc minute daily temperature series for the 50-year period 1950 - 1999, derived by Schulze and Maharaj (2004). Areas were considered climatically unsuitable for dryland soybean production when mean annual precipitation (MAP) < 600 mm, January mean temperature < 18°C, October-March heat units < 1 000 or > 2 600 ° days (see Figure 36).

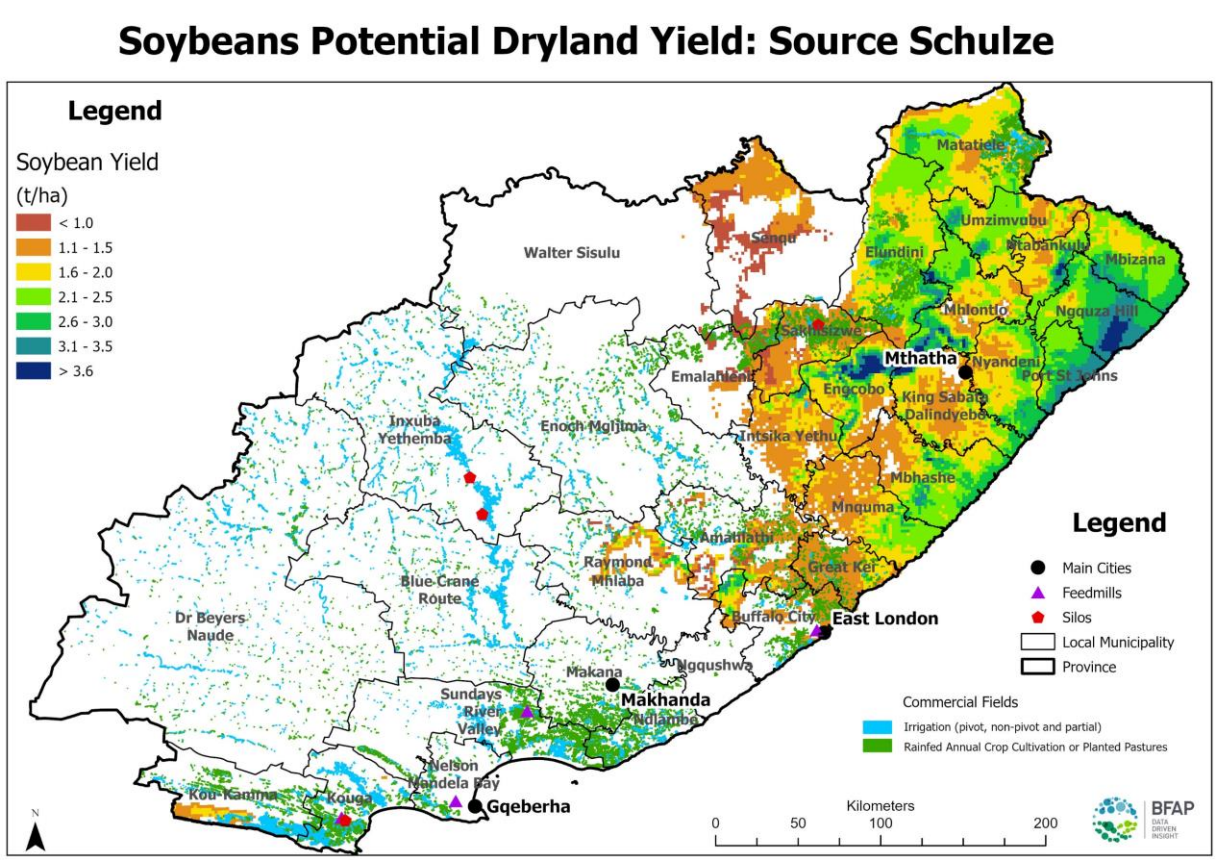


Figure 36: Soybean production potential on dryland

Source: Schulze

Global Agro-Ecological Zones (GAEZ v4) project modeled yield at a 30 arc minute level (9km x 9km) at a global scale. Both potential (the agronomically possible upper limit to produce individual crops under given agro-climatic, soil and terrain conditions and applying specific management assumptions and agronomic input levels) and attainable yield (combining agro-climatic potential yields with soil/terrain evaluation results, i.e., yield reduction factors due to the constraints induced by soil limitations and prevailing terrain-slope conditions) were calculated. *For the study the attainable yield under rainfed or irrigated conditions using high level of input was used (see* Figure 37Figure 37*).*

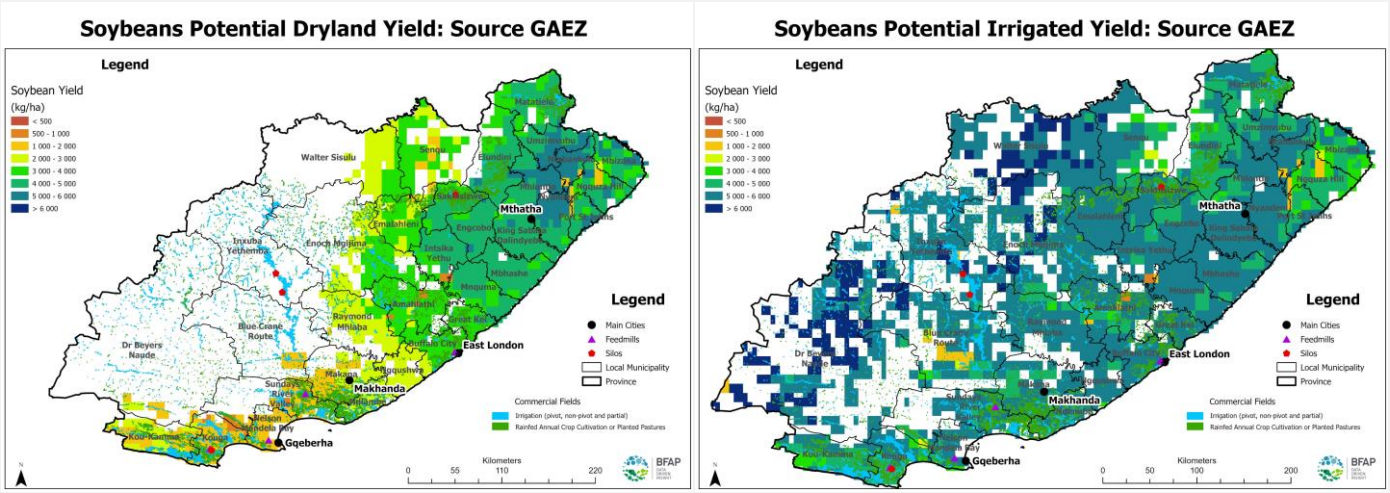


Figure 37: Soybean potential dryland and irrigated yield (GAEZ)

Source: GAEZ (2023)

Figure 38 presents a boxplot summary of the Schulze and GAEZ Dryland and Irrigation soybean yields as linked to field crop boundaries in the Eastern Cape. Evidently, the yield models and assumptions have a big influence on the ultimate production potential calculation:

- Schulze dryland soybean yields range between 1.1 to 3.6 t/ha with an average of 1.43 t/ha.
- GAEZ dryland soybean yields range between 0.6 and 5.2 t/ha with an average of 2.86 t/ha.
- GAEZ irrigation soybean yields range between 1.3 and 6.2 t/ha with an average of 5.09 t/ha.

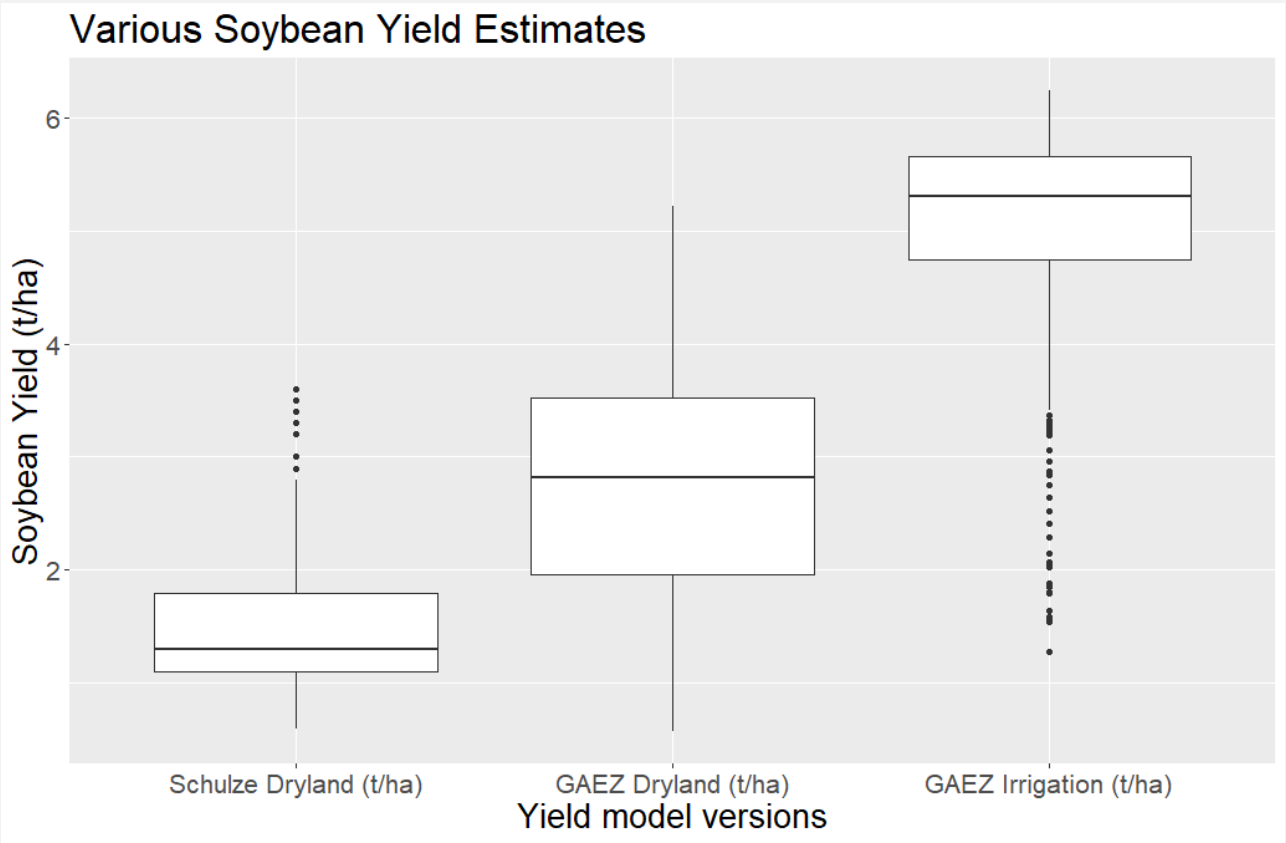


Figure 38: Boxplots of various yield model assumptions

Source: own calculations

Using field boundaries delineated for 2017 (based on 2014-2016 Landsat imagery, 30 m resolution) and 2021 (based on 2019-2021 Sentinel imagery,10m resolution, and aerial photography) a link was made between each field and the yields from the different sources using the contained per quaternary catchment in the Schulze yield data set, the mean for GAEZ and the majority DALRRD coverage. With the known area per field,

and whether these are under a dryland or irrigated management system, the production potential for each field was calculated. To present the field level production in a more meaningful way the production was summarised to quaternary catchments and mapped. *In other words, the dryland managed fields were only associated with the dryland yields, with the same rules applied to irrigation production calulations.*

To derive a production using only the DALRRD suitability indicators, the majority class for the field was used indicating either suitability only for irrigated production systems or suitability for both dryland (rainfed) or irrigated production systems (see Figure 39). Yields based on 5-year averages for either dryland or irrigation based as calculated by the Crop Estimated Committee's (CEC) secretariat for a split between dryland and irrigated area were used to estimate a fields production:

- Dryland potential soybean yield of 2.01 t/ha (2018 – 2022 average)
- Irrigated potential soybean yield of 3.48 t/ha (2018 – 2022 average)

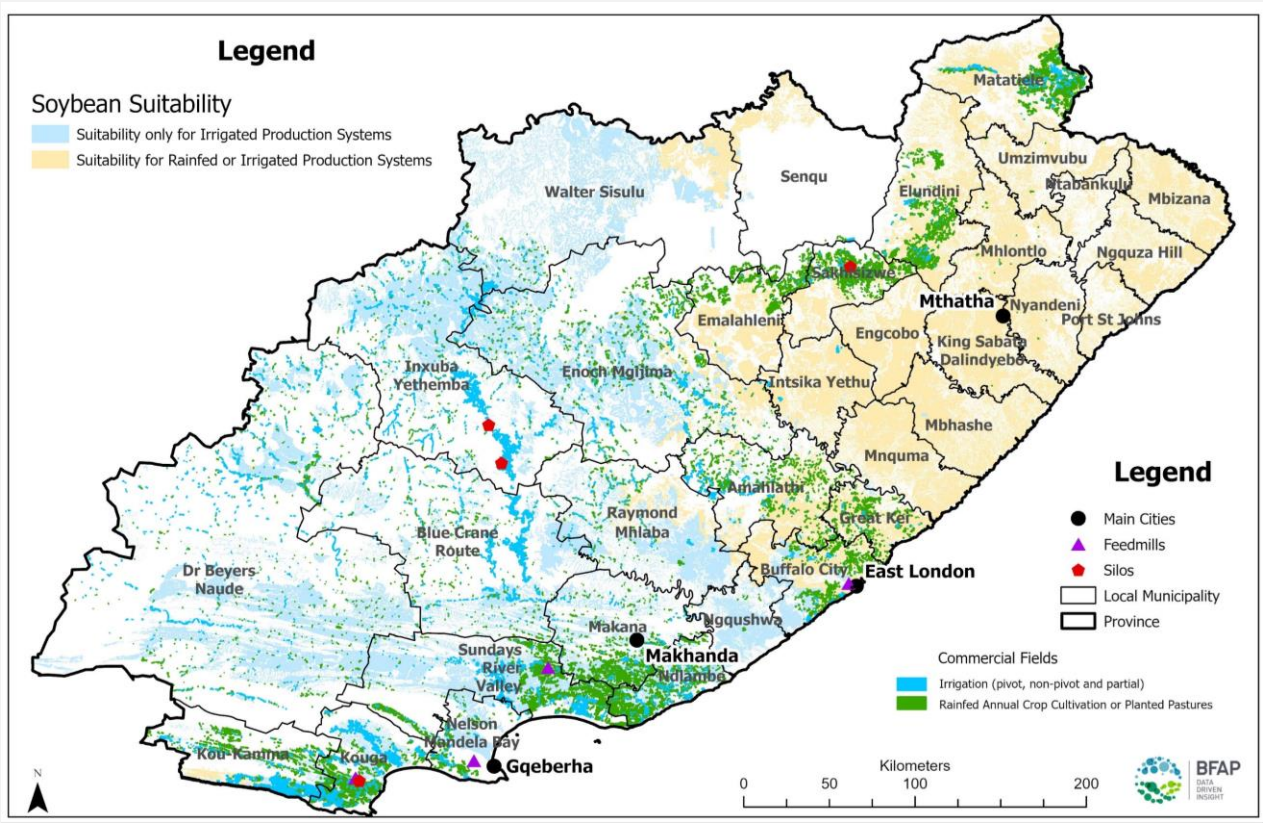


Figure 39: Indication of whether or not a field boundary is suitable or not for soybean production.
Source: DALRRD (2020)

Production potential

Figures 33 - 36 illustrate that the various soybean yield data versions do not cover the total or the same parts of the Eastern Cape province and therefore the production potential summaries presented in Table 9 are based on not only different yield potential models, but also on varying total production areas, based on where soybean production is viable according to the yield models.

Table 9: Soybean production potential summary

	PRODUCTION ('000 TONNES)	AREA ('000 HA)**	OVERALL AVERAGE YIELD (T/HA)*
SCHULZE (FIGURE 40)	165.95	110.75 (26%)	1.50
GAEZ DRYLAND	924.72	318.38 (74%)	2.90
GAEZ IRRIGATION	661.78	130.16 (69%)	5.08
DALRRD DRYLAND	192.59	95.82 (22%)	2.01
DALRRD IRRIGATION (FIGURE 41)	180.97	52.00 (28%)	3.48

*Overall average yield is calculated from total production and area quoted in the table and differs slightly from the boxplot results in Figure 38Figure 38.

**Percentage of total available Dryland, Irrigation and Subsistence area indicated.

Source: own calculations

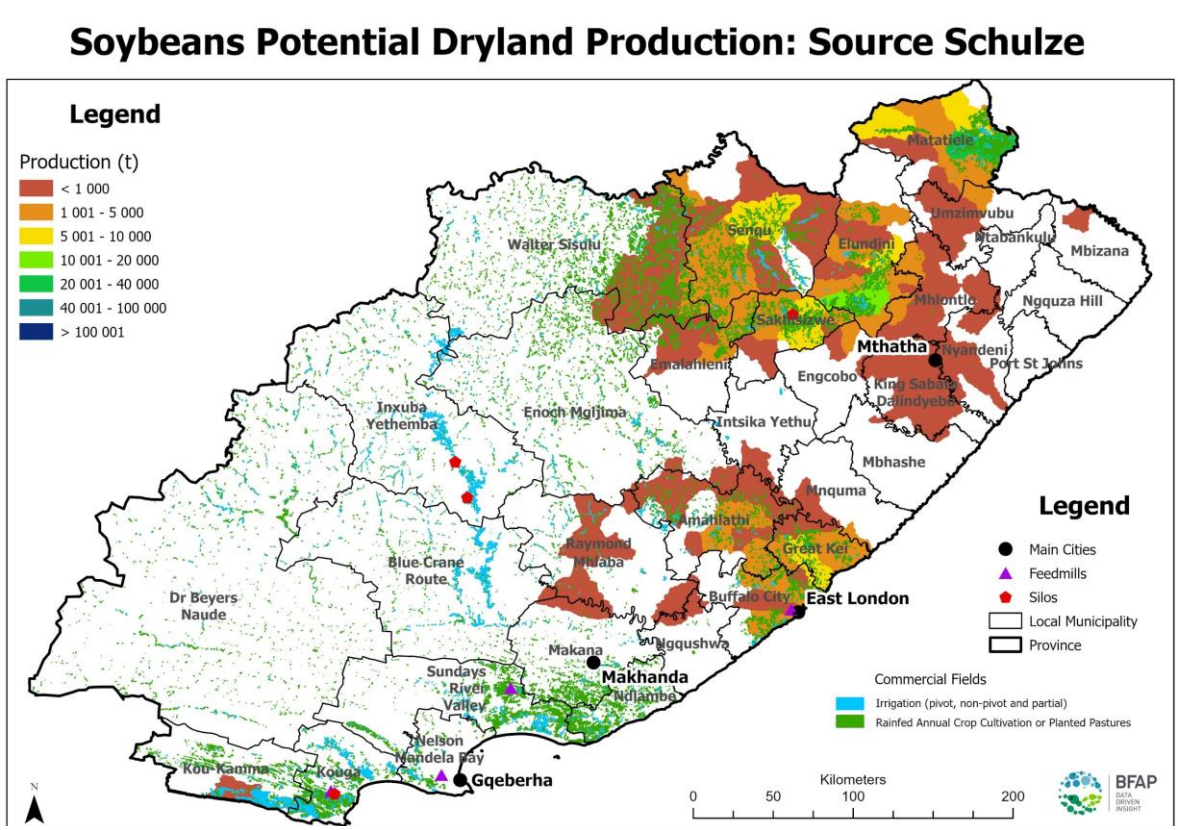


Figure 40: Soybean potential dryland production

Source: Schulze

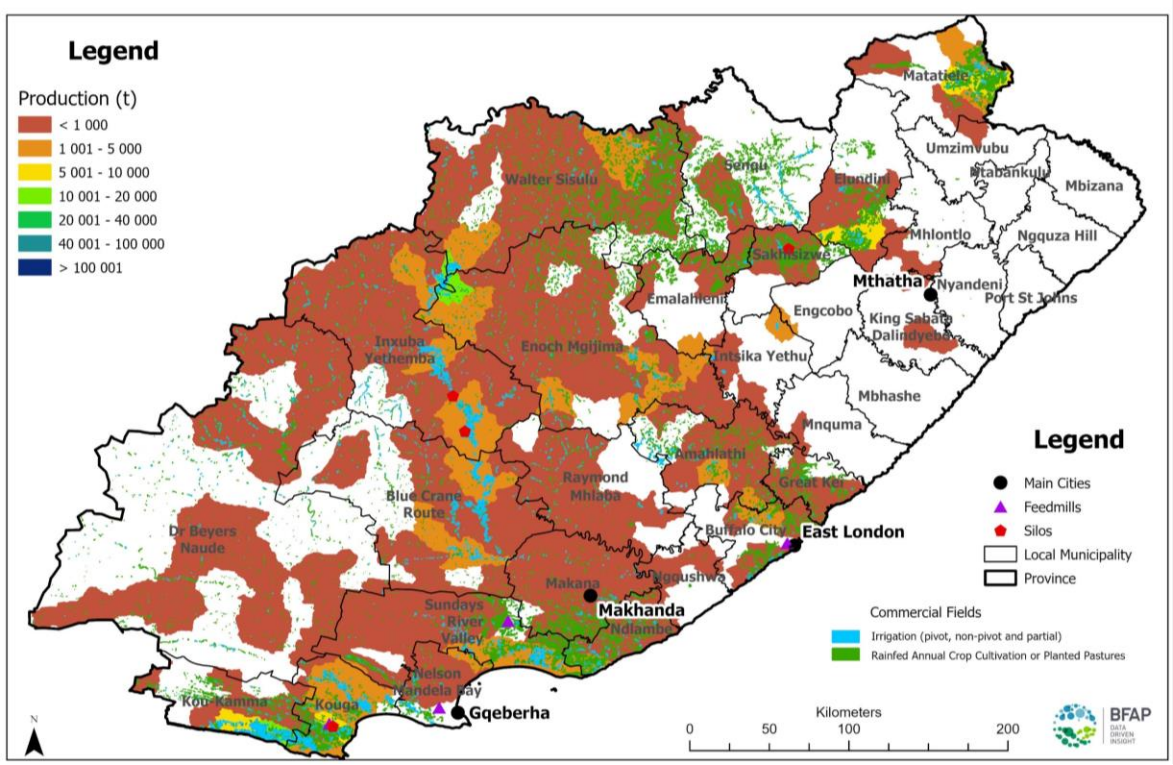


Figure 41: Soybean potential irrigated production

Source: DALRRD (2020)

If the highlighted versions are selected as most accurate representation of total area and attainable yield (Table 9), the total soybean production potential for the Eastern Cape is as much as **347 000 tonnes**. This does not take crop mixes and rotations into account but assumes that all agricultural fields available are planted to soybeans, which is not realistic.

We assume that 10% of all agricultural fields are fallow in a given year and 55% of planted pasture fields are unlikely to be converted to cash crop production given marginal climate and soil conditions, the total field crop area with some soybean suitability is 56 960 hectares.

Lastly, we cannot assume that all cash crop area suitable for soybean production will be planted to soybeans in every season: some crop mix/rotation needs to be taken into account. Currently, according to the Crop Estimates Committee, soybeans typically make up 8% of total cash crop area in the Eastern Cape (Table 6). This implies that the **area suitable for soybean production can vary between 4 560 and 56 960 hectares**, depending on the percentage that soybeans contribute to the crop mix.

The total area under soybean production should be revised as in Table 10 (here the current 8% of crop mix is assumed). **The revised potential soybean production can be calculated as 9 720 tonnes, given the current crop mix applied in the Eastern Cape.** That is a 37% increase of the average soybean production in the Eastern Cape over the past three years (2020 – 2022, see Table 8): 7 100 tonnes.

Table 10: Revised attainable soybean production potential

	Total Area with some yield potential ('000 ha)	Total Area less 65% fallow & planted pasture fields ('000 ha)	Estimated Soybean Area - 8% of crop mix ('000 ha)	Overall average yield (t/ha)	Production potential ('000 tonnes)
Dryland commercial production (based on Schulze)	110.75	38.76	3.10	1.50	4.65

Irrigated commercial production (based on DALRRD)	52.00	18.20	1.46	3.48	5.07
Total	**162.76**	**56.96**	**4.56**		**9.72**

Source: own calculations

Conclusion

The Eastern Cape was mentioned in the National Development Plan as a region “with untapped potential” (National Development Plan 2030, 2012) however, there are a number of factors that limit this potential. These include physical characteristics like soil depth, soil quality (pH, soil nutrients) topology and degradation (erosion) as well as land use dynamics i.e., highest yield potential from a climatic point of view, often coincides with aforementioned physical constraints as well as high competition for land from population density and livestock grazing requirement perspectives. Furthermore, infrastructure limitations in the rural areas of the Eastern Cape affect the access to market for surplus grain production.

It was found, based on the area and yield assumptions listed above, that the potential maize production can be estimated as 578 040 tonnes, off a total area of 212 000 hectares. That is a three-fold increase from the current production of 175 000 tonnes.
The potential soybean production is estimated as at least 9 720 tonnes (37% increase from current average soybean production) off a total area of 4 560 hectares if the current 8% contribution to the crop mix is assumed. Soybean area could increase to a total of 56 690 hectares that are calculated to have some soybean production potential, depending on soybeans’ share of total crop mix.

Future Research

Future research required to refine the outcomes described above includes:

- Refinement of available field crop boundary/cultivated fields database in the Eastern Cape to actual field areas (e.g. grouped fields to be individually digitised, a fly-over dataset for the province to compile a detailed snapshot of current cultivation and land use in the province).
- Analysis of crop competitiveness (profitability) to determine producers' willingness to plant maize and soybeans relative to other producer revenue streams.
- A detailed crop type distribution analysis (as done by GeoTerra Image) to verify the crop mix and production area per municipality in the province.
- Periodic full fly-over of the province to accurately and periodically determine the extent of urbanisation, urban sprawl, agricultural activities and changes ,etc.
- Define other cash crop suitability data (e.g. canola and wheat) in order to quantify production potential for other cash crops as well.

References

ARC-ISCW, 2004. Overview of the agricultural natural resources of South Africa. ARC-ISCW Report No. GW/A/2004/13, ARC-Institute for Soil, Climate and Water, Pretoria.

Department of Agriculture, Land Reform and Rural Development (DALRRD). 2020. Maize Suitability Areas for South Africa – spatial data layer, 2020. Pretoria.

Department of Agriculture, Land Reform and Rural Development (DALRRD). 2020. Soybean Suitability Areas for South Africa – spatial data layer, 2020. Pretoria.

Department of Agriculture, Land Reform and Rural Development (DALRRD). 2019. Crop Type Classification. Spatial data layer, 2019. Pretoria.

Fischer, G., Nachtergaele, F.O., van Velthuizen, H.T., Chiozza, F., Franceschini, G., Henry, M., Muchoney, D. and Tramberend, S. 2021. Global Agro-Ecological Zones v4 – Model documentation. Rome, FAO. https://gaez.fao.org/pages/data-viewer

GeoTerra Image. 2023. Crop Type Distribution for the Eastern Cape. Data accessed in 2023. Pretoria. South Africa.

NASA Shuttle Radar Topography Mission (SRTM). 2013. Shuttle Radar Topography Mission (SRTM) Global. Distributed by OpenTopography. https://doi.org/10.5069/G9445JDF. Accessed: 2023-05-31

Schulze, R.E. and Walker, N.J. 2007. Maize Yield Estimation. In: Schulze, R.E. (Ed). 2007. South African Atlas of Climatology and Agrohydrology. Water Research Commission, Pretoria, RSA, WRC Report 1489/1/06, Section 16.2.

Van der Burgh, G. 2016. The economics of spatial reallocation of maize production in South Africa. University of Pretoria. Pretoria. South Africa.