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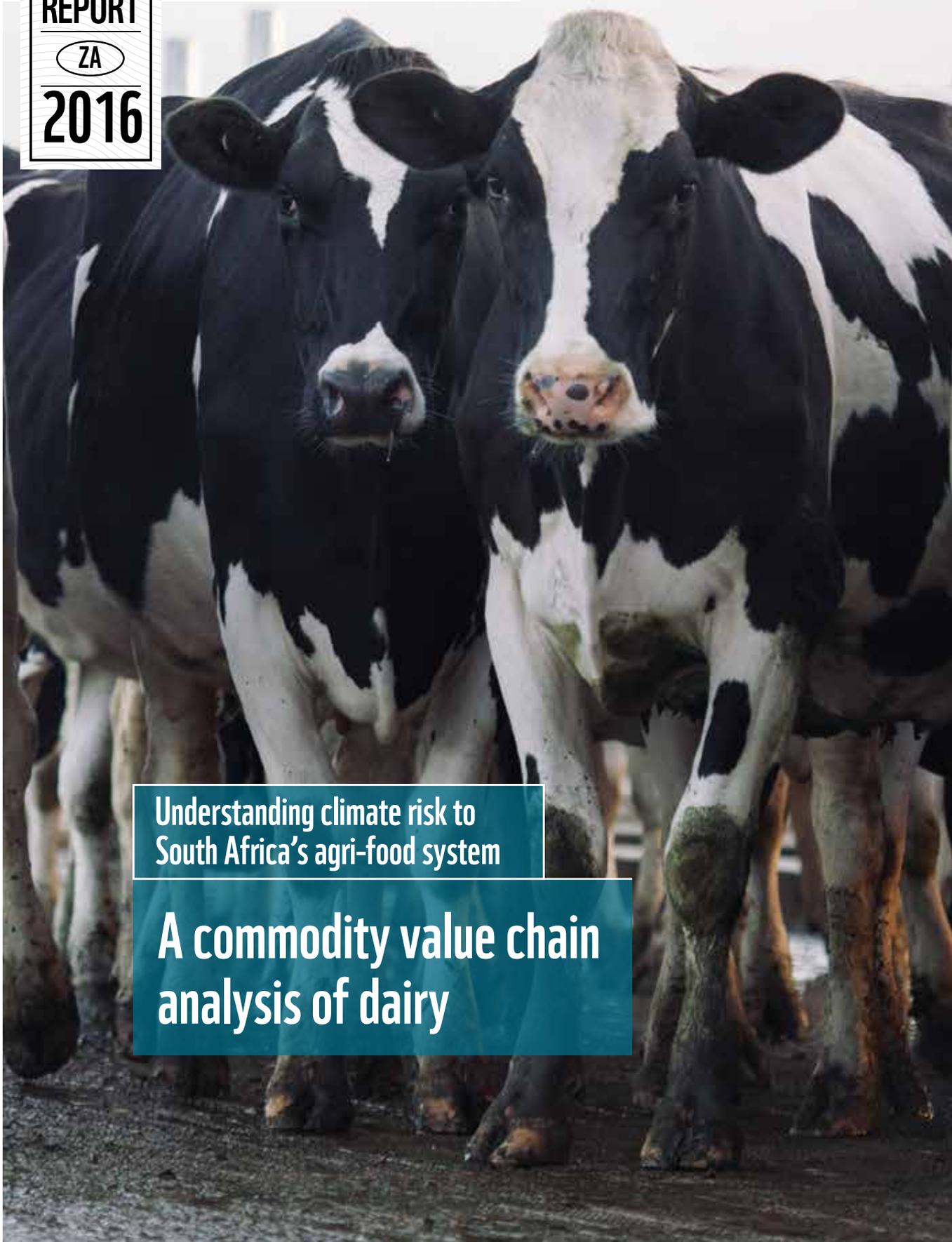
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Understanding climate risk to
South Africa's agri-food system

A commodity value chain
analysis of dairy



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Under contract from WWF-SA, Newlands, South Africa

ABOUT THIS STUDY

WWF received funding from the British High Commission to establish a programme to provide the South African agri-food value chain with tools and information to understand and proactively respond to climate risks in the value chain thereby supporting on-going productivity in South Africa and continued local and international market access for South African supply farms.

PAPERS IN THIS STUDY

1. *Commodity value chain analysis for wheat*: Stephanie J.E. Midgley
2. *Commodity value chain analysis for dairy*: Stephanie J.E. Midgley
3. *Commodity value chain analysis for apples*: Stephanie J.E. Midgley

ABOUT WWF

The World Wide Fund for Nature is one of the World's largest and most respected independent conservation organisations, with almost five million supporters and a global network active in over 100 countries. WWF's mission is to stop the degradation of the Earth's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

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CONTENTS

1. Summary	2
2. Role of the dairy value chain in the agricultural economy	3
3. Recent trends and outlook for the dairy value chain	6
4. What are the recent historical and current climate risks to the value chain?	8
5. How is climate change expected to change the climate risks?	10
6. Where are the opportunities for strategic responses in the value chain?	13
7. References	16

1. SUMMARY

Dairy production in South Africa is responsive to the growing domestic and regional demand but is also sensitive to the producer price. Increased milk production is stimulated when the producer price for milk rises above a certain threshold. The dairy sector's primary contribution is to national food security and the domestic economy. However, it is increasingly supplying neighbouring countries with milk products, encouraged by the drop in the value of the rand and the attractive international price of milk (in US dollars).

The dairy supply value chain consists of large commercial, medium and small dairy producers, bulk milk collectors, importers, dairy processors, exporters, transport operators, retailers, informal traders and consumers. Producers have been forced into a "price-taking" role in negotiations with milk buyers, resulting in low prices to producers. To maintain profitability at production level, the dairy sector has thus seen a reduced number of producers, increasing herd sizes and greater efficiencies of production. Production has also shifted to the climatically milder coastal regions where pasture-based systems are less expensive than the intensive feedlot systems in the interior.

In the last few years, steadily rising demand and a favourable milk-to-feed price ratio have buffered the impact of global supply and price fluctuations and of domestic drought-driven feed price increases. These trends are expected to continue over the next decade, creating incentives to increase national milk production. However, growth of the dairy industry is limited by the availability of farmland and water. Sufficient and reliable rainfall is needed for pasture growth, and water availability is essential for drinking, milking and processing. Producers will respond mainly to milk and feed price signals and locally specific climatic challenges.

The greatest climatic threat to dairy production and its value chain is variable weather conditions, especially droughts, which affect both rain-fed and irrigated pastures, as well as price fluctuations of purchased feed. Other climate risks include erratic rainfall patterns with long dry spells, heavy rainfall and floods, heat waves and high maximum temperatures; conditions which promote outbreaks of pests and diseases; and high costs of energy for cooling under hot conditions. Currently, about 90% of commercial dairy cattle in South Africa suffer from heat stress during the warmest part of the day between October and April. Extreme weather events can damage transport, water and energy infrastructure and disrupt the transport of perishable milk due to road and bridge closures.

Recent climatic changes in the Southern Cape, a key dairy production area, include reduced rain days and rainfall amounts in autumn and spring, the peak rainfall seasons. This has negatively affected pasture growth. Climate change is projected to bring about warming and changes in seasonality and rainfall amounts, with both more and less rain being possible, according to various climate models. Changes which could cause the most damage to dairy farming include a progressively later start and end to the rainfall season, possible reductions in total seasonal rainfall, longer dry spells, more frequent cycles of drought and flood, and increasing heat stress.

Climate change is expected to have both direct impacts on the dairy cattle, and indirect impacts from lower pasture and fodder yields, increased disease pressure, feed scarcity and rising costs of feed, damage to infrastructure, and rising energy needs and costs. The intensity and frequency of heat stress on dairy cattle will increase and negatively affect conception rates, milk yield and milk quality. Cows will require more drinking water and shade during warm weather. The effect of heat stress on the composition of milk is likely to influence primary and secondary processing and lead to lower producer prices. Effective adaptation options will include ensuring a secure supply of water and energy, pasture management practices that conserve water and optimise production under variable climatic conditions, choosing heat- and disease-tolerant dairy breeds, providing nutritional supplements and conserved forages, and evaporative cooling of the animals.

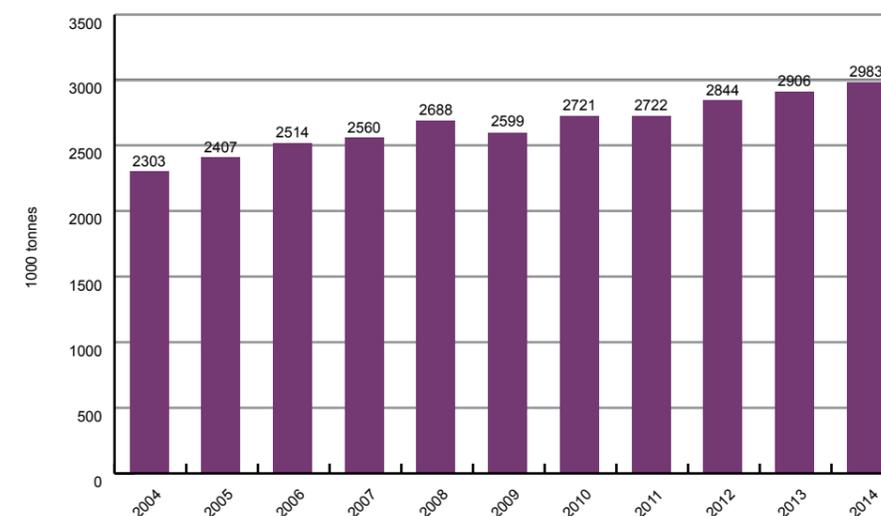
Impacts of climate change on the dairy supply chain will also be transmitted via costs and prices. Greater efficiencies along the whole chain will be required. For example, good transport infrastructure and a cost-efficient transport system will be essential to help keep the prices of dairy products as low as possible.

Milk producers are currently absorbing the cost of most of the risks associated with climate variability and change. It will be unsustainable to expect producers to continue bearing the costs of adaptation as climate change progresses. Value chain actors such as financial institutions, retailers and government (through strategic policy development and support) should adopt a partnership approach to spreading the costs more equitably. This would benefit the whole system and ultimately stabilise the consumer price of dairy products. Processors and retailers should assess their potential roles in supporting on-farm technology developments, supporting investments in renewable energy and greater energy and water use efficiencies, and partnering with the producer bodies to lobby government to create a stronger enabling environment for growth and adaptation to the impacts of climate change.

2. ROLE OF THE DAIRY VALUE CHAIN IN THE AGRICULTURAL ECONOMY

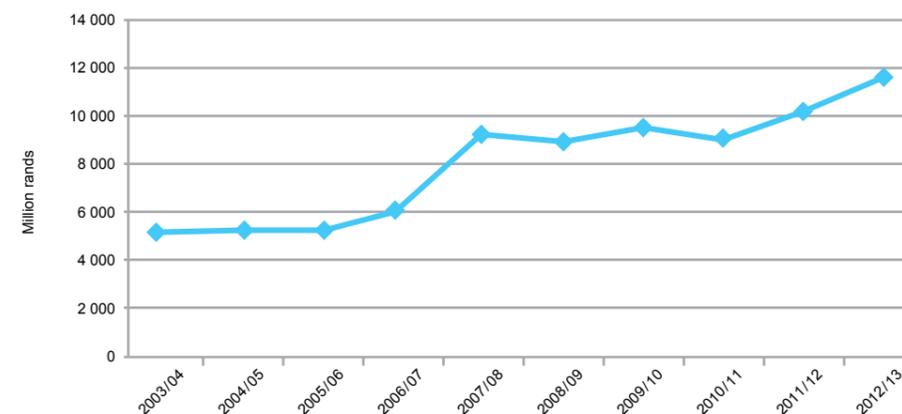
Whole fresh cow milk is South Africa's third largest agricultural product in terms of production (tonnage) and the fifth most important in terms of value. Milk production has risen steadily over the last decade (Figure 1) and currently stands at around 28 billion litres (MPO, 2015). The dairy herd totals about 1.7 million animals.

FIGURE 1: MILK PRODUCTION IN SOUTH AFRICA, 2004-2014



Source: MPO (2015)

FIGURE 2: GROSS (NOMINAL) VALUE OF FRESH MILK PRODUCTION IN SOUTH AFRICA OVER THE LAST 10 YEARS

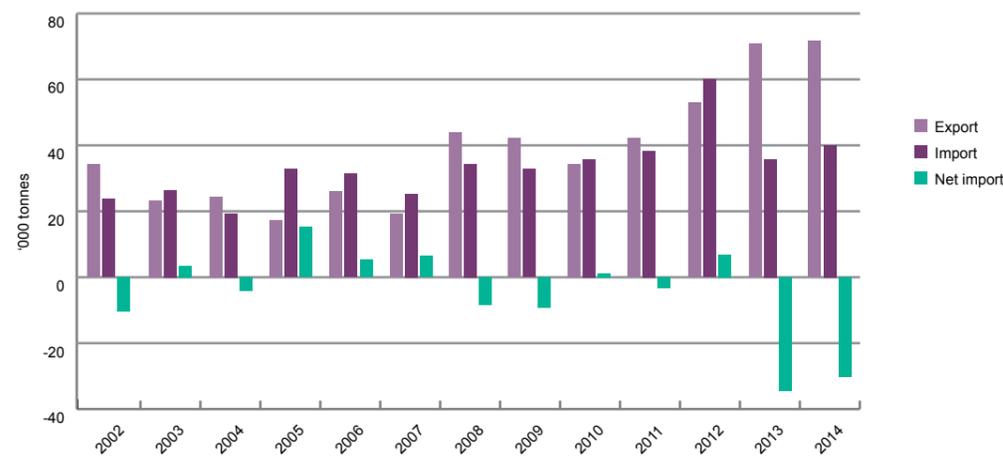


Source: DAFF (2014)

The producer price of fresh milk influences the quantity produced, and both determine the total gross value of production nationally. This value is steadily increasing and stood at R11.6 billion in 2012/13 (Figure 2).

Most of the milk produced is for local consumption: 95% is sold in the formal market and 2% informally; the rest is used for own consumption and calves. Traditionally, milk production in South Africa has been fairly in line with demand and shortages are seldom experienced. In addition, milk and dairy products are both exported and imported (Figure 3). During 2014, exports of products (mainly liquid) came to 71,099 tonnes; 40,199 tonnes (mainly concentrated) were imported (MPO, 2015). Exports have risen significantly since 2010, in both quantity and value, driven by the attractive international price of milk. Export earnings are now around R1.1 billion (DAFF, 2014). Export destinations are almost all in the Southern African Development Community (SADC) region, mainly Mozambique, Zimbabwe and Angola. Milk and dairy product imports have fluctuated, with the value peaking in 2012 at R1.4 billion and then decreasing again, partly due to the drop in the value of the rand. Milk and dairy products are imported mainly from the European Union (46% of all imports are from France, Germany, Ireland and Denmark), New Zealand (17%) and Uruguay (11%) (DAFF, 2014).

FIGURE 3: DAIRY PRODUCT IMPORTS AND EXPORTS, 2002-2014

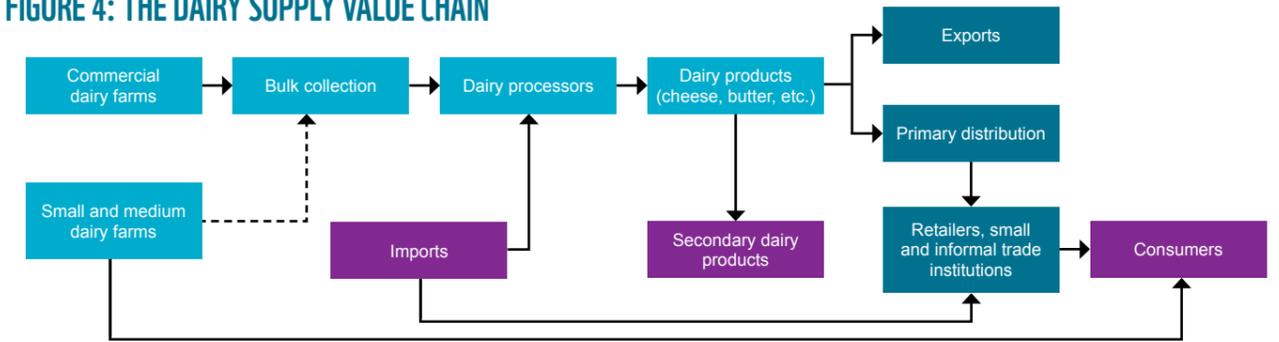


Source: MPO (2015)

The milk and dairy value chain (Figure 4) begins with two broad types of producers: large commercial dairies that sell milk to dairy processors; and small and medium-sized producers that sell directly to retailers and consumers (“producer-distributors”), with some sold to processors. There are a few large processors operating nationally, a growing number that operate in more than one region and many smaller processors operating in specific areas (MPO, 2015).

Dairy processors use milk bought locally as well as imported milk concentrates to produce a range of dairy products. Local processors and importers supply the local traders and retailers. Some local products are used for further processing, or exported. The South African dairy market is divided into 58% liquid (pasteurised milk, UHT milk, yoghurt, buttermilk) and 42% concentrated products (cheese, butter, milk powder, whey, condensed milk).

FIGURE 4: THE DAIRY SUPPLY VALUE CHAIN

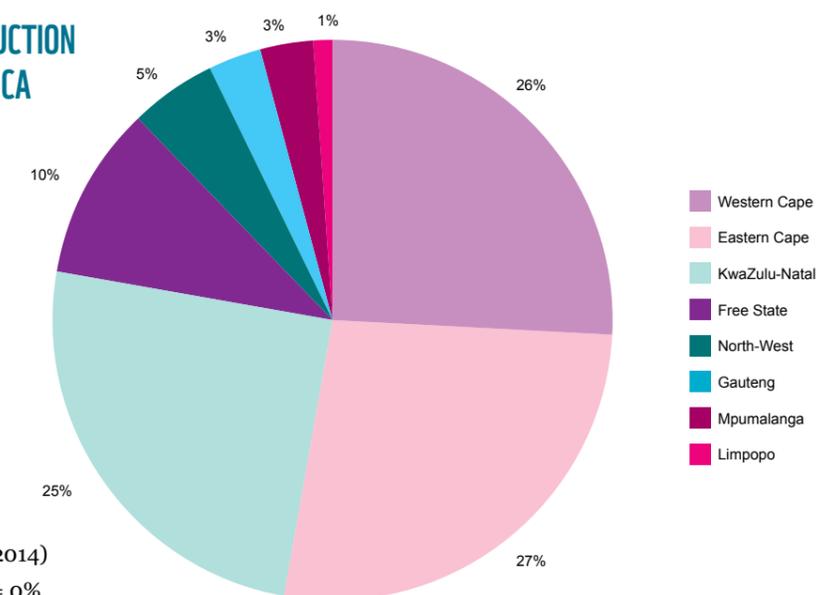


Source: DAFF (2014)

The economic value of the dairy industry is spread throughout the supply chain, but there has been dispute between producers and processors around low producer milk prices. Producers have been forced into a “price-taking” situation owing to their large numbers and lack of product differentiation. This has led to many of the smaller producers leaving the industry or being bought out by larger dairies. The number of milk producers decreased from 3,899 in January 2007 to 1,834 in January 2015 (MPO, 2015), a drop of 53%. However, improved prices have stabilised this trend over the last two years. South African herd sizes are ranked fourth highest in the world (MPO, 2015), partly because of this concentration. Milk production is intensifying as average farm size increases. The quantity of milk produced per farm is also increasing because of higher cow numbers and an increase in yield per cow (FPMC, 2004).

Milk production is concentrated along the coastal areas from the West Coast area north of Cape Town to northern KwaZulu-Natal. Figure 5 shows the percentage contribution of the provinces to milk production in South Africa in 2013. Figure 6 indicates the density of milk production per district. The Western Cape, Eastern Cape and KwaZulu-Natal were together responsible for 78% of national production. They have climates with mild temperatures and sufficient rainfall, which is required for the growth of good-quality natural and planted pastures, providing a lower cost production system. The drier and hotter inland regions are not well suited to dairy production, which is only possible with intensive high-cost feedlot systems. Some of the inland regions remain viable due to their favourable market location for feeds and proximity to large processors and concentrations of consumers (FPMC, 2004).

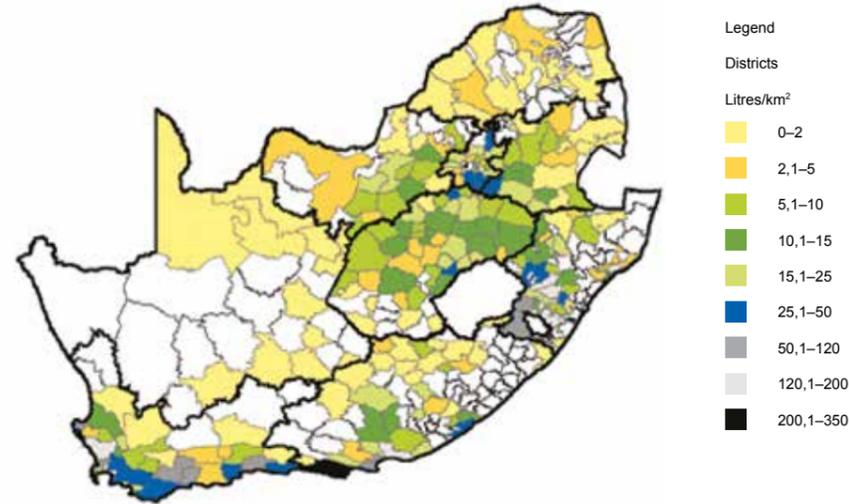
FIGURE 5: MILK PRODUCTION AREAS OF SOUTH AFRICA PER PROVINCE, 2013



Source: MPO in DAFF (2014)

Note: Northern Cape = 0%

FIGURE 6: MILK PRODUCTION DENSITY (LITRES/KM²) PER DISTRICT, 2014



Source: MPO (2015) based on the October 2014 statutory survey

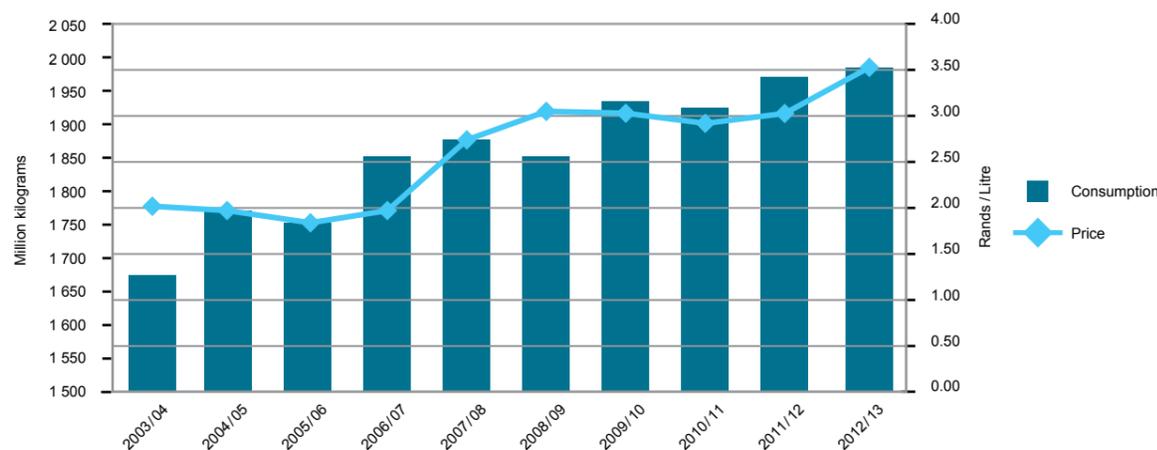
The cost of milk production per farm in South Africa is just above US\$35 per 100kg of milk, equal to New Zealand but lower than most other dairy countries. Production costs are higher than in Argentina and other South American countries, mainly because of lower grain prices in those countries.

The dairy industry provides 60,000 on-farm jobs with benefits to those employees' dependents. The value chain provides another 40,000 jobs, for example in milk processing plants.

3. RECENT TRENDS AND OUTLOOK FOR THE DAIRY VALUE CHAIN

The variability of production and economic value of South Africa's dairy industry has been lower than that experienced globally. The global economic crisis starting in 2007/08 put a damper on growth but a recovery has taken place in the last two to three seasons. The national dairy herd has remained relatively constant since 2009, and the SADC market has provided a growing centre of demand for milk and dairy products from South Africa.

FIGURE 7: CONSUMPTION AND PRICE OF FRESH MILK IN SOUTH AFRICA

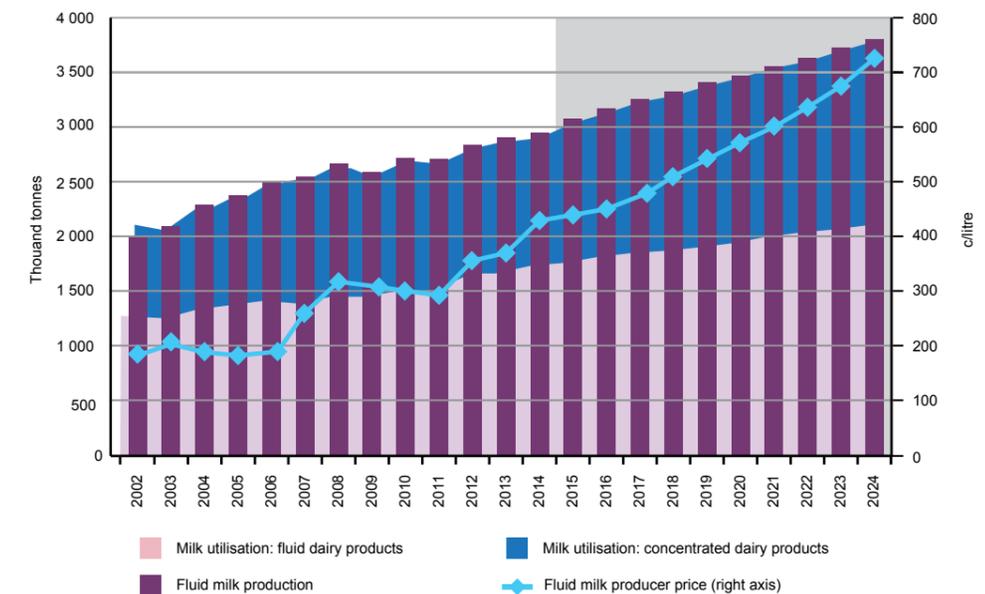


Source: DAFF (2014)

The producer price of raw milk has seen two periods of rapid increase in the last 10 years, from 2006/07 to 2009/10, and again since 2011/12 (Figure 7). The domestic drought and rising cost of feed grain placed pressure on production. However, higher prices, partly because of the drop in the exchange rate, and good demand have balanced this out and production has continued to increase. Usually the consumption of milk (demand) is negatively affected when prices rise rapidly. Nevertheless, overall milk consumption is increasing and reached 2 million kilograms in 2012/13. Production expanded even further in 2014/15 in response to the recovery of the milk-to-feed price ratio (BFAP, 2015; MPO, 2015).

In the supply chain, prices are established through negotiations between farmers and buyers (dairy companies), and between processors and retailers. Farmers in effect remain "price takers" in this system and experience continuous "price-cost squeeze" (Funke, 2006). Affordability to the consumer must also be taken into account. The structure of the supply chain and the product determine the "fairness" of distribution of value added in the chain. This structure also decides the ability of different role players in the supply chain to influence their share of the value added (FPMC, 2004).

FIGURE 8: SOUTH AFRICAN MILK PRODUCTION, UTILISATION AND PRICE, 2002-2014, AND PROJECTED TO 2024



Source: BFAP (2015)

If the weather conditions remain "normal" and milk-to-feed price ratios stay favourable, the steadily increasing demand for milk and dairy products in South Africa is expected to continue over the next decade. This will be accompanied by a matching rise in producer prices, thus driving increases in milk production of an estimated 28% (Figure 8) (BFAP, 2015). On the demand side, most of the growth will lie in concentrated dairy products, especially cheese, a continuation of the current trend.

Growth of the dairy industry nationally is limited by the availability of farmland and water (NAMC, 2012). Sufficient and reliable rainfall is required for pasture growth, and water availability is essential for milking and processing. Area-based expansion (where land is available), herd size expansion and increasing efficiencies can all contribute to growth. Producers can be expected to respond mainly to milk and feed price signals and locally specific climatic challenges.

4: WHAT ARE THE RECENT HISTORICAL AND CURRENT CLIMATE RISKS TO THE VALUE CHAIN?

Sections 4 and 5 focus on the Southern Cape dairy production region, stretching from the Gouritz River to Plettenberg Bay. The broader discussion will also include other production regions in South Africa.

The Southern Cape has all-year rainfall with peaks in spring and autumn and the driest months in winter (Midgley et al., 2014). The area is suited to rain-fed and irrigated pastures for beef and dairy cattle. The western part around Mossel Bay–Herbertsdale is drier and warmer with more erratic rainfall, mainly in winter, and occasional summer rains. The soils are generally poor. Eastwards in the area between Groot Brak and Plettenberg Bay rainfall is spread more evenly through the year, although it is often still not sufficient and irrigation is needed for pasture growth. Compared to other regions of the province, the Southern Cape has a very mild climate. However, rainfall extremes are common and the region suffers from dry spells and floods. The low water storage capacity for irrigated pastures makes the dairy farms vulnerable to periods of low rainfall and extended dry spells.

The key current climate risks for dairy production in this region include:

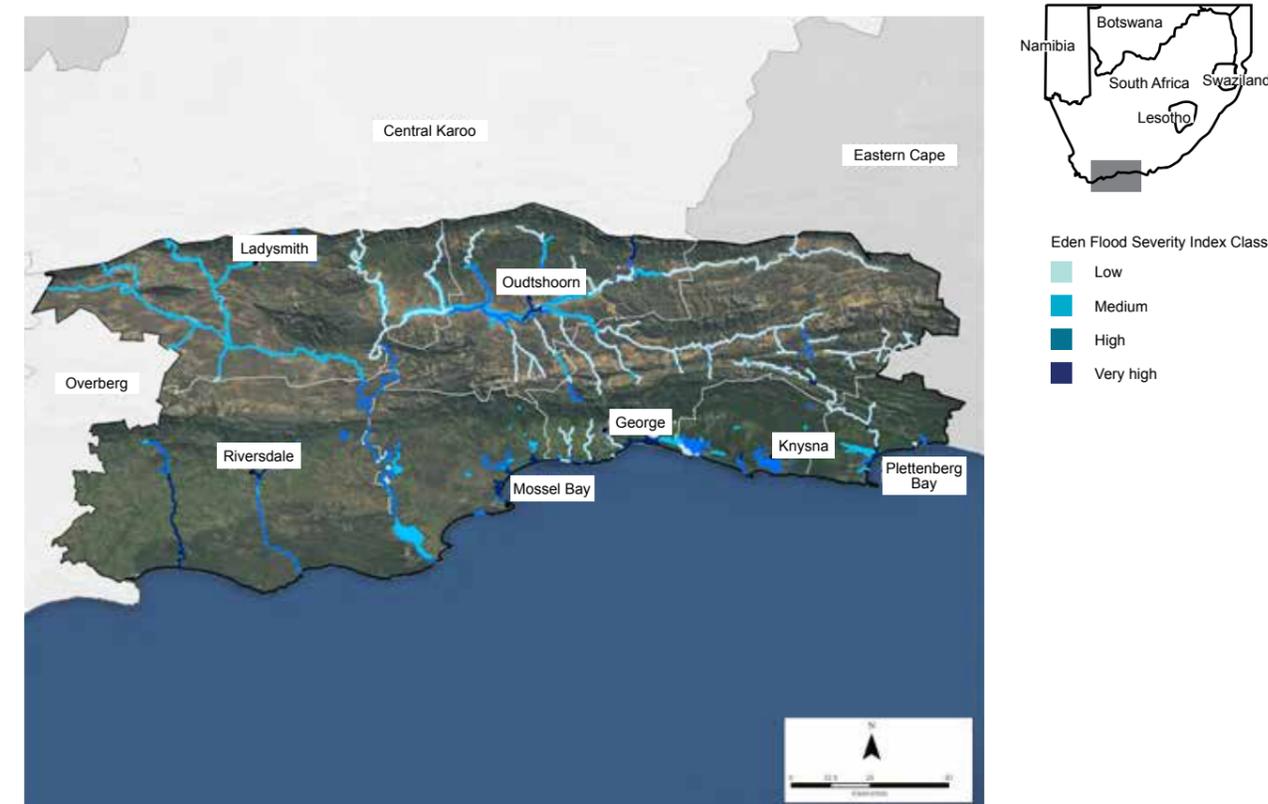
- Water stress from insufficient rainfall or availability of water for irrigation, or changes in rainfall seasonality lead to reductions in pasture growth and nutritional value. In areas where the water supply is shared with growing urban settlements (e.g. George), agriculture is under pressure to use water more efficiently. Under conditions of drought and low dam water levels, agriculture is not assured its usual water supply. Other risks include the high levels of water pollution in some localised areas. Availability of land and water is an important current limitation in the dairy industry (NAMC, 2012).
- Heat waves and high maximum temperatures lead to reduced calving, reduced growth of calves and reduced milk production of cows.
- Climatic conditions promote diseases and outbreaks of pests/parasites in pastures and animals.
- Heavy rainfall leads to localised flooding for an extended period (in areas of poor drainage), with negative impacts on pasture growth and grazing.
- Increased temperatures lead to increased costs of energy for cooling milking parlours and milk storage facilities.

Currently, an estimated 90% of commercial dairy cattle in South Africa suffer from heat stress during the warmest part of the day between October and April, leading to losses of more than R500 million annually (Du Preez, 2014). The results of heat stress include reduced milk productivity (10% to over 25%) and reproductive performance (calving rate).

In the last two decades or so, the Southern Cape has experienced repeated cycles of drought and flood. This has disrupted agricultural production and led to considerable soil erosion. For example, a severe drought in 2003/04 was followed by heavy rainfall in 2004/05. More floods followed in 2006, 2007 and 2008. The drought of 2009/10 had further serious impacts on the region. The topography and river systems in the region lead to high risks and impacts of flooding (Figure 9).

When extreme climate events damage dairy production, the impacts are felt throughout the value chain. This can happen because of loss or damage to infrastructure such as roads and bridges, electricity pylons and lines, dams, irrigation systems and processing facilities. Contamination of water can affect processing, which requires high-quality water. Road closures prevent farmers and distributors from moving perishable milk and dairy products. In addition, the direct impacts on production lead to supply shortages and price increases, which are ultimately passed on to the consumer.

FIGURE 9: HYDRO-METEOROLOGICAL HAZARD – FLOOD POTENTIAL (RIVER) FOR THE EDEN DISTRICT MUNICIPALITY IN THE WESTERN CAPE



Source: Eden District Municipality

BOX 1

“The impact of fluctuating weather conditions has been evident throughout agricultural markets over the past decade. Particularly in the dairy industry, it has been a key driver of market volatility, due to its impact on both the cost of feed and productivity of the global dairy herd. Contrary to most agricultural commodities, only about 8% of dairy production is traded in the global market and in light of the sensitivity of production levels to fluctuating weather conditions, shifts in exogenous drivers in any one of the major dairy producing regions impacts significantly on global price levels. Dairy markets are often characterised by a typically cyclical pattern as price peaks induce a supply response that forces prices down again. The steepness of these cycles in recent years reflect dramatic changes in weather conditions, at times combined with macroeconomic instability that affected demand patterns to create supply and demand dynamics that induce drastic shifts in dairy markets ...

As in the global market, seasonality and production cycles are typical in the South African dairy sector. In line with global trends and the perishable nature of the products concerned, trade continues to represent a very small share of fresh dairy consumption domestically, resulting in a tight balance of supply and demand and consequently a volatile domestic market. This volatility is further exacerbated by the sensitivity of production levels to climatic conditions, reflecting fluctuations in the levels of feed use due to changes in milk to feed price ratios, as well as the impact of weather conditions on productivity in traditional pasture based systems.” (BFAP, 2015)

5. HOW IS CLIMATE CHANGE EXPECTED TO CHANGE THE CLIMATE RISKS?

Based on the current understanding of climate processes, climate change will cause shifts in locally important climate systems or processes, such as shifting the rain-bringing frontal storm tracks further south during winter (Midgley et al., 2014).

Already, weather data shows that year-round warming has occurred (0.2°C per decade). There have been fewer rain days during late summer to autumn (January–May) and spring (August–November) in the Southern Cape, the peak rainfall seasons. Rainfall amounts have decreased in March and September. As yet, there are no obvious trends in total annual rainfall.

The climate models used to project climate changes in the Western Cape from 2040 to 2060 (Midgley et al., 2014) indicate the following:

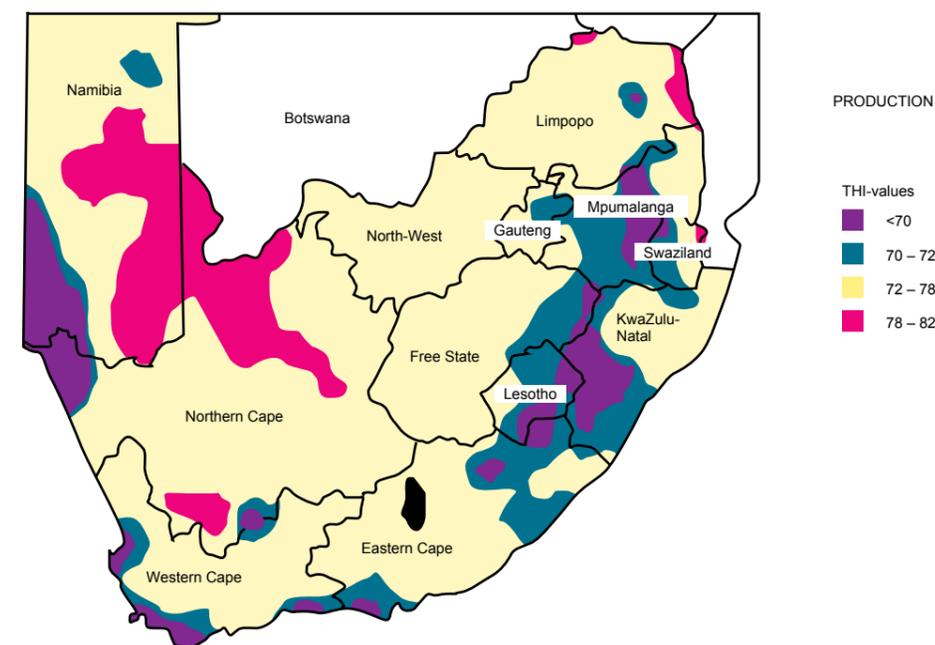
- Higher minimum and maximum temperatures, more so inland than along the coastal areas.
- Increases in annual temperatures of 1.5°C to 3°C, with the Southern Cape tending towards the lower part of this range.
- More hot days and fewer cold days.
- Reduced annual rainfall by mid-century (most climate models agree on this, with a strong indication of drying in the western parts of the region).
- In the short to medium term (before mid-century), the possibility of increased rainfall on the windward mountain slopes and in autumn and spring.
- Possibility of increased rainfall in the eastern part of the province, which could include the dairy production region of the Southern Cape.
- Increased frequency of droughts, floods and heat waves, and possible changing pattern of hail and strong wind (there is greater uncertainty in these projections).

Climatologists are advising decision-makers to consider both increased and decreased rainfall as possible outcomes. Decreased rainfall generally poses the highest risk to dairy production.

For dairy production, climate change is expected to have both direct impacts on the dairy cattle, and indirect impacts from lower pasture and fodder yields, increased disease pressure, feed scarcity and rising costs of feed, damage to infrastructure, and rising energy needs and costs.

Future climate projections suggest that climate change will affect the intensity and frequency of cattle heat stress and negatively affect conception rates, milk yield and milk quality (Archer van Gaarderen, 2011; Du Preez, 2014b). High-producing dairy cows are very sensitive to heat stress, which can occur when temperatures are above 25°C or when the Temperature Humidity Index (THI) is higher than 70–72 (Figure 10, Table 1). Projections of heat stress (maximum daily conditions) in South Africa suggest that dairy cattle might be severely stressed under present (1971–1990) and intermediate future (2046–2065) climate scenarios over most of the country (Nesamvuni et al., 2012). During periods of heat stress and particularly when cows are lactating, the drinking water demand rises, reaching 150 litres per day, and the composition of the milk is altered. There is a decrease of 20–40% in milk fat, 10–20% in skim solids and 10–20% in total milk protein (Du Preez, 2014b). Milk primary and secondary processing could be negatively influenced by these changes in the quality of raw milk, and lower quality milk fetches a lower price for the producer (FPMC, 2004).

FIGURE 10: MAP OF THE THI FOR LACTATING DAIRY COWS FOR THE FIVE WARMEST MONTHS (NOVEMBER–MARCH) OF THE YEAR



Source: Du Preez (2014a)

TABLE 1: CLASSIFICATION OF THI FOR DAIRY CATTLE (SEE FIGURE 10)

THI VALUE	LIVESTOCK CLIMATE SAFETY INDEX	INTERPRETATION	MINIMUM PREVENTATIVE MEASURES	COLOUR CODE IN FIGURE 10
≤70	Normal	<ul style="list-style-type: none"> • optimal performance • low/no heat stress • handling has no negative impacts 	<ul style="list-style-type: none"> • natural or artificial shade 	Purple
70-72	Warning for approaching the critical index level for milk production	<ul style="list-style-type: none"> • a level of heat stress • performance (production, reproduction, etc.) is already reduced • handling begins to have a negative impact • cooling of animals is desirable 	<ul style="list-style-type: none"> • shade and assured ventilation in shade area • sufficient drinking water in the shade 	Green
72-78	Warning for exceeding the critical index level for milk production	<ul style="list-style-type: none"> • a level of heat stress • performance, especially milk production, is seriously reduced • handling has a negative impact on performance 	<ul style="list-style-type: none"> • shade and ventilation, sprinklers, artificial ventilation in the milking parlour holding area • dietary adjustments • consideration of breed used • management changes 	Yellow

THI VALUE	LIVESTOCK CLIMATE SAFETY INDEX	INTERPRETATION	MINIMUM PREVENTATIVE MEASURES	COLOUR CODE IN FIGURE 10
78-82	Dangerous	<ul style="list-style-type: none"> serious heat stress performance is very seriously reduced handling must only occur in the early morning cooling of animals is essential 	<ul style="list-style-type: none"> all the above, as well as shade provision and ventilation at the feeding trough 	Pink
≥83	Disaster	<ul style="list-style-type: none"> deaths of animals occur easily, in addition to the impacts on performance cooling of animals is essential 	<ul style="list-style-type: none"> consider whether dairy farming is feasible 	Not applicable

Source: translated from Du Preez (2014a, 2014b)

Where water is available, some dairy farmers are able to irrigate their planted pastures. Under climate change warming, irrigation water demand to maintain current crop production levels is expected to increase by about 10% by mid-century (DEA, 2013). Projected decreases in rainfall, the possibility of more frequent and/or severe droughts and the risk of dams not filling sufficiently, would lead to more frequent limits on irrigation water. This would put pastures under stress and reduce milk yields. Water prices and energy prices for irrigation pumping will almost certainly rise. Milking parlours and milk processors also require large volumes of high-quality water, which may not be assured in future. On the other hand, the Southern Cape and other coastal areas and mountainous areas on the eastern seaboard of South Africa could benefit from increased rainfall in future, which is projected under some climate models. This could give dairy farming a boost if the additional rainfall is distributed favourably through the year.

Dairy farmers and milk processors are vulnerable to interrupted power supplies and rising costs of electricity (WCG Provincial Treasury, 2014). Milk must be stored optimally at 3–4°C and processed dairy products also require chilling. As temperatures rise, more energy will be needed to maintain the cold chain, starting in the milking parlour, then in refrigerated tankers and storage facilities, the processing facility, and through to distribution and retail markets. This increases costs, especially given the expectation that energy costs will rise in future. Increasing frequencies and intensities of heat waves could place the grid under pressure and put strain on air-conditioning machinery, thus increasing the risks of power outages and product spoilage.

The national requirement to reduce energy demand and transition to a low carbon economy will lead to an increasing cost of energy, which will also affect the transport sector of the value chain. Switching to cleaner affordable fuels will be one way of dealing with price increases while contributing to greenhouse gas emissions reductions.

The South African dairy value chain is also vulnerable to the sustained drop in the value of the rand, which leads to higher input costs for imported fertilisers, fuels and some animal feed components. Currently, this is offset by the rise in dairy product exports. In the Southern Cape, locally produced feed components used on dairy farms, such as canola oilcake, could also show price increases if local weather conditions affect production.

A little acknowledged impact of climate change on agriculture in the coastal areas of South Africa is the trend in land use change and the impact of population demographic shifts. Dairy production is already limited, to a

large degree, to the coastal areas. In many places, it is starting to compete with an increase in tourism and the development of lifestyle estates, in terms of both land and water. The current in-migration of people into coastal towns is adding to this pressure on land and water resources and can be expected to increase with climate change, as the interior regions of the country suffer more from warming. This will lead to a diminishing area of suitable land accommodating more and more people but also having to provide for the country's dairy needs.

For dairy farmers, effective adaptation options are available which could provide sufficient resilience, at least in the short to medium term. Additionally, planning for droughts and floods is essential.

The critical element is security of water for pastures and dairies and an increase in water sources and efficiencies to account for rising demand in future. In the case of irrigated pastures and drinking water, threats can arise through malfunctioning water storage infrastructure and irrigation systems, as well as increasing competition from other water users such as growing settlements, particularly in times of drought. Farming practices will focus increasingly on conserving soil moisture, particularly in rain-fed systems.

For dairy farmers, choice of heat-tolerant breeds is one of the primary adaptations already being used. To counterbalance harmful climate effects without jeopardising milk production, high milk-producing exotic breeds have been cross-bred with heat-tolerant indigenous breeds (DAFF, 2013). Breeds that are more resistant to diseases and parasites are also available. Providing nutritional supplements can reduce the effects of heat stress. In low rainfall areas or during periods of low rainfall, farmers are using bought-in commercial dietary supplements and conserved forages (Midgley et al., 2014).

Other options include stock and grazing strategy management, and reseeding pastures with improved grasses and legumes to cope with drought and long dry spells. In addition, heat stress can be reduced: more animal shading can be provided with sufficient water in the shade, overcrowding can be reduced and ventilation increased, sprinklers followed by fans can be used to cool the animals down through evaporation from the skin (Du Preez, 2014c), the handling of animals can be avoided during the hottest part of the day, and animal health monitoring and management can be improved. Some of these adaptive responses increase the costs of producing a litre of milk, but should be weighed up against the costs of productivity losses.

6. WHERE ARE THE OPPORTUNITIES FOR STRATEGIC RESPONSES IN THE VALUE CHAIN?

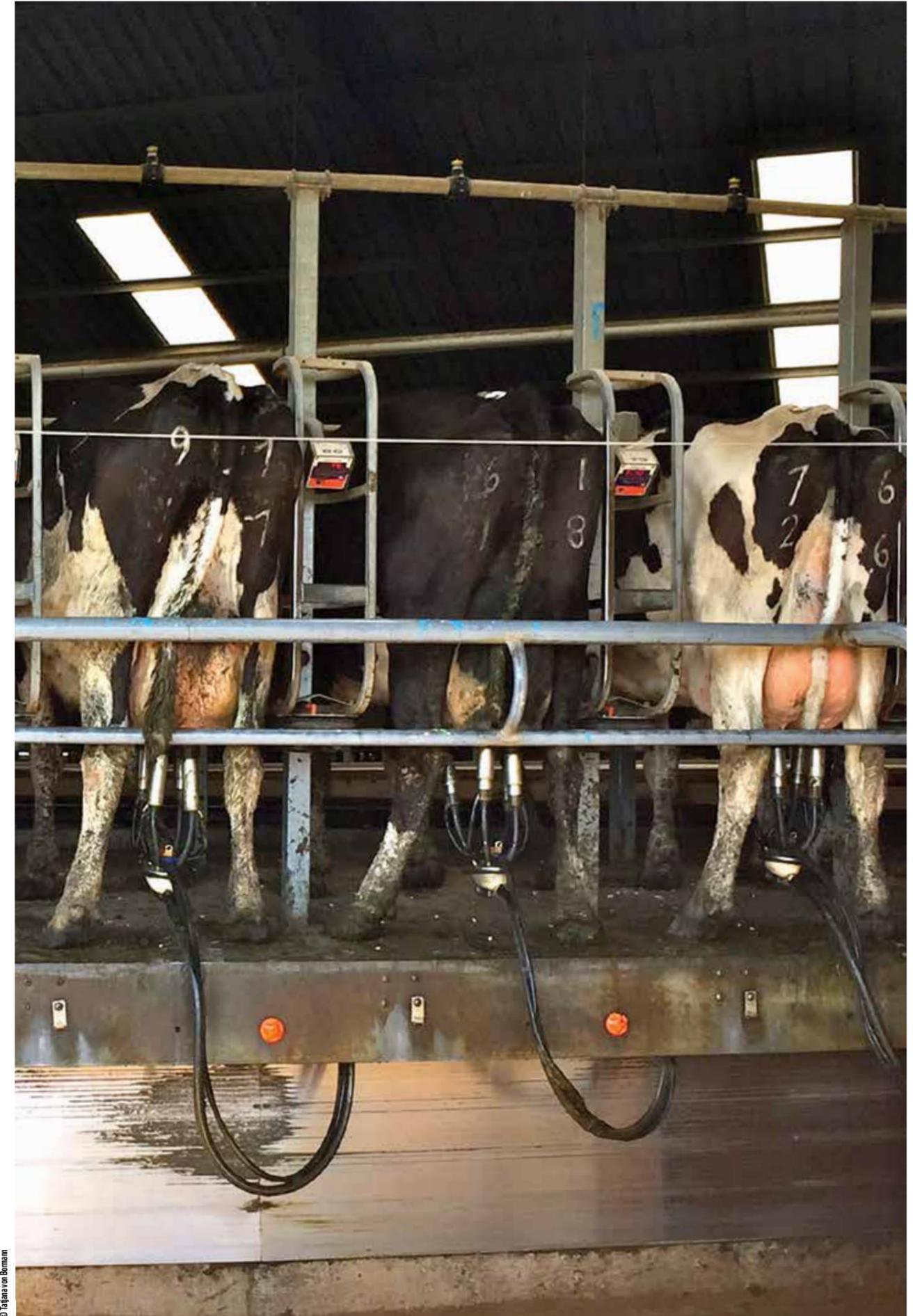
Dairy production in South Africa is expected to continue growing, driven by increases in local and international demand as populations grow and dietary preferences change to include more dairy. However, climate change could place pressure on milk production and quality with negative impacts on the whole value chain unless adaptive measures are taken. Various options are available to dairy farmers, many of which are already being implemented by industry leaders. They will need to become standard practice in future.

However, the cost of climate risk reduction is handled almost solely by the farmers themselves despite the high capital outlay required, for example for installing efficient irrigation systems or renewable energy technology. A partnership approach between multiple agents in the value chain and farmers would benefit the whole system.

Opportunities for greater support from the value chain lie in:

- Supporting effective knowledge and extension to farmers dealing with climate stress.
- Participating in partnership research models to support locally relevant on-farm technology development and more “climate-smart” ways of farming.
- Supporting investments in renewable energy for on-farm and dairy energy needs.

- Supporting the drive towards greater energy efficiencies along the value chain through reliable energy audits and technical/operational responses.
- Supporting research on maintaining the cold chain in an economical way in the case of small and medium producers, distributors and small processors.
- Supporting the industry in ensuring a minimum level of water supply for dairy farms in times of scarcity, maintaining minimum water quality standards and continuing to develop innovative approaches to increase water use efficiency.
- Switching the transport fleet to lower-cost greener transport fuels.
- Collaborating with producers to monitor possible changes in milk quality and how to manage this for the benefit of the value chain.
- Lobbying government to develop forward-looking integrated policies which support effective responses to climate change in the agricultural sector, and incentives for investments in climate change adaptation in the dairy industry.



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