SUSTAINABILITY IN THE SA DAIRY INDUSTRY: A STATUS AND PROGRESS REPORT

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Contents

1. Executive summary 2
2. The Report 6
   2.1 Guidelines and principles 6
   2.2 Advances in key DSF criteria 7
      2.2.1 Greenhouse Gas Emissions 7
      2.2.2 Soil and Soil Nutrients 11
      2.2.3 Waste 15
      2.2.4 Water 19
      2.2.5 Biodiversity 22
      2.2.6 Market development 23
      2.2.7 Rural economies 25
      2.2.8 Working conditions 27
      2.2.9 Product safety and quality 28
      2.2.10 Animal care 30
3. Concluding remarks 32
4. References 33

1. Executive summary

The overall purpose and goal of the dairy industry is to provide nutritious food to the population in an economic, social and environmentally responsible manner. To achieve this, the industry should be enhanced into becoming more sustainable, competitive, increase its market share, and support new entrees. Practically, this requires dedicated provision of relevant information, training, market and trade regulations, administration of statutory regulations, food safety and quality control, R & D, consumer education, and effective liaison with authorities, stakeholders and the global dairy community to remain on the forefront.

The report on sustainability is structured according to the FAO-IDF Dairy Declaration of Rotterdam (DDoR) and the Dairy Sustainability Framework (DSF), which endorses the UN 2030 Agenda for Sustainable Development and provides guidelines for sustainable development. The report in particular pays attention to (1) environmental integrity as it pertains to greenhouse gas (GHG) emissions, soil health and nutrient supply, waste management, water quality and quantity, and biodiversity; (2) socio-economics in terms of market development, rural stability and farm worker conditions; (3) dairy product quality and safety, and (4) animal care. As further support to GHG reductions, the Organized Dairy Industry committed to the 'Pathways to Dairy Net Zero' of the Global Dairy Platform (GDP).

The most recent (2016) official Government GHG figure for dairy cattle in South Africa is 3.72 Mt CO_2 eq/annum, which is about 10.5% of all cattle GHG emissions. At an annual milk production of 3.3 Mt/annum, the per kg of milk number amounts to about 1.13 kg CO_2 eq/kg milk, which is lower than the actual measured number on pasture-based dairy farms in 2021-2023, which in one study in the Eastern Cape, varies between 1.02 to 1.57 (mean 1.30) kg CO_2 eq/kg FPCM and in the second 0.96 and 2.3 (mean 1.35) kg CO_2 eq/kg FPCM, which are in line with the reported number of Oceania of 1.31 CO_2 eq/kg milk. The large variation is concerning and suggests that improvement is required on certain farms for pasture-based dairy farming to meet its obligation towards reducing GHG and climate change. In general, while accepting that the methods of calculation probably differ and the calculation error is relatively large, it does appear that enteric emissions of dairy cows between 2009 and 2024 have declined; increased efficiency possibly being one of the reasons, as the number of cows in milk in the country has not changed significantly whereas the total milk production has increased from 2.52 to 3.35 million tons/annum.

Apart from calculating CH_4 emissions, we believe that net emissions which also consider carbon sequestration/sink through calculating the biogenic carbon component, should rather be calculated, and accordingly that a more effective way of reducing GHG is to sequester atmospheric CO_2 into plants and, in particular, into soils. To that effect a systems dynamic model (DESTiny) has been developed, which is accessible from: https://assetresearch.org.za/on-farm-carbon-capture-and-storage-capacity. This is based on a total carbon balance approach, quantifying all contributing sources and outlets. With the modelling approach (DESTiny), and based on actual inputs from farms, more carbon was predicted to be sequestrated than emitted if certain practices are followed. This was shown with the farms in the second study in the Eastern Cape, where despite some of them exhibiting very high GHG emissions, the net emissions were -3 to -7 kg CO_2 e/kg FPCM, implying more carbon was sequestered than emitted. This illustrates that effective resource and pasture management on dairy farms will assist in mitigating the accumulation of GHG.

This will have a profound effect if the argument about staying time is accepted, and according to preliminary calculations taking into account carbon sequestration, should indicate that a large number of pasture-based dairy farms could be carbon neutral. To calculate net carbon emissions (emissions – sequestration/sink), a systems dynamic model DESTiny was developed, accessible from https://assetresearch.org.za/on-farm-carbon-capture-and-storage-capacity. In support, a model (DIEET) to estimate milk's carbon footprint in relation to its nutritive value, food security and production economy, compared with soy, almond and oat beverages, has also been developed. From a marketing perspective, the outcomes are highly favourable for milk.

Healthy soils support proliferation of soil microbes and nutrient cycling, in turn supporting sustainable production and reduced costs associated with fertilizer application. Soils rich in organic carbon are associated with enhanced biodiversity, water cycling, agricultural productivity, and climate change mitigation and adaptation. By sequestering carbon, soil is able to store vast amounts: the first meters of mineral soils contain between 1 500 and 2 400 Pg organic C. This is about three to four times the amount of C stored in vegetation (450–650 Pg C) and two to three times the amount in the atmosphere (~829 Gt C). In this context, therefore, both increases in soil organic carbon and protection against losses from this pool are important strategies to counteract CO_2 accumulation in the atmosphere. The effect on net emissions is dramatic, as a study in the Eastern Cape shows: On one particular farm the soil C declined from 4.9 to 4.2%. The farm CO_2 eq emissions were 8 412 tons/annum, however due to the decline, the net emissions increased to 20 612 CO_2 eq. On another farm the soil C increased from 2.6 to 2.8%. This farm's CO_2 eq emissions were 15 563 tons/annum, but because of the increase, the net emissions decreased to 7 123 CO_2 eq.

Maintaining soil health is pivotal towards ensuring that the soil can function as a living ecosystem, keeping it in biological balance to ensure productive agriculture. Through the implementation of careful manure management, regenerative farming practices and sustainable cultivation in South Africa, many dairy farmers contribute to the sequestration of carbon into soil. Typical effluent management on dairy farms relies on the waste stream to be collected and stored in ponds before being spread onto lands or pastures using a variety of methods. It is essential that this should be carefully managed to prevent seepage and pollution of sub-surface water while monitoring the gradual accumulation of nutrients in the soils which could reach unsustainable levels if not properly controlled.

Waste is of concern from pre-farm gate through to dairy processing plants. As implied above, most dairy farms have waste disposal and sewage systems that allow them to use the solids as fertilizers and the water either in irrigation or to recycle for cleaning. Of particular concern, is that the quality of the water in many instances does not meet the standards set for either irrigation or discharge into waterways, and efforts to investigate and treat effluent from dairy farms have been instigated.

Some of the larger processors have waste reduction and water cleaning operations, some of which generate CH_4 for electricity generation, whilst the purified water is further recycled for cleaning operations. The best route for disposal or reuse of industrial waste depends on specific characteristics of the waste stream. In recent years there has been progress in the ability of dairy processors to collect and harness the economic value of various waste streams, which ultimately also drives more environmentally sound methods of disposal.

The threat which plastic pollution poses to the environment remains a topic of concern. South Africa is fortunate in that it has a fairly robust plastic recycling industry which contributes to the ability of dairy operations to divert this form of solid waste from landfill disposal sites. Cross-contamination of packaging with dairy product waste remains a limiting factor which can devalue the material before being received by recyclers. This highlights the need for efficient 'at source' separation of waste which has become a standard practice for dairy processors. The escalating costs of landfill disposal are an additional driving factor for processors to consider more environmentally sound methods of waste management.

Water is a finite and vulnerable resource and must be dealt with responsibly, both as it applies to quantity and quality. Recent developments and initiatives around water in the South African Dairy Sector are steadily contributing towards creating a culture of circularity and sustainability. A water stewardship program has been introduced by the MPO in collaboration with the WWF-SA, encouraging innovative initiatives in water management, ecosystem protection and recycling on dairy farms.

Water use and effluent treatment (e.g. COD) in dairy factories have also received increased attention. Recent industry surveys which are based on limited data derived from mainly large dairy processors suggests that the reported COD levels of 0.1-4 g/l compare well with international literature levels of 0.5-10 g/l, whereas the amount of water intake per unit dairy product produced has declined from 7L/L in 1989 to 2.4L/L in 2022. This points to significant production efficiency improvements.

Participation by several processors and farmers in the water stewardship program indicates that water is a growing concern in the sector and that the program has established a platform for knowledge-sharing. A valuable initiative has been the development of best practice guidelines for protecting aquatic and wetland buffer zones for dairy farms, and to investigate and treat effluent from dairy farms.

South Africa is a country with a rich endowment of natural resources, which include its biodiversity and ecosystems. The National Biodiversity Strategy and Action Plan (NBSAP) is responsible to fulfil the objectives of the Convention on Biological Diversity (CBD). With the adoption of the CBD's Strategic Plan for Biodiversity, the NBSAP has outlined a path to ensure that the management of biodiversity assets and ecological infrastructure continue to support South Africa's development path and play an important role in underpinning the economy.

As the demand for agricultural products has increased, the importance of developing a biodiversity-based agricultural system to ensure future sustainability should be regarded as a key driver for the Industry. Many dairy farms across South Africa have undertaken to integrate biodiversity-conscious approaches in their businesses. The vast costs involved in repairing damaged soils are understood and therefore the benefits in monitoring soil health, structure, nutrients, and biological activity are recognised. In general, therefore, the dairy industry supports the vision and strategies of the NBSAP.

The dairy industry in South Africa is one of the most deregulated industries in the world. The industry is not subject to any statutory intervention in the production and marketing of its products aimed at managing or influencing the supply and demand of unprocessed milk and dairy products, and it is not supported by government subsidies. A totally free and competitive dairy market prevails which creates a very dynamic industry that continuously adapts to the changing needs of consumers and industrial users. However, this results in other challenges which require sophisticated and continuous analyses of market signals and the collection of information, also from consumers.

Consumers and dieticians are also trained and informed through a Consumer Education Project which has received accolades by the International Dairy Federation (IDF). Various important markets have been identified with the potential of serving as trading partners, with the Sub-Sahara African market perhaps being the most prominent, especially as an export market.

In rural development the core emphasis is to promote competitive, profitable, and sustainable existing black and new enterprises by contributing to the reduction of commercial venture constraints. One should also not underestimate the value of milk production as a stimulus in rural development as it provides infrastructure, electricity, service delivery etc.

The Milk SA initiative is aligned with the South African developmental priorities, namely food security, poverty reduction, promoting equitable economic transformation and contributing to general economic development and growth. Skills and knowledge development are supported by Milk SA to ensure the continuation of an appropriate skills and knowledge dispensation. In the context of rural economy development, Milk SA's Skills & Knowledge Development Program supports training at new and black-owned dairy enterprises.

The rural dairy economy is not only supported by the organized dairy industry through Milk SA, but also by several provincial departments associated with agriculture which drive entrepreneurial programs and training. The training and development initiative is therefore well served.

Working conditions in the Dairy Industry, as in other industries, are informed by several Acts associated with the Bill of Rights of the National Constitution. These provide regulations and guidelines for the right of freedom of association of both the employer and employee, the protection of employers and those seeking employment, the protection of the rights of employees, the organizational rights of employees such as access to the workplace by a representative of the trade union, collective bargaining rights, the right of employees to strike and the right of an employer's recourse to lockout, unfair dismissal and unfair labour practices. In general, employers in the dairy industry comply with the regulations and guidelines.

In terms of product quality and safety, the dairy quality and safety initiatives of Milk SA are the responsibility of the Dairy Standard Agency (DSA), a non-profit company established by the industry, in collaboration with the Research and Development Programme of Milk SA. The DSA monitors and supports procedures to promote milk and dairy product compliance with product composition and food safety standards. This is a demanding and multi-dimensional task guided by regulations relating to product composition, food safety, animal health, animal feed, milking parlours, transportation of milk, processing plants and storage, all of which are regulated by different Acts (also managed in different government departments), which requires careful monitoring. In terms of its mandate the DSA has progressively moved to a landscape where today it is well-recognised by the respective government bodies, the organised primary and secondary dairy industry and other stakeholders, for example national consumer bodies and the retail sector.

The DSA has the capacity to maintain successful milk and dairy product monitoring programs; maintain a remedial action program for regular contraveners of legal standards; identify non-conformances in the industry in respect of milk and other dairy products; and maintain an effective communication program with all stakeholders concerned.

The lack of a harmonised (standardised) system at national level for the calibration of laboratory instruments for the measurement of fat, protein, lactose, milk urea nitrogen, somatic cell count, and other quality parameters of milk, also created a need for the DSA to initiate a national independent laboratory service. Expansion to the services and tests provided by the DSA are continuously evaluated. To that effect, methods of analyses need to be developed or compared, recent examples being a comparison of methods to determine antibiotic and other residues in milk, a rapid test to detect psychrotolerant bacteria which serves to supplement the alizarol test, and the importance of *E. coli* and Coliforms in addition to *Enterobacteriaceae* for revision of Food Safety Regulation 1555.

A significant addition to the food safety domain, is a research project to investigate the use of probiotic yoghurt to combat infections such as Listeria, Candida, *E. coli* and others. With dedicated and strenuous selection and adaptation, probiotic strains with effective viability at normal yoghurt shelf life have been shown to be effective against all pathogens studied. The exception was biofilm-forming *Listeria monocytogenes* strains, illustrating the difficulty in dealing with biofilm-forming organisms.

Animal care is a function of wellbeing, being disease-free and optimal productivity. The dairy industry is committed to the implementation of best practices to ensure optimal animal care. Specific to welfare, as a member of the IDF and by consulting the IDF's Guide to Good Animal Welfare in Dairy Production, the SABS SANS 1694 and 1488 guide for dairy cattle welfare and humane transport of livestock, respectively, and further supported by Milk SA guideline documents on paired/grouped housing and disbudding of dairy calves, and selective dry cow therapy, the DSA with the assistance of other stakeholders has been developing and implementing auditable criteria to measure compliance with relevant animal welfare standards. The purpose is to assist farmers in the process of risk identification, to evaluate the risks, and to implement management practises which can improve welfare. In addition, a research project is being conducted to establish if dairy farmers that follow good agricultural practices, which include an array of criteria including animal welfare, are benefitting financially.

Recent animal health research programs by Milk SA emphasise the control of mastitis, hoof health and sporidesmin induced liver disease (facial eczema), and photosensitivity in dairy cattle. A summary of previous work on mastitis and liver fluke research is available from the Milk SA office. The focus, as far as possible, is on prevention and alternative treatments to limit the use of antibiotics and drugs. In the facial eczema work, the focus is on characterization of the causing fungus and preventative measures such as a spore-counting service.

Other animal care and productivity based research programs by Milk SA and other institutions in the country include the use of 2D and 3D imaging and machine learning technologies to enable automated detection and tracking (monitoring) of body condition, claw health and lameness, selection for functional traits such as disease resistance through genomic testing, selection of more drought resistant forages, alternatives to rye grass such as plantain, alternatives to grain in supplements, small grain silage use in the Western Cape, and methane values for forage species by the GreenFeed System.

In conclusion, the Dairy Industry has recorded significant progress in most of the sustainability goals as defined in the DDoR and the DSF. It should be recognised that this is an endeavour which requires continuous attention through research, monitoring and training, and ultimately adoption by all role players across the dairy value-chain in South Africa. Several programs have therefore been documented. This report should be viewed as dynamic and is being updated regularly to reflect changes in the industry as additional information becomes available and new initiatives are developed.

An Addendum to this document shows the structure, functions, programs, and responsibilities of the organised dairy industry.

2. The Report

2.1 Guidelines and principles

The South African (SA) dairy Industry is a signatory to the FAO-IDF Dairy Declaration of Rotterdam which endorses the UN 2030 Agenda for Sustainable Development in so far as it guides sustainable development from a social, environmental, economic and health perspective. The Declaration highlights the following:

- The vital role of dairy for food security and poverty reduction and the important livelihood and development opportunities for family farmers, small holders and pastoralists.
- The critical contribution the industry makes toward ensuring balanced, nutritious and healthy foods, countries' economies, income and employment, and in the management of terrestrial ecosystems and the need to address environmental degradation, climate change and biodiversity.

- The diversity of dairy production systems and dairy breeds, contexts and priorities.
- The need for continuous and open dialogue and joint actions at all levels.

The SA dairy industry is an affiliate member of the Dairy Sustainability Framework (DSF) and has committed to the 'Pathways to Dairy Net Zero', which is a specific initiative by the GDP to reduce GHG across the global dairy value chain. The DRF's vision aligns with the Rotterdam Declaration, and states: "A vibrant dairy sector is committed to continuously improving its ability to provide safe and nutritious products from healthy cattle, while preserving natural resources and ensuring decent livelihoods across the industry".

The DSF focuses on 11 key globally accepted dairy sustainability criteria. Each criterion has an indicator on which the DSF reports on an aggregated basis for the global dairy value chain. The criteria with their respective goals are:

- *Greenhouse gas emissions (GHG):* GHG emissions across the full value chain are quantified and reduced through all economically viable mechanisms.
- *Soil nutrients:* Nutrient application is managed to minimize impacts on water and air, while maintaining and enhancing soil quality.
- *Waste:* Waste generation is minimized and, where unavoidable, waste is re-used and recycled.
- *Water:* Water availability, as well as water quality, is managed responsibly throughout the dairy value chain.
- *Soil:* Soil quality and retention is proactively managed and enhanced to ensure optimal productivity.
- *Biodiversity:* Direct and indirect biodiversity risks and opportunities are understood, and strategies to maintain or enhance it are established.
- *Market development:* Participants along the dairy value chain are able to build economically viable businesses through the development of transparent and effective markets.
- *Rural economies:* The dairy sector contributes to the resilience and economic viability of farmers and rural communities.
- *Working conditions:* Across the dairy value chain, workers operate in a safe environment, and their rights are respected and promoted.
- *Product safety & quality:* The integrity and transparency of the dairy supply chain is safeguarded, so as to ensure the optimal nutrition, quality and safety of products.
- *Animal care:* Dairy animals are treated with care and are free from hunger and thirst, discomfort, pain, injury and disease, fear and distress, and are able to engage in relatively normal patterns of animal behaviour.

The status of the SA dairy industry and the progress made are provided with alignment to the 11 DSF criteria.

2.2 Advances in key DSF criteria

2.2.1 Greenhouse Gas Emissions

Prelude: Plants when growing use carbon dioxide (CO_2) from the atmosphere and nitrogen (N) from the soil and re-distribute it among different pools, including both above and below-ground living biomass, dead residues and soil organic matter (stocks). The CO_2 and other GHG's, such as methane (CH_4) and nitrous oxide (N_2O), are in turn released to the atmosphere by plant respiration, by decomposition of dead plant biomass and soil organic matter, and by combustion.

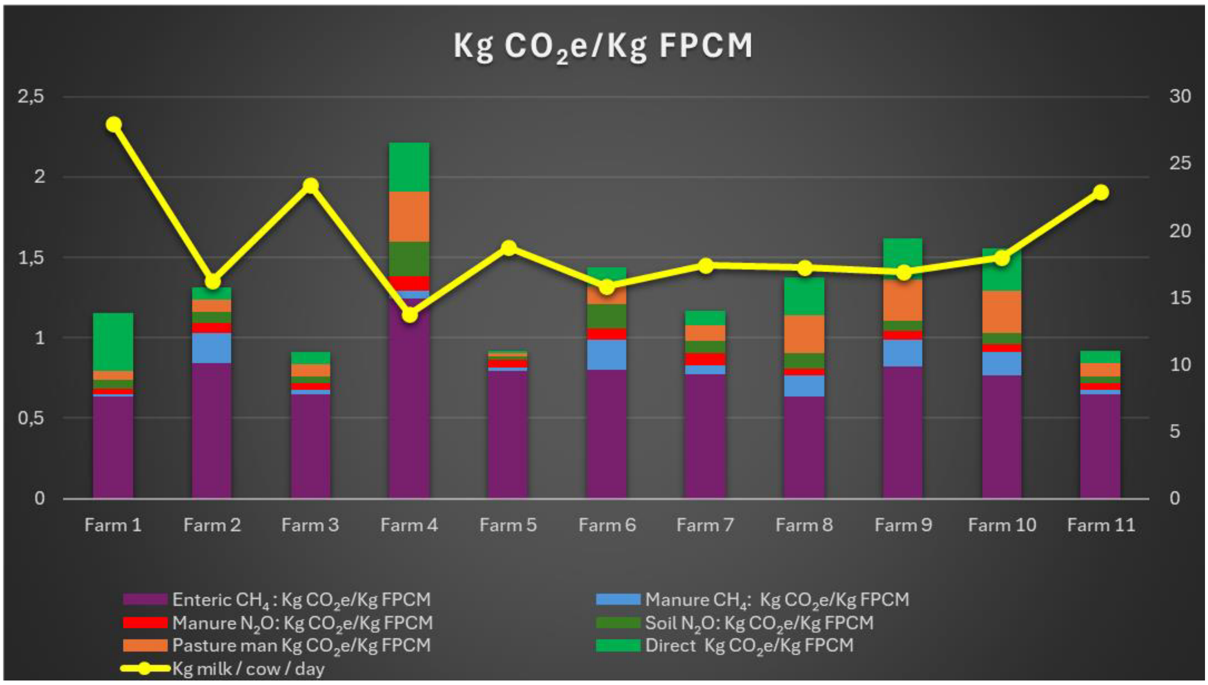
Thus, there is a continuous flux in and out of pools. Anthropogenic activities (e.g. cultivation of croplands, deforestation, poor rangeland management and destroying wetlands/ecosystems) and changes in land use or cover (e.g. conversion of forest lands and grasslands to cropland and pasture) can cause additional changes to these natural stocks and fluxes.

These agricultural activities lead to increased emission of CO_2 and non-CO_2 emissions primarily from CH_4 from enteric fermentation and manure management in livestock and N_2O from manure storage, agricultural soils (primarily chemical N fertilization) and biomass burning. The increase in GHG is associated with rising atmospheric temperature with already experienced profound climatic alterations with mostly negative effects, such as increased flooding, droughts, wildfires, early frosts and frequency and intensity of severe weather events, across the globe, also in South Africa. To counteract these negative effects GHG emissions of agriculture and all other sectors must be reduced, preferably to pre-industrial levels.

Status of GHG knowledge:

The 2016 Government accepted estimate of annual GHG of all cattle in SA is 35.4 million ton (Mt) CO_2 eq/annum and of dairy cattle *per sé* 3.72 Mt CO_2 eq/annum, or about 10.5% of all cattle emissions. Since the annual milk production is about 3.3 Mt/annum, the per kg of milk number amounts to about 1.13 kg CO_2 eq/kg milk. It is accepted that this number is a rough estimate and has probably not taken all variables into account. What has to be considered when estimating GHG emissions include: enteric and manure CH_4, manure and soil N_2O, and direct emissions (electricity, fuel etc). Such direct measured estimates from more than 400 observations on pasture-based dairy farms, producing almost 10% of the national milk, showed numbers of 1.02 to 1.57 (mean 1.30) kg CO_2 eq/kg FPCM, which is in line with the reported number for Oceania of 1.31 CO_2 eq/kg milk. In another study in the Eastern Cape based on the same variables, which included 12 farms, the average was 1.35 kg CO_2 eq/kg FPCM, again in line with the numbers above, but with even more variation (0.96 – 2.3 kg CO_2 eq/kg FPCM) between farms. The large variation is of concern and suggests that much needs to be done on certain farms to improve for pasture-based dairy farming to meet its obligation towards reducing GHG and climate change.

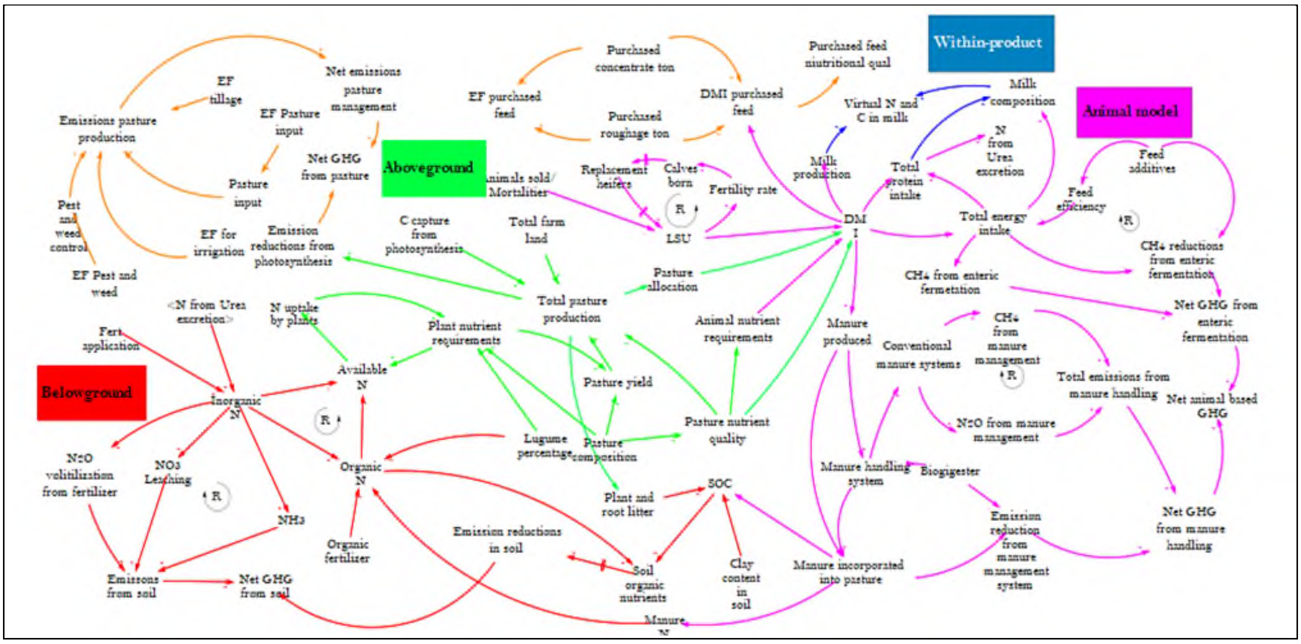
It is accepted that efficiency of production is negatively associated with GHG emission output, although the relationship is not highly correlated, which implies that other factors should also be considered. The relationship is shown in Figure 1, where the yellow line depicts FPCM/cow/farm. Farms 1, 3, 5, 7 and 11 illustrate high milk yields and moderate to low GHG emissions, whereas farms 2, 4, 6, 8, 9 and 10 illustrate lower milk yields and comparatively higher GHG emissions.



As shown in Figure 1, the main contributor to GHG emissions in ruminant livestock is enteric CH_4. In 2010, methane emissions of dairy cattle were estimated by Government officials as being Gg/annum and in 2017, 123 Gg /annum. The 31% reduction suggests improved breeding and feeding practices. This deduction is supported by official numbers: Since 2009, the number of dairy cows in milk did not change significantly, but the total milk production increased from 2.52 in 2009 to 3.35 million tons in 2024. This also implies that not only GHG emissions but also waste and water use per unit product have declined to the benefit of overall sustainability.

Apart from calculating CH_4 emissions, we believe that net emissions which also consider carbon sequestration/sink through calculating the biogenic carbon component, should rather be calculated. To that effect a systems dynamic model (DESTiny) has been developed, which is accessible from: https://assetresearch.org.za/on-farm-carbon-capture-and-storage-capacity. This is based on a total carbon balance approach, quantifying all contributing sources and outlets as shown in Figure 2, which is a high-level illustration of the DESTiny model where each of the sub-models is indicated by a different colour

Figure 2: Causal loop diagram showing the flow of sources and sinks within a dairy farm system. [Note: Red sub-model: belowground; Green sub-model: aboveground; Purple sub-model: animal model; Blue sub-model: within-product; Orange sub-model: external sources].



In line with the discussion above, the most logical approach to mitigating the potential negative environmental impacts associated is to increase farm productivity and efficiency. In the Eastern Cape studies, more efficient feed conversion was associated with higher N use efficiency and lower GHG emissions. Another example of increased efficiency contributing to reduced environmental impacts is the association of these measures with milk production per hectare: Increased milk production per hectare was associated with higher N use efficiency and lower GHG emissions. Milk production per hectare was also positively influenced by various other practices which contribute to higher N use efficiency and lower GHG emissions. These practices include rotational grazing management, multispecies pastures, improved genetic value of cows, improved health care of animals and more effective feeding practices.

As implied above we believe that a more effective way of reducing GHG is to sequester atmospheric CO_2 into plants and into soils. In fact, with the modelling approach (DESTiny) followed, based on actual inputs from farms, more carbon was predicted to be sequestrated than emitted if certain practices are followed. This was shown with the farms illustrated in Figure 1, where despite some of them exhibiting very high GHG emissions, the net emissions were -3 to -7 kg CO_2 e/kg FPCM, implying more carbon was sequestered than emitted. This illustrates what we have come to realize, namely that effective resource and pasture management on dairy farms will assist in mitigating accumulation of GHG. In this context, it is also worth noting that management practices that raise soil organic carbon are largely low in cost compared to alternative greenhouse gas abatement practices.

Soils rich in organic carbon are associated with enhanced biodiversity, water cycling, agricultural productivity, and climate change mitigation and adaptation. By sequestering carbon, soils can store vast amounts: the first meters of mineral soils contain between 1 500 and 2 400 Pg organic C. This is about three to four times the amount of C in vegetation (450–650 Pg C) and two to three times the amount in the atmosphere (~829 Gt C). In this context, therefore, both increases in soil organic carbon and protection against losses from this pool are important strategies to counteract CO_2 accumulation in the atmosphere.

The effect on net emissions is dramatic. For example, in an Eastern Cape study, it was shown that on one farm, the soil C declined from 4.9 to 4.2%. The farm CO_2 eq emissions were 8 412 tons/annum, however due to the decline, the net emissions increased to 20 612 CO_2 eq.

Comparatively on another farm, the soil C increased from 2.6 to 2.8%. On this farm, the CO_2 eq emissions were 15 563 tons/annum, however due to the increase, the net emissions decreased to 7 123 CO_2 eq.

Carbon sequestration into soils will be increased upon conversion of conventional till to no-till farming, generally referred to as conservation agriculture (CA). Application of manures and other organic amendments serve as another significant improvement strategy which is readily practised. Several long-term experiments in Europe have shown that the rate of soil organic carbon sequestration is greater with application of organic manures than with chemical fertilizers.

Furthermore, soils under diverse cropping systems generally have a higher soil organic carbon pool when compared to those under monoculture. Work in this context is being undertaken in SA in general, but specifically also in dairy pastures. For example, since the late-nineties minimum tillage practices have been introduced in the south-eastern seaboard. This has improved soil quality and carbon was dramatically sequestered. In an experiment on soil analysis from Swellendam to Humansdorp, soils from kikuyu-ryegrass systems and shallow tilled soils recorded carbon contents of 50.3 kg C/m^3 and 54.3 kg C/m^3 respectively, vs only 34.6 kg C/m^3 for conventional deep tilled soils. This represents an improvement of 50% in soil carbon stocks.

Pastures established with minimum tillage including the kikuyu-ryegrass management system, but now expanded to multi-species pasture compositions, comprise 70-80 % of commercial dairy farms in this area.

GHG work in progress: More scientific evidence is required to optimize eco-efficient ways of farming on pasture based dairy systems in SA, e.g. reducing CO_2 emissions. These pastures are usually irrigated, and dairy farmers additionally use high concentrations of fertilizers to promote plant growth, even though CA is practiced, and soil carbon is improved. As a result, nutrient loading (N, P and K) on dairy farms is a problem that is generally experienced. This can be associated with leaching and environmental pollution. In addition, N_2O emissions to the atmosphere exponentially increase with N fertilizer application.

In a study to develop management guidelines for N application, the importance of N fertilisation following multiple years of no-tillage in the Eastern Cape was investigated. The study also determined whether P and K have an influence on pasture response to N. Fertiliser application rates were grouped into three treatments viz., <200, 200-350 and >350 kg N/ha. Yield response was recorded over five years. There were no differences found in treatment yields over the years measured.

There was also a significant shift of farms from high to low N application rates over years. The shift indicates a gradual trend of the adoption of low N systems by dairy-pasture farmers. It is evident that N fixation by legumes, cycling of N via manure and urine, and the mineralizable pool of N, contribute enough N under many circumstances to sustain plant productivity. Evidence from this and subsequent studies in the area has established that in many cases 150-200 kg N/ha/annum should be sufficient, but site-specific conditions such as low soil C and N and pasture management procedures, will dictate whether benefits should accrue with more N application.

2.2.2 Soil and Soil Nutrients

These two DSF criteria are discussed together as soil nutrient status is influenced by soil health.

Prelude:

High rates of soil organic carbon sequestration are obtained with no-till farming, crop residue retention as mulch, growing cover crops in the rotation cycle and integrated nutrient management, including applying manure and through restoration of degraded soils. While improving soil quality and agronomic productivity, agricultural intensification through adoption of these principles also improves water quality, increases fixation of N from the atmosphere, reduces general pollution by decreasing dissolved and sediment loads, and reduces net rate of CO_2 emission through carbon sequestration.

Pasture growth is a highly active process and therefore cannot be sustained without the replenishment of nutrients removed during the growth phase. The supply of soil nutrients to plants can be through natural processes like mineralisation (i.e. the conversion of organic nutrients into inorganic, plant available forms) following CA and the preferred management options described above, or in the form of chemical fertilisers. Nutrient cycling in soil relies on soil microbes and soil fauna, such as earthworms.

A healthy soil supports proliferation of soil microbes and nutrient cycling, thereby supporting sustainable production and guaranteeing reduced costs associated with fertiliser application. There is also an interaction between soil microbes and earthworms, as earthworms act as biochemical reactors to convert labile plant compounds into stabilized soil microbial biomass.

Status:

A generally accepted norm in crop production is that an improvement of 1% carbon in the upper 30 cm soil will coincide with fixation of 25 kg N from the atmosphere. If, however soil health is improved, turnover can be improved and more NH_4–N, which results from chemical fertilizer, and otherwise will be converted into the GHG N_2O, can be utilized to the benefit of plant growth. As an adjunct, in a study at Delmas, improvement in soil organic carbon coincided with a 27 ppm increase in utilizable P. This equated to 100 kg P at a soil depth of 30 cm. Thus, improved soil health status can result in considerable savings in fertilizer costs.

Excessive N fertilizer application could result in excess imported N and in more GHG emissions. Nitrogen use efficiency in an Eastern Cape and KZN dairy pasture-based study varied considerably between farms, but averaged 29-30%. A similar average N use efficiency was reported from studies conducted globally.

Wide ranges of P use efficiency have also been found across dairy farms but the average P use efficiency of 33 to 44% found in the Eastern Cape-KZN study was in fact better than the average of e.g. 32% reported in Australia. In general, the nutrient use efficiency has improved since previous reports, but excesses to the extent of 190-260 kg N, 22-36 kg P and 29-90 kg K/h are still measured.

These excess nutrients have the potential to generate negative environmental impacts through accumulation in the soil, loss to the atmosphere through volatilization, loss to surface water through run-off, and/or loss to ground water through leaching. It is recommended that future research should be directed at better understanding of the cycling and loss of nutrients on pasture-based dairy farms, in order to minimize the overall environmental impact of these farms. A research project to that effect has been initiated.

Soil work to be done:

Due to the wide range in nutrient use efficiencies discussed above, in many instances uncertainty, and the poor health of many soils under pasture, and therefore lacking the ability to support high productivity, large amounts of chemical fertilizer are still being used by farmers. However, farmers should be made conscious of how over-fertilization poses an environmental risk and inhibits the natural processes in soils, and furthermore results in reduced profitability.

It is crucial that nutrients are replaced according to the specific demand of plants. Complete elimination of chemical fertilization is unlikely, as pasture systems in South Africa, specifically in the Tsitsikamma, lose more nutrients than what they can naturally replace. These soils are sandy with poor soil organic matter content, leaving them prone to nutrient leaching. Improving the health of these soils is a sustainable mechanism to improve pasture yield, and farm productivity and thus reducing the need to fertilize frequently.

Soil protection and improvement:

Maintaining soil health is pivotal towards ensuring that the soil can function as a living ecosystem, keeping it in biological balance to ensure productive agriculture. Through the implementation of careful manure management, regenerative farming practices and sustainable cultivation in South Africa, many dairy farmers contribute to the sequestration of carbon into soil, as well as replenishing soils with other nutrients which are essential for crop cultivation. Controlled manure application is used in South Africa towards the restoration of soils and has shown to reduce dependence on fertilizer inputs. Chemical fertilizers are widely considered to be of greater environmental detriment as implied above, with lower N, P and K application typically linked to better overall health of the environment. The application of pesticides to crops is also being recommended to be conducted in a controlled manner to minimise the threat of impacting soil quality, biodiversity and the spreading of contamination through water run-off and wind.

Typical effluent management on dairy farms relies on the waste stream to be collected and stored in ponds before being spread onto lands or pastures using a variety of methods. It is essential that this should be carefully managed to prevent seepage and pollution of sub-surface water, while alternatively not resulting in the gradual accumulation of nutrients in the soils to unsustainable levels.

There are examples of farms where all slurry manure is collected in specifically designed concrete-lined channels and diverted to a contained sump. From there, the solid and liquid manure fractions can be separated, either by gravity or mechanical means. Liquid-solid separation of manure slurry provides several benefits including the production of value-added products (e.g. bedding).

Care must still be taken to divert, collect and contain liquid effluent run-off from stalls and cow housing. Ground water and soil contamination with faecal coliforms, nitrates and salts can occur through the leaching of run-off if not controlled properly. Therefore, effective manure management on a dairy farm is critical to using this waste stream in a sustainable manner. Numerous farms across South Africa have well-designed, appropriate effluent management measures in place and there are examples of innovative practices in this regard.

Farmers also use the slurry water after separation in the ponds for irrigation, which is commendable in terms of circular economy principles, although chemical analyses of the water should be carefully monitored as it could have levels of major constituents which substantially exceed the regulatory guidelines for irrigation and discharge as the table below shows.

Constituent	Slurry pond	Irrigation limit*	Discharge limit
Electr. cond. (mS/m)	102 – 326	150	70 – 150
NH_4N (mg/L)	75 – 276	3	6
COD (mg/L)	235 - 2010	75	75
TDS (mg/L)	665 – 7280	25	25

**For irrigation total of 2000 – 5000m^3 per day; COD = chemical oxygen demand; TDS = total dissolved solids.*

To acquire more knowledge and develop guidelines, Milk SA has funded a project on the feasibility of low-cost biological wastewater treatment options for dairy farms. One of the aims of this project is to do laboratory testing and modelling in order to address the following aspects:

- Physico-chemical analysis of commercial dairy wastewater from pasture-based dairy farms;
- Socio-spatial assessment of the suitability of such farms for low-cost biological wastewater treatment solutions, for example by testing the efficacy of algae species to reduce NH_4, PO_4^{-2} and COD levels in dairy wastewater from the parlour.
- Recent results from the study demonstrated that while the removal of phosphate through the algal treatment was not efficient, it was encouraging that over a 19 day treatment period, COD reduction was recorded to be between 48.63% and 81.05% using diluted dairy wastewater (dilution ranging between 50 and 100%) while Ammonia Nitrogen (NH3-N) could be reduced by up to 97% using 75% diluted dairy wastewater. These results suggest that phycoremediation could be applied to treat dairy wastewater although further work is required towards improving effectiveness.

Manure and slurry application rates on soil is best managed through soil testing. Routine sampling and soil testing allows farmers to accurately determine the status and availability of nutrients and to be informed of any specific nutrient deficiency or excess. The results can further be used to enable a ‘precision’ approach to determine specific crop nutrient needs which allow fertilizers to be applied ‘only as required’, thereby benefitting the farm both economically and environmentally. A summary of possible N, P and K contributions (in mg/l) for different manure management systems shows high variability, but nevertheless provide guidelines:

Mechanical separator	380 ± 477 N	65 ± 37 P	465 ± 178 K
Multi-pond	465 ± 475 N	39 ± 27 P	420 ± 300 K
Single-pond	406 ± 475 N	25 ± 21 P	245 ± 246 K

Other threats to soil health:

Soil pollution mitigation in South Africa also extends to other potentially harmful substances. Any operation that deals with chemicals or petrochemicals must consider the environmental risks associated with storage, handling and potential spills and leakage. Underground fuel tanks for instance, should be positioned within a concrete or bricked wall, with the space underneath the tank filled with an inert material to prevent the fuel from seeping into the soil below. It is preferable to use above ground storage as any problems or leaks can be attended to easily.

Routine inspections and maintenance should be performed, taking note, of flanges, valves and pumps with any noticeable leaks being attended to immediately. Legislation requires that a bund wall be in place surrounding any above ground fuel tank. It is advised that written instructions be available of the procedures to be followed in the event of spillage or any emergency.

SANS 10206:2010 provides a general guide for the handling, storage and disposal of pesticides. It also describes procedures to reduce environmental as well as human health when handling pesticides.

Generally, the basic guide is that all chemicals/hazardous substances/pesticides must be stored in a lockable store. The store should be well ventilated and have a dedicated floor area. Signage should be displayed, and personal protective equipment be available for staff when handling these substances. Staff should also have the required training to safely handle chemicals and must be declared medically fit to do so. Legislation further requires material data safety sheets to be displayed or be readily available on file, while care should be taken to store flammable and non-flammable substances apart.

Used or spent machine/motor oil should also be stored and disposed of properly. There are numerous registered oil collectors and recycling centres that would assist in the collection and safe disposal on behalf of the farmer. If disposed of appropriately, the risk of soil or general environmental pollution is mitigated, and the used oil can be recovered and repurposed through a variety of treatment processes.

2.2.3 Waste

Prelude:

Waste is of concern pre-farm gate as well as at the dairy processing plant. Waste at the farm level is both a safety and a resource pollution risk. For example, syringe needles which are not properly disposed of may be dangerous to children and animals, whereas milk obtained from antibiotic or drug treated cows which are flooded to pasture may affect soil chemistry and biology. Although whey disposal into streams/natural river systems is controlled by strict legal regulations, there are challenges in terms of proper handling especially in terms of dilution and ability to remove residual milk solids.

Furthermore, recycling and value-addition largely depends on yield, infrastructure as well as energy and water costs. This would typically require a comprehensive analysis and feasibility assessment, therefore the emphasis on the matter in the previous section and the dedicated research. Post-consumer packaging waste is also receiving increased attention with mounting pressure on Brand Owners to utilise more environmentally sound materials and incorporate packaging design which is better suited for recycling.

Status:

Most dairy farms have waste disposal and sewage systems that allow them to use the solids as fertilizers and the water either in irrigation or to recycle for cleaning. Some of the large dairy processing companies have waste reduction and water cleaning operations, some of which generate CH_4 for electricity generation, whilst the purified water is recycled for cleaning operations. This was detailed in the section on soil health above.

Efficient and safe industrial waste management is a critical contributor towards maintaining environmental integrity. Due to its high organic load and nutrient content, dairy effluents should be managed carefully. Solid waste emanating from dairy processing can be either organic or inorganic in nature.

Typical organic waste includes milk solids, effluent sludge, spent product, paper and cardboard. In comparison, inorganic solid waste would include materials that are derived from non-renewable resources such as metals, glass and plastics. The best route for disposal or reuse depends on specific characteristics of the waste stream.

In recent years there has been much development in the ability of dairy processors to collect and harness the economic value of various waste streams, which ultimately also drives more environmentally sound methods of disposal. As has been experienced in the International landscape, the waste market in South Africa is being placed under increasing pressure due to escalating landfill costs, which means that processors and waste producers are more likely to seek alternative means to dispose of spent organics or packaging materials. Regulation from National Government and local municipalities ensure that adherence to legislation is followed.

The Department of Environmental Affairs and Development has developed the Integrated Pollutant and Waste Information System through which waste generators and handlers are controlled. Compliance to this, as well as local municipal by-laws, ensures that waste is disposed of in the most environmentally sound manner possible. Record keeping of all generated and discarded waste is considered essential towards implementing sound waste management practices and enables the establishment of waste recycling baselines which can be used to benchmark waste recovery activities.

Through the implementation of controlled waste sorting operations and in many cases, the appointment of dedicated waste contractors to assist in waste recovery operations, dairy processors in South Africa are minimizing waste generation while improving on their waste recovery and recycling ability on waste streams which are unavoidable. This includes a combination of solid and organic waste streams. Key waste metrics based on DSF guidelines at farm level should be whether a farm has implemented a Waste Management Plan (WMP), while at the Processor level being able to report on the amount of waste being sent to landfill is regarded as a valuable sustainability criterion. These should be the basis on which the industry develops baselines for waste disposal and management.

The threat which plastic pollution poses to the environment remains a topic of concern internationally, with South African consumers also increasingly aware of its negative impact. South Africa is fortunate in that it has a fairly robust plastic recycling industry which contributes to the ability of dairy operations to divert this form of solid waste from landfill disposal sites with varying degrees of success. Cross-contamination of packaging with dairy product waste remains a limiting factor which can devalue the material before being received by recyclers. This highlights the need for efficient 'at source' separation of waste which has become a standard practice for processors.

Producers and manufacturers of dairy products will need to continue efforts towards finding alternative packaging solutions which are environmentally sound without compromising product integrity. Commitment and progress have been demonstrated through manufacturers using packaging which comprises a percentage of recycled material as well as using materials which are sustainably sourced, such as cardboard which is certified by the Forest Stewardship Council (FSC).

Processors are further encouraged to reduce or if possible, eliminate any unnecessary plastic packaging from their supply chain which will contribute to the prevention of unintended and environmentally harmful consequences. Ultimately, the ability to recycle is dependent on the availability of recycling facilities and the locality of dairy processing operations to such sites. Developing the recycling industry post-consumer in this country will unlock our potential to divert waste from landfill.

Extended Producer Responsibility (EPR) regulations were first gazetted by the Department of Environment, Forestry and Fisheries (DEFF) under Section 18 of the National Environmental Management Waste Act (NEMWA) in 2020. These regulations aim to extend the responsibility of producers (deemed "brand owners") based on the type and volume of packaging which they put out into the market. Government envisions that this system will provide a framework for the development, implementation and monitoring of EPR schemes by producers towards ensuring efficient management of the identified packaging materials at the end of its life as well as the stimulation of new circular economy initiatives.

The EPR scheme has a regulatory fee structure for various packaging types and producers need to be registered both with DEFF as well as a designated Producer Responsibility Organization (PRO) for each type of packaging material. Brand owners would need to liaise closely with their respective packaging suppliers to ensure the fees, which are typically levied per ton of material for each specific packaging type, are appropriately received by the respective PRO. There has been much interaction between stakeholders, with many brand owners having registered with suitable PRO's and DEFF respectively. It is then the responsibility of the PRO to ensure that the levy funds are directed towards meeting legislative requirements while stimulating the recycling market for the various packaging materials in the post-consumer stage of its lifecycle.

'Zero waste to landfill' could be viewed as the ultimate long-term waste disposal target for the sector although this presently is still not the most economically viable route. Waste incineration offers a means to combust organic materials to release heat which in turn can be used to generate electricity while also fulfilling a role in reducing landfill volumes. Although there are emission concerns with this technology, advances in emission control can circumvent exposure to toxic by-products.

South African manufacturers face increasing public scrutiny around the topic of plastic packaging, while food waste is a topic which will need to be addressed by the sector as the Carbon Footprint of this form of waste has been shown to be significant. To that effect the Dairy Industry is involved in an initiative coordinated by the Consumer Goods Council of South Africa towards measuring and quantifying food loss throughout the dairy value chain. The aim is to establish a food loss baseline against which stakeholders would be able to track their progress with regards to the respective food waste reduction initiatives which they have implemented. Figures and data relating to this initiative shall be reported upon as they become available.

The EPR system additionally aims to encourage producers to shift their packaging materials to formats which are deemed 'more recyclable' and therefore hold a higher value in the post-consumer recycling market. To enable the circular transition of packaging materials, design for recycling is considered a key enabler. The compatibility of materials coupled with ease of separation, have a role in determining the recyclability of a particular product. It has been suggested that further growing the end use demand for recycled content in various packaging types will contribute locally to maximise circularity and the recovered value of the material. There is focus on South Africa to develop and grow the post-collection processing capacity of packaging materials to match current collection rates.

Waste to Energy projects in the South African Dairy Industry have been challenged by National and Provincial policy, especially gaining the required approvals which can be a lengthy and costly process. This is often accompanied by the need for numerous specialist studies to adhere to all the relevant regulations which escalate project costs and can impact feasibility.

Successful implementation of such technology has been achieved by Woodlands Dairy in the Eastern Cape Province using a combined effluent stream which emanates from several different production processes. The membrane bioreactor system converts wastewater into energy and clean water, which can then be safely discharged or reused for other applications. The methane gas produced through this process serves as a clean energy source which is used to fuel the onsite biogas boiler.

Currently, the dairy industry faces numerous challenges, none more so than the exponential rising cost of fuel and its impact on the entire dairy value chain. Coupled to the severe National electricity shortfalls and more frequent load-shedding over the past few years, emphasis should be directed towards the potential energy value of manure and other organic waste streams which will become highly sought after as industry needs to find alternative energy solutions to continue with business.

There has been a positive shift towards the integration of solar PV to supplement electricity requirements both on-farm and at processing facilities. There are examples of dairies in South Africa that have successfully incorporated the use of renewable energy into their respective energy mix. This contributes towards reducing demand on the National grid while offsetting coal-derived electricity with clean energy, ultimately reducing the impact on the environment

In addition to more conventional waste streams, dairy farmers and processors are also responsible for controlling the disposal of chemical and hazardous wastes. From an agricultural perspective, chemical waste would include insecticides and pesticides used for crop spraying.

The National Environmental Management Act provides clear guidelines as to how these wastes should be discarded, as spillage or improper disposal has the potential to cause severe environmental degradation. Irrigation run-off can transfer chemical residues into natural river systems and this need to be managed responsibly. These have been alluded to in the section on soil health preservation above.

Waste is generated during the processing of milk and dairy products and this poses a threat to water quality. Chemical Oxygen Demand (COD) is used by most dairies as an indicator to assess the level of organic compounds in their effluent stream. Through using either onsite treatment systems or preventative measures to reduce organics from entering their effluent stream, dairies can reduce their relative COD load, thereby minimising the impact of their effluent.

Emphasis should be placed on reducing COD levels before primary treatment. In the case of most processors this would be before final discharge. As per the DSF guidelines, the adoption or implementation of an Effluent Management Plan (EMP) is regarded as the most important sustainability indicator around controlling the impact of dairy effluent on the environment.

Recent limited data of mainly large dairies suggests that COD levels of 0.1-4 g/l compare well with international literature levels of 0.5-10 g/l, and is below the maximum permissible load of 5 g/l of, for example, determined by the City of Cape Town's effluent discharge standards. Water use in the processing facilities can also be deemed to be satisfactory. Recent analyses showed that the amount of water intake per unit dairy product produced in South Africa has declined from 7L/L in 1989 to 2.4L/L in 2022.

2.2.4 Water

Prelude:

Water in South Africa is a finite and vulnerable resource and must be dealt with responsibly, both as it applies to quantity and quality. Importantly, water is essential towards ensuring the production of high-quality dairy products as it is required throughout the processing chain serving critical functions in cooling, heating, washing and cleaning. Apart from rainwater, dairy pasture-based systems use irrigation to promote productivity of pastures; the general use being high compared to other agricultural systems and with the further implication of nutrient leaching and pollution of watercourses and wetlands. This initiated several projects which promote sustainable methods of production and stimulates innovation.

Initiatives:

Recent developments and initiatives around water in the South African Dairy Sector are steadily contributing towards creating a culture of circularity and sustainability. A water stewardship program has been introduced by the MPO in collaboration with the WWF-SA, encouraging innovative initiatives in water management, ecosystem protection, and recycling, and effluent treatment in dairy factories.

As per the WWF definition, water stewardship encompasses increased improvement in water usage, a reduction in all water related impacts and a commitment to collective action which includes other businesses, NGO's, communities, and government departments. The program needs to be rolled out to as many participants as possible, the initial action was to conduct a survey to establish needs and application.

Participation by several processors and farmers indicates that water is a growing concern in the sector and that this and other initiatives in the sector have established a platform for knowledge-sharing around water throughout the dairy value chain. It further emphasizes recognition from the wider dairy industry that water stewardship is of great importance.

A second initiative was to develop a Best Practice Guideline for determining and development of aquatic and wetland buffer zones for dairy farms. The supporting research has refined the approach developed by the WWF-SA for a wide range of sectors, through focusing on sector specific aspects that would allow for improved wetland and watercourse management, and secondly undertaking a cost-benefit analysis to inform sustainable wetland and watercourse management.

The Guideline provides the dairy farmer and their network of supporting consultants, researchers, and milk buyers with the necessary steps to develop a plan for improved management of wetlands and rivers using riparian buffer zones and enhanced wetlands, in addition to maintaining biodiversity. The work, which was carried out in KZN and the Western Cape, has shown that the benefits of riparian buffers are most tangible when continuous strips of unbroken buffers are implemented.

Therefore, it is advised that landowners within a catchment work together to form coordinated management plans for the larger catchment (from headwater to higher order streams), to ensure maximum effectiveness of the implemented strategies. Various costs like those for environmental authorization could be shared between landowners. Nevertheless, it is acknowledged that full implementation of the complete suite of recommendations in the guideline would require significant resources (time, money, staff and persistence), but it is recommended that farm management begin with establishing a plan which at least identifies where low-cost interventions could yield benefits in the short- to medium-term.

With the envisaged impact of climate change contributing to progressively increasing temperatures and therefore more evaporation, together with decreasing precipitation, it is important to pay attention to water use efficiencies on pasture-based farms. Acknowledging that factors such as rainfall and bought-in feeds can have major effects, efficiencies of on-farm water use have been calculated to vary between 150 and 190 litres/litre milk produced. The numbers currently may have limited value to establish benchmarks as many farmers do not measure irrigation output. This should be addressed.

Minimum water requirements of forage species, which are of importance to dairy farming, should be established. Some limited data are available, suggesting that depending on accompanying precipitation, 25mm irrigation water on average is required per week, but varying between 10 mm when evaporation is low, such as in winter, and increasing to 30> mm in summer.

There may, however, be substantial differences between species/cultivars, whether established in monoculture or mixed pastures, and grazing intensity and frequency. Water requirements in combination with irrigation scheduling and their suitability to topography, climate, soil, irrigation system and water availability should be studied further.

The aim should be to compare and calibrate different irrigation scheduling systems for different pasture mixes for various topographic, soil and climatic conditions under normal and especially restricted water conditions. As an accompanying initiative, cultivars requiring less water should be selected in view of the climate change expectations.

For farmers to control and effectively manage their environmental footprint as depicted by the variables water, soil and nutrients, and GHG, they need an integrated tool which (1) quantifies the contribution or influence of individual variables in the integrated system, and (2) relates these to the financial results of the farm. To that effect, the above discussed systems dynamic model and accompanying web-based application have been developed to assist farmers to calculate and monitor the impact of water and other environmental variables on the economic outcome of their operations.

The model and application enable the farmer to provide inputs to key parameters of his/her operation, followed by real-time estimates of the various impacts. The farmer will thus be able to select an optimum management intervention from both a bio-physical and economic vantage point. For application see: https://assetresearch.org.za/on-farm-carbon-capture-and-storage-capacity.

From a dairy processing perspective, organizations across South Africa have adopted a wide range of approaches to improve their water resilience and operational efficiencies. Dairy processing, along with many other agro-processing industries, requires a high net usage of water and in turn also contributes to higher effluent outputs. Depending on the process requirements, each factory or processing facility has unique opportunities for water use reduction, water recovery and re-use as well as effluent recovery and cleansing.

Through technological advancements in the re-use of water as well as wastewater recovery and treatment, processors are driving down consumption while reducing the demand on municipal water supply systems as suggested above. With respect to water intake (requirements) in factories, efficiency benchmarking results show that the industry is on par with international water use efficiencies, yielding benchmarks (litre water used/litre product produced) of 2.25 for milk, 1.5 for UHT milk, 2.25 for yoghurt, 3.00 for butter and 2.75 for cheese, or on average: 2.4L/L in 2022.

Many South African Dairies have placed their focus on areas of water consumption that can readily be managed and where immediate reductions in water usage are possible. Processors across the country use staff training and awareness as a primary means to reduce water wastage. Optimization of 'clean in place' (CIP) systems has presented dairies with steady water savings through efficient sequence planning of product batches as well as modifications which enable the re-routing of rinse water to ensure collection and re-use. Water use efficiency (typically the volume of water used per volume of product manufactured) reporting is the key metric to initiate and measure continuous improvement programs or projects related to water consumption.

Though water scarcity challenges face numerous provinces in South Africa, it is possible to augment water through alternative means while doing so in an environmentally beneficial manner. This has been successfully demonstrated by the establishment of an integrated water and waste recovery system implemented by Woodlands Dairy in the Eastern Cape Province. The wastewater treatment plant was required due to under-capacity and inefficiency of the municipal wastewater treatment system to effectively deal with effluent.

The integrated system can recycle wastewater using reverse osmosis technology to convert it back to a potable standard. This allows for reuse of the water inside the factory. In addition to reclaiming water, an anaerobic bioreactor enables methane to be produced from the organic content. This gas in turn serves as a fuel source to drive a boiler which supplements a portion of the processing plant's steam requirements.

2.2.5 Biodiversity

Vision and strategy:

South Africa is a country with a rich endowment of natural resources, which include its biodiversity and ecosystems. The diversity of these ecosystems delivers a range of services that are essential to people and the development and growth of the economy. The National Biodiversity Strategy and Action Plan (NBSAP) nested in the Department of Forestry, Fisheries and the Environment is responsible for fulfilling the objectives of the Convention on Biological Diversity (CBD).

With the adoption of the CBD's Strategic Plan for Biodiversity, the NBSAP has outlined a path to ensure that the management of biodiversity assets and ecological infrastructure continue to support South Africa's development path and play an important role in underpinning the economy. The vision is to: Conserve, manage and sustainably use biodiversity to ensure equitable benefits to the people of South Africa, now and in the future.

Prelude:

Agriculture is widely affected by the loss of biodiversity, largely through habitat destruction because of the conversion of natural lands for agricultural use, coupled with the intensification of agricultural practices. As alluded to above, these have contributed to the pollution of soils through the application of fertilizers and pesticides, whereas soil erosion through unsustainable farming practices places mounting pressure on ecosystems. This is a pressing issue and one which the industry must address.

As the demand for agricultural products has increased, driven by the nutritional needs of a growing population, the importance of developing a biodiversity-sensitive agricultural system to ensure future sustainability should be regarded as a key driver for the South African Dairy Industry. Such a system aims to develop input services without significantly decreasing effective agricultural production. These ecosystem services are defined by land use management practices coupled with soil and climatic conditions.

The development of a resilient agricultural system relies on a balance between the exploitation and use of biodiversity, ecosystem services and the natural environment. Both agriculture and the relevant ecosystems will ultimately benefit through the adoption of approaches towards resilient systems. These would focus on optimising the use of agro-biodiversity while reducing both economic and natural long-term risks through the application of effective ecosystem practices, rather than external inputs.

Dairy farms across South Africa have widely undertaken (although still not always to a formal extent, especially among smaller-scale farmers) to integrate biodiversity-conscious approaches in their businesses. The vast costs involved in repairing damaged soils are understood and therefore the benefits in monitoring soil health, structure, nutrients and biological activity are recognised. This extends to the careful management of fertilizers, manure and pesticides, with specific attention to application rates and timing to maximize soil retention of nutrients and prevent unwanted leaching into waterways.

Other key services include the diversity of animals and gene pools which contribute to the overall resilience of the ecosystem. This also holds true for crops, where a mixture of crop varieties tends to reduce vulnerability against diseases, pests and nutrient deficiencies. The CBD vision and objectives could be aligned to the South African Dairy Industry as dairy production does impact biodiversity and ecosystems, not only through changes made to habitats but also factors such as the application of fertilizers and other input products, nutrient losses and associated greenhouse gas emissions.

Commitment: The dairy industry supports the vision and strategies of the NBSAP

Status:

South Africa is known for preserving animal and plant genetic resources, although there are concerns regarding scarce gene pools. Dairy farming operates primarily in intensive and closed environments, but the industry is conscious of the importance of conserving bordering wetlands and ecosystems as the stewardship program and the implementation of programs to enhance soil microbial and fauna contents discussed above suggest.

The Best Practice Guideline for determining and development of aquatic and wetland buffer zones for dairy farms, discussed above, should go a long way in assisting farmers to protect biodiversity next to waterways and wetlands. They also are, as elsewhere in the world, conscious of the narrowing of genetic diversity within dairy breeds resulting from semen use of international sires with exceptional breeding values.

However, this is closely monitored and occasionally crossbreeding is implemented as a way out, usually with coinciding benefits to the immune system and longevity. In support, a program has been implemented to incorporate genomic testing to identify superior South African sires which should be helpful.

2.2.6 Market development

Prelude:

Internationally compared, the South African dairy industry is one of the most deregulated industries. The industry is not subject to any statutory intervention in the production and marketing of its products aimed at managing or influencing the supply and demand of unprocessed milk and dairy products, and it is not supported by government subsidies.

A totally free and competitive dairy market prevails in South Africa which created a very dynamic dairy industry that continuously adapts to the changing needs of consumers and industrial users. Functionally, market development is supported by (1) market signals and information, which are made available to the industry through formal publications and other measures; (2) customs and market access, by being involved with an initiative in international trade relations, export certification activities, import monitoring activities and animal health; (3) consumer education, which aims to empower the consumer with information to enable them to make informed and responsible choices, and (4) pursuance of new market opportunities.

Status and initiatives:

Market signals and information are made available to the industry through formal publications and other measures on a continuous basis. A selection of information provided includes:

- Import and export statistics
- Unprocessed milk and dairy product distribution statistics;
- Year-on-year change in demand and prices of dairy products;
- The domestic and international economic situation in relation to unprocessed milk production and dairy product volumes and prices.

Consumer information and education is provided by the Consumer Education Project (CEP) of Milk SA. The project aims to convey the health and nutritional benefits of dairy and is continuously evaluated and developed. The project is multidisciplinary as it uses expert knowledge from different disciplines that is communicated to the target audiences through television, radio and print.

A combination of sound scientific information and good understanding of consumer perceptions anchors the project. The project conveys messages that cannot be communicated adequately through conventional branded advertising. The purpose of the project is not only to serve the interests of the dairy industry but also to empower consumers with information to help them make informed and responsible choices on dairy.

Occasionally the CEP needs to deal with competitive products that enter the market, which carry claims that these are more beneficial, from several perspectives, than milk or other dairy products. Recently this was the case with several plant-based beverages. A comprehensive research project funded by Milk SA revealed the following summarized results:

DIEET Model index scores for bovine milk and plant-based beverages

Parameter	Milk	Almond	Soy	Oats

Nutritional score (NS)	**3.672**	**1.547**	**2.206**	**1.204**
Farm environmental score (FES)	**1.203**	**2.250**	**0.722**	**1.034**
FES/NS	**0.328**	**1.454**	**0.327**	**0.859**
Price for reference poverty level	**0.130**	**0.389**	**0.265**	**0.405**
Economic score	**0.848**	**0.589**	**0.713**	**0.574**

The results demonstrated that milk outperforms the plant-based beverages in nutritional value, but its environmental score (GHG and water use) when considered per kg product is less favourable. However, when corrected to per unit nutritional value (FES/NS in table), milk's environmental score is on par with soy beverage and better than almond and oat beverage. When the beverages are considered from a food security point of view, taking into consideration price and nutritional value to contribute to the wellbeing of the poor, milk outperforms all plant-based beverages. The same applies to the economic score.

It must be stated that these results apply when specific production systems are employed and may vary substantially with other production systems. If, for example, regenerative methodologies are used, environmental footprints of all beverages could be 15-20% lower.

Of important markets which have been identified with potential as trading partners, the Sub-Sahara (SS) African market is maybe the most prominent, especially as export market. However, because the industry does not have knowledge of their regulatory environment, food safety and other control measures, a dedicated project was conducted to acquire information in order to: promote and stimulate export; provide informed contributions on the contents of the trade agreements which South Africa may negotiate; harmonize the legal standards of SS African countries which are applicable to the composition, safety and metrology of unprocessed/fresh milk and dairy products, and protects the country against unfair competition from imported dairy products. The project covered 15 countries in eastern and southern Africa and the reports are available from the Milk SA office.

2.2.7 Rural economies:

Goals and developments:

The dairy industry is aligned to the Agriculture and Agro-Processing Masterplan (AAMP) as developed through collaboration between the Department of Agriculture, Land Reform and Rural Development, business, labour and civil organisations in the agriculture and agro-processing sectors in South Africa.

The AAMP aims to foster a growing, equitable, inclusive, competitive, job-creating, low-carbon, and sustainable agriculture and agro-processing sector in the country. Its approach focuses on bringing different sectors together and enhancing the inclusion and participation of black farmers, as well as small-scale and emerging farmers throughout agricultural production and the value chain.

This effort is particularly crucial for farmers on the fringes of the mainstream economy in rural areas, who often face challenges in integrating into value chains. In addition to facilitating the commercialization of emerging farmers, it is vital that the outcomes of the

Master Plan result in improved working conditions and enhanced socio-economic opportunities for farm workers and those within the broader value chain.

The AAMP aims to achieve several key objectives which are summarised below:

a. Increase food security in South Africa.
b. Promote sustainable transformation in agriculture and agro-processing.
c. Enhance market access, both locally and internationally, by improving supply quality.
d. Boost competitiveness and entrepreneurship through technological innovation, financing models for black farmers, infrastructure development, and digitalization.
e. Establish effective support systems for farmers and incentives for agro-processing.
f. Create inclusive employment opportunities while improving working conditions and wages.
g. Enhance safety for the farming community by reducing theft and attacks.
h. Foster a capable state and supportive policy environment.
i. Build resilience against climate change and promote sustainable natural resource management.

The AAMP has listed several anticipated outcomes to be achieved by 2030 based on successful implementation of the proposed interventions. These include growth of around R32 Billion in added agricultural value, sustaining 865,000 jobs in primary agriculture and 263,000 jobs in secondary agriculture while creating 72,000 new employment opportunities.

The plan further aims to expand commercial cropland area in the country by 65,000 Ha, adding close to 20,000 Ha of irrigation and 1.5 million Ha of pasture. In doing so, it estimates to enhance food security in the country while supporting over 300,000 livelihoods. Importantly, the AAMP strives to increase the proportion of black farmers in overall production to 20% by 2030 to promote meaningful transformation, recognizing that in certain industries, this share could be lower due to structural constraints, capital needs, and the long-term cyclical nature of the products concerned.

The core emphasis is to promote competitive, profitable and sustainable existing black and new enterprises by contributing to the reduction of commercial venture constraints. The initiative, which is driven by the Milk SA Enterprise Development Project, is aligned with the South African developmental priorities, namely food security, poverty reduction, promoting equitable economic transformation and contributing to general economic development and growth.

Based on needs assessment of existing dairy enterprises along the dairy value chain and according to Milk SA criteria, Milk SA intervenes with the following assistance: supply of electricity, pregnant heifers, veterinary services, on-farm infrastructure, technical know–how, establishment of permanent pasture, technical training, development of business plans and feed supply during critical drought periods.

After the initial support for assets which was funded 100% by Milk SA, entrepreneurs are encouraged to acquire additional assets such as heifers on a 40/60% cost sharing basis between the entrepreneur and Milk SA respectively. The goal of this approach is to instil an enterprise / entrepreneurial culture in project beneficiaries.

Skills and knowledge development are supported by Milk SA to ensure the continuation of an appropriate skills and knowledge dispensation. In the context of rural economy development, Milk SA's Skills & Knowledge Development Program supports training at new and black dairy enterprises.

The rural dairy economy is not only supported by the organized dairy industry through Milk SA, but also by several provincial departments associated with agriculture which drive entrepreneurial programs and training.

The most notable programs are offered by KZN, the Eastern Cape and the Western Cape. For example, the Eastern Cape's initiative is in association with the company Amadlelo as strategic partner with community based large dairy operations such as at the Fort Hare University Dairy Trust, Middledrift Dairy Production, Keiskammahoek Dairy Production, Ncora Dairy Production, Shiloh Dairy Production, Mantusini Dairy Production, and with the Du Plessis brothers at Wittekleibos Dairy Production.

As an adjunct to training and development, the value of milk production as a stimulus in rural development should not be underestimated as it provides infrastructure, electricity, service delivery etc.

2.2.8 Working conditions:

Applicable Acts:

This section is informed by The Labour Relations Act (Act 66 of 1995), The Employment Equity Act (Act 55 of 1998), The Basic Conditions of Employment Act (Act 75 of 1999), The Skills Development Act (Act 97 of 1998), The Compensation for Occupational Injuries and Diseases Act (Act 130 of 1993) and The Land Reform (Labour Tenants) Act (Act 3 of 1996).The overriding principle is that farmers need to ensure that the rights and well-being of farm workers and their families are upheld and that they contribute to the social and economic development of the local community and on the periphery.

Employer obligations:

Employers in the dairy industry should commit themselves to the following, if they have not done so already:

- Comply with the conditions legislated for fair labour practice.
- Contribute to employee unemployment benefits.
- Contribute to the skills development of employees.
- Provide for compensation of death or disablement resulting from occupational activities.
- Provide for the safety and health of the employees at work.
- Uphold the rights of labour tenants and farm occupiers to reside on land and to acquire land where applicable.
- Ensure that recreational areas on the farm are available.
- Participate in actions towards establishment of a sustainable local economy.

One way of participating in such actions is to adopt a policy of preferential employment of residents from the local community or from labour tenants on the farm. Applicable research results suggest that agricultural growth and efficient management of natural resources are dependent on the political, legal and administrative capabilities of rural communities to determine their own future and to protect their natural resources and other economic interests. The umbrella principle is that farmers are the mainstay of the economy of towns, townships and the surrounding rural environment, and they have the knowledge and skills to support development towards a viable and sustainable local economy.

2.2.9 Product safety and quality:

Prelude:

The dairy quality and safety initiatives of Milk SA are the responsibility of the Dairy Standard Agency (DSA), a non-profit company established by the industry, and in support, the Dairy Research and Development Programme of Milk SA. The DSA monitors and supports procedures that actively promote product compliance with product composition and food safety standards (these functions are respectively driven by the Dairy Quality & Safety and Dairy Regulations & Standards projects of Milk SA).

The monitoring and support are a prerequisite for the growth of the dairy industry, as substandard products reaching the retail market can harm both the industry and the consumer. Promotion of compliance with standards relating to milk and other dairy products is a demanding and multi-dimensional task of the DSA, because of the involvement of regulations relating to product composition, food safety, animal health and welfare, animal feed, milking parlours, transportation of milk, processing plants and storage, all of which are regulated by different Acts which are managed in different government departments.

Status and progress:

In terms of its mandate the DSA has progressively moved to a landscape where today it is well-recognised and respected by the respective government bodies, the organised primary and secondary dairy industry and other stakeholders, for example national consumer bodies and the retail sector.

The main objective of the Company is to promote the quality and safety of milk (unprocessed and processed milk) and other dairy products in respect of, especially food safety and product compositional standards by for example:

- Monitoring compliance and providing dairy technical and scientific knowledge and advice regarding compulsory and voluntary standards, to members of the dairy industry and bodies in the public sector;
- Contributing to the maintenance and development of functional, compulsory and voluntary standards relevant to the dairy industry;
- Participating in international forums and organizations dealing with standards relevant to the dairy industry, and promoting in especially the African Union, the harmonization of standards applicable to dairy products, especially food safety, product compositional and metrology standards.

- Effectively liaising, communicating and co-operating with governmental and dairy industry structures, as well as with any other organisations which are active in respect of regulations relevant to the dairy industry.

Laboratory support:

The lack of a harmonised (standardised) system at national level for the calibration of laboratory instruments for the measurement of fat, protein, lactose, milk urea nitrogen, somatic cell count, and other quality parameters of milk, created technical barriers and added to potential legal disputes. Consequently, the DSA Laboratory Services was established. The resulting infrastructure also addresses the need for an independent proficiency testing scheme (laboratory ring test) for dairy laboratories in South Africa. Milk SA considers the harmonisation of standards as critical to the dairy industry of which some of the benefits are:

- Providing standards for the calibration and use of measuring equipment and tests to compare with results from external test laboratories;
- Test results to support research and development as well as statistical data used during herd health management programs;
- Mitigation of disputes between milk producers and milk buyers as a result of payment on quality parameters of milk.

Expansion to the services and tests provided by the DSA are continuously evaluated to provide a more comprehensive service to the industry. To that effect methods of analysis need to be developed or compared, a recent example being a comparison of methods to determine antibiotic and other residues in milk.

The quality of milk country wide has been affected by a poor quality condition which is associated with coagulation of milk protein. In unprocessed milk the destabilisation of the milk protein results in coagulation with the alizarol alcohol platform test, and is referred to as flocculation. This may be caused by a variety of factors, including probably acid production by bacteria, mastitis which causes the pH of the milk to increase, bacterial enzymes produced due to unhygienic practices, and other reasons.

In Ultra-High-Temperature (UHT) milk the type of coagulation is referred to as gelation which affects shelf life and occurs when the milk protein becomes destabilized during storage as a result of residual intrinsic milk enzymes and bacterial enzymes. Since contamination with psychrotrophic bacteria such as *Pseudomonas* arguably is the major cause of the flocculation/gelation problem, rapid tests are being developed and validated in support of the alizarol test.

In the regulatory environment a research project has been conducted by the DSA laboratory to investigate the significance of *Enterobacteriaceae*, coliforms and *Escherichia coli* in milk in the South African market. This is done to update microbial specifications in Regulation 1555 of 1997 (Act 54 of 1972), since there is concern that these organisms are becoming a threat in milk entering retail stores. In contrast to international arguments that testing for *Enterobacteriaceae* is sufficient, the results of the study suggest that we need to maintain tests for coliforms and *Escherichia coli.*

In support of combatting conditions such as Listeria, Candida, *E. coli* and other infections, the use of probiotic yoghurt has been investigated. With strain selection, using adaptation and strenuous measures, probiotic strains of dairy origin namely, *Lactobacillus acidophilus* D and *L. rhamnosus* V, and bovine origin namely, *Lactobacillus pentosus* LIP and *Lactiplantibacillus plantarum* VLL1 as well as *L. acidophilus* ATCC 4536, exhibited good inhibitory activities against the pathogenic *E. coli*, enterohemorrhagic *E. coli* (EHEC), enteroaggregative *E. coli* (EAEC), enteroinvasive *E. coli* (EIEC), and enterotoxigenic *E. coli* (ETEC). These probiotic strains also exhibited good inhibitory activities against the *C. albicans* strains *C. albicans* ATCC 10231, *C. albicans* 1051255, and *C. albicans* M0826. The co-benefits were that the probiotic strains remained viable in yoghurt during normal shelf-life. With regard to *Listeria monocytogenes,* the probiotic species *L. plantarum* (ATCC 14917 and VLL5), *Limosilactobacillus fermentum* ATCC 549 and *L. rhamnosus* (ATCC 53103 and DSM 9338) showed potential against *L. monocytogenes* strains (ATCC 19115, T69, 159/10 and 243), but the response of the pathogen strains may vary due to genetic differences that influence biofilm formation, which is a major problem in combatting Listeria infections.

2.2.10 Animal care:

Prelude:

Although animal care in the DSF criteria is primarily defined in the context of welfare, health and production are also components of animal care, with all components having an effect on one another. Whereas health and production are well understood, what people interpret to be acceptable animal welfare can be influenced by many factors including personal values, religion, nationality, gender, previous experiences, age, socio-economic status, etc. From a scientific and farmer perspective, however, an animal is in a good state of welfare if the five freedoms are recognized and manifested as being healthy, comfortable, well nourished, safe, relatively able to express its innate behaviour, and is not suffering from negative states such as pain, fear and distress.

Good animal welfare requires amongst others disease prevention and veterinary treatment, appropriate shelter, management, nutrition, humane handling, transport and eventually, humane slaughter.

Developments:

The dairy industry is committed to implementation of best practices to ensure animal welfare based on scientific evidence. As a member of the IDF and by consulting the IDF's Guide to Good Animal Welfare in Dairy Production, the SABS SANS 1694 and 1488 guide for dairy cattle welfare and humane transport of livestock, respectively, and further supported by Milk SA guideline documents on paired/grouped housing and disbudding of dairy calves, and selective dry cow therapy, the DSA with the assistance of other stakeholders has been developing and implementing auditable criteria to measure compliance with relevant animal welfare standards at the milk production level. The audit criteria are regularly reviewed and updated where necessary.

The purpose of this outcome based driven auditable and assessment criteria is to assist farmers in the process of identification of risk areas, to evaluate the risks, and to implement management practices which can improve welfare. The audit program has been successfully tested and is in operation since 2022.

In addition, a research project is being conducted to establish if dairy farmers following good agricultural practices which include an array of criteria, including animal welfare, are benefitting financially.

Animal health research programs in South Africa are conducted or completed to control and prevent mastitis, liver fluke, hoof health and sporidesmin induced liver disease, also known as facial eczema. A summary of progress in both mastitis and liver fluke research is available from the Milk SA office. The focus where possible is on prevention and alternative treatments to limit the use of antibiotics and drugs. To that effect, in the liver fluke studies the focus was to control the intermediate snail host of the fluke by practical management procedures, whereas in the mastitis investigations apart from hygienic practices, the emphasis was to link mastitis pathogen species to those antibiotics that are still effective in order to enable specific instead of broad-based non-specific antibiotic treatment; broad-based treatment is known to promote antimicrobial resistance.

In the facial eczema work, the focus is twofold: early detection for effective control and remedial actions, and secondly, to characterize the fungus producing the sporidesmin toxin. Early detection is to find a blood parameter which can easily be monitored and a spore-counting service to warn farmers when to initiate preventative or remedial management. The fungus *Pseudopithomyces chartarum* infests primarily ryegrass pastures. Characterization focuses on DNA sequencing of the species/strains, its reproduction and sporidesmin biochemical isolation. At this stage it appears that there is only a single *Pseudopithomyces* species present in the five sampling regions of the Eastern Cape and that the species phylogenetically corresponds with the toxin producing species in New Zealand.

Other developments in relation towards ensuring dairy animals are in a space of good health, welfare and experience optimal productivity include the use of 2D and 3D imaging and machine learning technologies to enable automated detection and tracking (monitoring) of body condition, claw health and lameness, selection for functional traits such as disease resistance through genomic testing, selection of more drought resistant forages, alternatives to rye grass such as plantain, alternatives to grain in supplements, and description of the seasonal pasture trace mineral fluctuation in the Eastern Cape.

Further to the animal welfare discipline: Since the rearing of dairy calves and transport and slaughter of bobby calves presents potential for the public to view the dairy industry in a negative light, Milk SA has embarked on a program, through the Health and Welfare Program, to assess the situation in South Africa and advise farmers on best practice.

Maintaining and enhancing productivity of dairy herds is paramount towards upholding animal wellbeing and economic sustainability. Selection for wellness, implying stringent elimination of conditions such as metritis, lameness, mastitis, ketosis etc., in addition to enhancing fertility and feed efficiency, should be pursued in breeding objectives. Wellness will cut treatment costs and in the longer run enhances the productivity and wellbeing of the total herd. Productivity is also a function of milk yield, but even more important, feed efficiency. In the gross form, as can be used on-farm, feed efficiency is the ratio between milk yield and feed intake. It can also be calculated from milk composition data. Two recently locally compiled accurate equations for TMR systems which apply for cows weighing more than 500 kg, are:

- DMI (kg/day) = 8.81 + 0.212 Milk (kg/day) + 0.010 LW(kg), $R^2 = 0.90$ where: DMI = dry matter intake and LW = live weight of the cow. Gross feed efficiency (GFE) [milk (kg)/DMI (kg)] is then simply the cow's milk yield divided by the calculated DMI
- Using milk composition data, GFE can be calculated as: GFE (kg/kg) =1.881 + 1.344BFY −0.003LW, $R^2 = 0.91$ where BFY = butterfat yield (butterfat % x milk yield)

The relationship of GFE with butterfat is explained by better energy mobilization in more efficient cows. Utilizing this equation in selection will enhance both butterfat (and thereby milk solids) and milk yield. Of significance in the equation is that LW is negatively associated with GFE, which implies that GFE declines with LW. Farmers should therefore put a ceiling on cow LW to maintain GFE and limit maintenance needs of the cow.

The importance of having an effective biosecurity program on dairy farms in South Africa was highlighted through a recent Foot and Mouth Disease outbreak, where the first case was reported in April 2024, and the subsequent spread of the disease impacting numerous dairy herds in the Eastern Cape Province. Through strict animal movement control and vaccination of animals on farms bordering the infected areas, the further spread of the outbreak was well controlled. This however does not downplay the impact that the disease had on farms in the region, resulting in significant losses to those affected. Although FMD is not contagious for humans, the association of high somatic cell count (SCC) milk with the presence of pathogenic organisms and toxins does pose a potential safety risk to consumers.

The outbreak further emphasised other negative impacts on dairy farming operations. If a dairy farm becomes infected with FMD, milk production declines, SCC increases dramatically, large volumes of mastitis milk must be discarded, and animals are lost due to severe mastitis. Furthermore, cows are less likely to fall pregnant or may even lose their calves. Ultimately the farmer is stuck with heifers, dry cows and calves on the farm which are all consuming feed that should be destined for milk cows.

As animals cannot be moved, those that calve on other farms cannot be brought to the dairy parlour to be milked. Prices are reduced for the cull cow carcasses since they must be slaughtered at a FMD approved abattoir, while milk processors are losing milk volumes due to the decline in milk being supplied by the farmers.

Clearly the knock-on effects are detrimental to all members of the dairy value chain, therefore ensuring that strict biosecurity measures and protocols are followed on farm should be considered as an essential first step on farm.

3. Concluding remarks

The South African Dairy Industry has made significant progress in most of the sustainability goals as defined in the Dairy Declaration of Rotterdam and the Dairy Sustainability Framework, particularly in relation to the environment.

It should be recognised that this is an endeavour which requires continuous attention through research, monitoring and training, and ultimately adoption by all role players across the dairy value-chain in the country.

Several programs, which are either existing or in various phases of development, and which align to the aforementioned sustainability goals, have therefore been documented.

The report should be viewed as dynamic and is being updated regularly to reflect changes in the industry as new information becomes available and progress is made in related initiatives.

A summary of sustainability activities and responsible projects is also provided in the accompanying Addendum.

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Addendum

SUMMARIZED ACTIVITIES AND RESPONSIBILITIES OF THE SOUTH AFRICAN ORGANISED DAIRY INDUSTRY WITH REGARDS TO SUSTAINABILITY

The organised dairy industry of South Africa consists of MILK SA, its two members namely the Milk Producers' Organisation (MPO), which is the representative organisation of the producers of unprocessed milk, and the South African Milk Processors' Organisation (SAMPRO), which is the representative organisation of the producers of processed milk and the manufacturers of the other dairy products. In addition, the Dairy Standard Agency (DSA) and the SA National Committee of the International Dairy Federation (SANCIDF) also form part of the organised industry: The DSA is an expert body which independently promotes compliance of dairy products with stringent food safety, product composition and metrology standards. SANCIDF, through its specialist committees and linkages with Milk SA's committees, contributes towards the scientific and technical projects of the IDF. None of these organisations have no commercial interests.

The South African organised dairy industry recognises that the topic 'sustainability' involves:

- A variety of diverse matters;
- Many of these are inter-connected and have collective importance;
- Regulatory and other frameworks within which individual members of the dairy industry compete;
- National and international affairs; and
- Various South African and international dairies, as well as non-dairy organisations

Additionally, the South African organised dairy industry recognises that:

- Certain objectives, with regards to the relevant sustainability issues, are in competition and a balanced pursuit of the various objectives are required as these differ from country to country due to factors such as culture, climate and socio-economic issues; and that

- The organised dairy industry should follow a structured and balanced approach, in harmony with the Competition Act and other relevant legislation, to deal with matters regarding sustainability which are of collective importance.

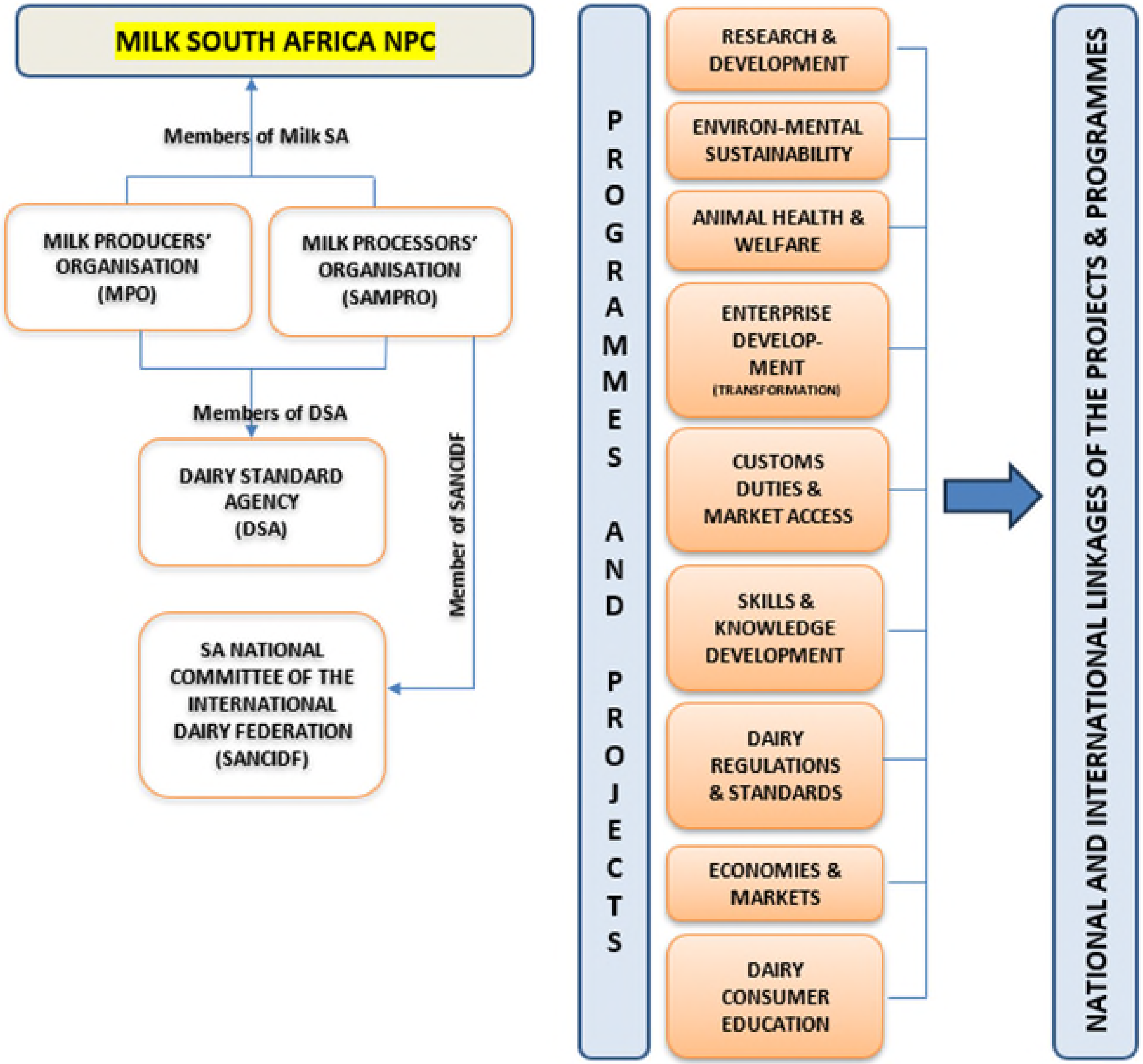
Matters regarding sustainability, which are of collective importance to the South African dairy industry, are attended to in the following programmes and projects:

Programme / Project	Manager	e-mail address
Research & Development programme	Dr Heinz Meissner	heinz@milksa.co.za
Environmental Sustainability programme	Dr Colin Ohlhoff	Colin.ohlhoff@fruitique.co.za
Animal Health & Welfare programme	Dr Mark Chimes	mark@milksa.co.za
Consumer Education project	Christine Leighton	christine@dairycep.co.za

Programme / Project	Manager	e-mail address
Economies & Markets project	Bertus van Heerden	bertus@mpo.co.za
Customs duties & Market access project	De Wet Jonker	dewet@sampro.co.za
Membership of and interaction with the International Dairy Federation via SANCIDF	Edu Roux	eduroux19@gmail.com
Promotion of the Quality of dairy products project	Jompie Burger	jompie@dairystandard.co.za
Regulations and Standards project	Jompie Burger	jompie@dairystandard.co.za
Enterprise Development programme (Transformation)	Godfrey Rathogwa	godfrey@milksa.co.za
Skills & Knowledge Development in the primary industry sector project	Ronald Rapholo	ronald@mpo.co.za
Skills & Knowledge Development in the secondary industry sector project	Gerhard Venter	gerhard.venter@sampro.co.za

The different programmes and projects interact with the International Dairy Federation, the Global Dairy Platform, the Dairy Sustainability Framework and the International Farm Comparison Network. These organisations are providing very useful information and interaction with multilateral organisations including Codex, the Food and Agricultural Organisation (FAO), and the World Health Organisation (WHO).

THE ORGANIZED DAIRY INDUSTRY



- Schools & Tertiary Education Institutions
- Association for Dietetics in SA
- Consumer Goods Council of SA
- SARS
- African Organisation for Standardization (ARSO)
- Competition Commission
- International Farm Comparison Network
- Provincial Departments
- Local authorities
- Animal Health Forum
- World Trade Organization
- Agricultural Trade Forum
- Codex
- National Treasury
- Department of Rural Development
- Milk producers / MPO
- Milk processors / SAMPRO
- SABS
- Perishable Products Export Control Board
- Department of Higher Education
- Quality Council for Trades and Occupations
- SA Qualifications Authority
- Foodbev Seta
- Agri Seta
- Centre for Diabetes and Endocrinology
- Agricultural Research Council
- SA Studbook
- International Trade Admin Comm
- Department of Health
- Health Practioner Associations
- Department of Education
- DALRRD
- National Agricultural Marketing Council
- Global Dairy Platform
- International Dairy Federation
- SA & Foreign Research Institutions
- Etc