DAIRY SUSTAINABILITY: TEN ENVIRONMENTAL CONSIDERATIONS

High impact responses to achieve low environmental impact dairy production

By Mark Botha
Edited by Tatjana von Bormann

Sponsored by Green Choice
Critical Ecosystem Partnership Fund
Livestock is the largest agricultural sector in South Africa, boasting an animal population almost equivalent to that of the human population. It is a thriving industry, linked so indelibly to the nation’s shared cultural customs that Heritage Day and National Braai Day have virtually become synonymous.

There is visible evidence that the industry is both expanding and intensifying in response to price pressures and growing demand. As a result the potential negative impacts of dairy farming, particularly in the biodiversity rich Cape Floral Kingdom, have long registered on WWF’s barometer of production concerns.

This guide attempts to answer the question “What does good dairy production look like in South Africa? It aims to provide a minimum set of the most important actions to reduce the impact of dairy production in South Africa. The focus is on reducing environmental and often practical impacts, whilst recognizing and supporting the need for both economic and social issues to be included in a holistic approach to securing sustainability.

Dairy production is one of the most energy, water and fertiliser-intensive land uses, and is associated with significant negative environmental impacts. Production risks associated with the high levels of Green House Gas (GHG) emissions and the impact on ecosystem functioning are self-evident but there are also some clear opportunities to adopt better practice, improve sustainability, whilst significantly reducing input costs.

This report’s recommendations are based on investigations into dairy practices and a detailed Fluid Milk Life-Cycle Analysis (LCA, Notten & Mason-Jones 2011) This LCA focused on five dairy farms for the entire dairy value chain in the Western Cape, from production to final post-consumer packaging disposal. The LCA focussed on assessing the impact of GHG, water greenhouse gas emissions, water and land impact analysis.

Ten desired environmental outcomes are highlighted here for consideration by the dairy industry (from small producers to processors and retailers), in addition, simple metrics are provided to determine how farm management practices reflect progress towards these outcomes. Although simple response strategies are suggested, three important considerations persist:

1. Impacts occur right along the value chain. Although the opportunities for greatest environmental benefit lie at the farm, processors, retailers and consumers have significant roles to play in paying a fair price, minimising milk wastage and reducing energy consumption associated with each litre of milk.
2. Dairy is produced from farms with widely differing environments and production systems. It is not possible nor practical to develop a unitary set of metrics for both intensive stall-based feedlots and extensive pasture-based systems. The presence or lack thereof of on-farm processing facilities plays an important factor in maximizing efficiencies and reducing the impact of effluent by utilizing the outputs of one systems as inputs for another (e.g. CO2-generation).
3. There are significant trade-offs in the choice of production systems (e.g. buying or growing all feed) in terms of their differential impacts on land, water, climate and waste outcomes, and the costs to the farmer. These should be made visible to the market, and the least damaging, most economically viable solution found that internalises the full costs of milk production.

It is not possible to recommend a single route to environmental sustainability that will suit all farms and the metrics suggested here are not absolutes or qualifying criteria for any scheme. Rather they seek to highlight the potential undesirable impacts and promote insightful, measurable ways of quantifying them. This should have the effect of increasing the efficiency of on-farm resource use, minimising unnecessary input costs and increasing long-term economic viability of a dairy enterprise, as well as improving environmental sustainability. Achieving this economic outcome and thus farmer buy-in, however, will likely depend on a more level regulatory playing field, greater risk-sharing along the value chain, capital investment and a more transparent, equitable and stable milk market.

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Biggest Wins:
Two areas for creating the biggest potential benefits: (1) installing biogas systems to capture and process manure for energy generation and fertiliser displacement; and (2) deploying meters to more accurately gauge pasture water and nutrient requirements to minimise abstraction and nutrient run-off.
Summary Table:
The ten most important environmental outcomes for good dairy production on farms. Some are readily indicated or measurable, others are targets to be understood and aimed for at farm level.

<table>
<thead>
<tr>
<th>Desired outcome / principle</th>
<th>Indicator or target</th>
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<tbody>
<tr>
<td>LAND</td>
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</table>
| 1. Threatened ecosystems are protected & well managed | ✓ No new pastures established on virgin veld (i.e. in areas that have not been developed for 10 years or more)  
✓ A 32m well-vegetated buffer is maintained around all water resources (including seasonal wetlands and streams). |
| 2. Feed and fodder production and use has minimal impact on the environment | ✓ Maximum of 100kg N/ha/yr applied in artificial fertiliser on pastures  
✓ Feed is produced under accepted good practice for field crops and/or in non-water-stressed catchments, or rain-fed. |
| WATER                      |                     |
| 3. Pastures, sheds and cow holding areas avoid concentrating manure runoff into natural veld or water resources. | ✓ N-levels in natural water resources don’t exceed 20mg/l  
✓ All practically available manure and run-off is captured for processing  
✓ Waste water does not leave site “unpolished”  
✓ No irrigation or fertilisation with NO3 fertilisers within 50m of a water resource. |
| WATER                      |                     |
| 4. Water abstraction for irrigation, drinking, and washing does not compromise the river’s minimum ecological flow requirements (“ecological reserve”). | ✓ All water use and waste discharge is registered and authorised with Dept. Water Affairs and local Water User Association. |
| WATER                      |                     |
| 5. Water use efficiency maximised. | ✓ All water use is regularly measured and monitored, including abstraction, irrigation and water use in dairy facilities and offices.  
✓ < 400m3 blue water used per ton Flow Per Cubic Metre (FPCM). |
| ENERGY                     |                     |
| 7. Electricity demands reduced by timing and soil moisture metering. | ✓ Maximum of 10 litres municipal water/l FPCM is used for all drinking and washing.  
✓ Electricity draw for pumping & irrigation timing avoids morning and evening peak demand.  
✓ On-farm energy production approaches 40% of total need.  
✓ No direct use of fuel oil or coal for heating or cooling.  
✓ Explore potential of solar powered pumps. |
| WATER                      |                     |
| 8. Fuel demands reduced for milking, storing and primary processing | ✓ Energy intensity of milk safety/ pasteurisation is reduced through heat exchangers or UV photo-purification, and is less than 300kJ/l. |
| WATER                      |                     |
| 9. Transport requirements reduced. | ✓ Distance feed is transported <250km.  
✓ Distance milk is transported to processor <500km. |
| WASTE                      |                     |
| 10. Manure handling minimises greenhouse gas emissions and maximizes energy production and fertiliser output. | ✓ >95% all manure is collected from holding, feeding and milking areas, treated anaerobically, and resultant gas captured for energy production (minimise CH4 emission)  
✓ Slow-release fertilisers are applied under non-saturated conditions to pastures (minimise NO3 emission). |
Dairy farming in South Africa has significant negative impacts on our water, biodiversity and climate. Recent empirical research and a Fluid Milk LCA commissioned by WWF South Africa has begun to quantify these impacts with the aim of finding the biggest issues or sources of emissions and finding viable, durable solutions to them with all actors in the dairy chain. Fortunately, it also appears that the dairy industry is pre-adapted to finding internal solutions.

These guidelines aim to assist the industry to move towards understanding their impacts and finding scalable practical solutions. The outcomes suggested in these guidelines are not a manual for dairy farming, or a complete set of criteria with which to comply. Rather they indicate the direction that the industry (farmers, processors and retailers and possibly even consumers) must move in to improve their sustainability and long-term profitability.

These guidelines have not been tested on industry players, but are a thought-model for critical reflection, evaluation and improvement.

One particular opportunity is for all players in the dairy industry to acknowledge the impacts that dairying has on the landscape, rivers and atmosphere and to find the best practicable and most equitable and durable means to reduce them. There has been a demonstrable reduction in compliance monitoring and enforcement of regulations protecting natural resources, and it will take some time to improve the capacity of state-run extension services. Self-regulation by farmer groups and industry bodies may be the most efficient solution for better dairy practices. However, this will likely involve creating greater transparency in the value chain and committing as an industry to the right environmental outcomes.

How to minimise environmental impact and reduce losses along the value chain

The Fluid Milk LCA pointed out substantial contributions to the greenhouse gas footprint of milk after it left the farm gate. Given this, and the perishable nature of the product, there are also obvious practices and targets for processors and retailers to minimise environmental impact and reduce losses along the chain. In particular:

- using new, low energy pasteurisation methods that increase milk life-span (and avoiding "economic" milk dumping);
- rigorously maintaining coldchain integrity (including the buyer taking complete responsibility for the milk once it leaves the farm);
- minimising transport distances from supplier to store;
- improving efficiency of display fridges through regular servicing and nighttime shutters to retain the cold, and dealing with shrinkage and spoiled milk in the most efficient and nutrient-conserving manner possible (returning it to the farm, a common practice, is not an environmentally sensible strategy);
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1. Waste Management Act (Act 59 of 2008)
Dairy farmers would be bound by the duty-of-care in the Waste Act:

“General duty in respect of waste management
16. (1) A holder of waste must, within the holder’s powers, take all reasonable measures to
(a) avoid the generation of waste and where such generation cannot be avoided, to minimise the
toxicity and amounts of waste that are generated,
(b) reduce, reuse, recycle and recover waste,
(c) where waste must be disposed of, ensure that the waste is treated and disposed of in an
environmentally sound manner,
(d) manages the waste in such a manner that it
does not endanger health or the environment
or cause a nuisance through noise, odour or
visual impacts.”

There is also a general prohibition on an unauthorised disposal of waste, especially into water resources. A strong argument could be made for the Minister or MEC to declare dairy waste production as a “listed waste management activity” requiring regulated approaches, licences and non-compliance consequences to managing the problem or emissions. This is a likely outcome in certain stressed catchments or those with water quality issues. Compliance with dairy waste management regulations would be relatively easy to police for the 2,500-odd dairy farms in SA.

In the regulations of the Waste Act, a “basic assessment report” as envisaged in the EIA regulations under Section 24(5) of NEMA is required for:

7. The treatment of waste in sludge lagoons;
10. The storage, treatment or processing of animal manure, including the composting of animal manure,
at a facility that has a throughput capacity in excess of 10 tonnes per month, including the construction of
a facility and associated structures and infrastructure for such storage, treatment or processing. And/or
11. The processing of waste at biogas installations

The Ministers responsible for Environment and Water are empowered to act under the Waste Act, and although the penalties for non-compliance are severe, these are unlikely to be aimed at most farmers. The Act makes provision for industry-, site- or waste-specific programmes to assist with managing waste more effectively.

A Waste Discharge Charge system was being considered by Dept. Water Affairs and National Treasury in 2007 which could well apply to and impact dairy farms, but no clarity on this could be found.

The National Water Act is ambitious and comprehensive, but unfortunately suffers from weak enforcement and low compliance. Part 4 of the Act prescribes pollution prevention that would apply to a dairy farm:

“Prevention and remedying effects of pollution
19. (1) An owner of land, a person in control of land
or a person who occupies or uses the land on which -
(a) any activity or process is or was performed or
undertaken, or
(b) any other situation exists, which causes,
hazards or is likely to cause pollution of a
water resource, must take all reasonable
measures to prevent any such pollution from
occurring, continuing or recurring.”

This section gives a brief overview of relevant compliance and regulatory requirements, by a conservation practitioner, not a legal specialist. It is prudent to do a more thorough review of applicable laws and regulations, to clearly establish the legal environmental “duty-of-care” for a dairy farmer. It is difficult to give firm advice on better-practice guidelines that go beyond legal compliance when the latter is ill-defined and seldom enforced. Those items extracted below provide ample evidence of the tight controls that do or could soon pertain to the dairy farm, and would guide the focus of any appropriate response strategies. Any industry that proactively minimises its environmental footprint and internalises costs and self-regulation will be better placed in a rapidly growing, water- and climate-constrained world.

The number of laws and regulations that a dairy farmer must abide by is enormous; ranging from labour, health, and food safety to agricultural remedies, and animal welfare. Detailed international guidelines exist (FAO/FD 2004, SAI Platform 2009) that provide the range of all good agricultural practices, but this is not beyond the realm of possibility in a world where impacts from global change are beginning to be felt.

Any industry that proactively minimises its environmental footprint and internalises costs and self-regulation will be better placed in a rapidly growing, water- and climate-constrained world.
The measures referred to in subsection (1) may include measures to -
(a) cease, modify or control any act or process causing the pollution;
(b) comply with any prescribed waste standard or management practice;
(c) contain or prevent the movement of pollutants;
(d) eliminate any source of the pollution;
(e) remedy the effects of the pollution; and
(f) remedy the effects of any disturbance to the land and banks of a water resource.
(3) A catchment management agency may direct any person who fails to take the measures required under subsection (1) to -
(a) commence taking specific measures before a given date;
(b) diligently continue with those measures; and
(c) complete them before a given date.
(4) Should a person fail to comply, or comply inadequately with a directive given under subsection (3), the catchment management agency may take the measures it considers necessary to remedy the situation.
(5) Subject to subsection (6), a catchment management agency may recover all costs incurred as a result of a person failing to act as required under subsection (4) jointly and severally from the following persons:
(a) Any person who is or was responsible for, or who directly or indirectly contributed to, the pollution or the potential pollution;
(b) the owner of the land at the time when the pollution or the potential pollution occurred, or that owner’s successor-in-title;
(c) the person in control of the land or any person who has a right to use the land at the time when -
(i) the activity or the process is or was performed or undertaken; or
(ii) the situation came about; or
(d) any person who negligently failed to prevent -
(i) the activity or the process being performed or undertaken; or
(ii) the situation from coming about.
(6) The catchment management agency may in respect of the recovery of costs under subsection (5), claim from any other person who, in the opinion of the catchment management agency, benefited from the measures undertaken under subsection (4), to the extent of such benefits.

Furthermore, it is unclear whether the common dairy practice of irrigating fields from manure sludge ponds or post anaerobic digestion would be considered a controlled activity requiring specific authorisation.

Finally, under certain circumstances a responsible authority under the Water Act may require compulsory licensing to maintain the integrity of water regulation, and this power will likely be exercised more frequently with increasing water stress and declining water quality in many dairy production areas in South Africa.

In particular, the Minister may regulate, or a Water Use licence may contain conditions requiring compliance with:

- “26(1) (b) prescribing waste standards which specify the quantity, quality, and temperature of waste which may be discharged or deposited into or allowed to enter a water resource.
- (f) requiring that waste discharged or deposited into or allowed to enter a water resource be monitored and analysed, and prescribing methods for such monitoring and analysis”

For a dairy operation to be pursuing good environmental practice, the indicators noted in the table below must be at least compliant with these and other laws.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Compliance Level</th>
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<tbody>
<tr>
<td>Good practice</td>
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<tr>
<td>Good practice (2)</td>
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<td>Good practice (3)</td>
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<td>Good practice (4)</td>
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<td>Good practice (5)</td>
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<td>Good practice (18)</td>
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<td>Good practice (19)</td>
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<tr>
<td>Good practice (20)</td>
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</table>

It goes without saying that any better practice production system must be at least compliant with these and other laws. For a dairy operation to be pursuing good environmental practice, however, they would need to comply with at least the indicators noted in the table below.
Where possible, different indicators/metrics and response strategies are given for stall vs. pasture feeding.

In inspiring positive change it is useful to understand the on-farm decision-making process. Certainly, given the plethora of daily chores and imperatives waiting on a dairy farmer, environmental guidance will only be as useful as how it can make his/her life easier or increase profit. Few have the opportunity or training to measure and respond to all aspects of production, and many use private consultants for advice on irrigation or fertilisation regimes. What can farmers (or even producers/retailers) realistically refer to, to understand the desired environmental outcomes, and track progress towards them? The key outcomes listed below are intended as a starting point. Minimising the requisite measurements and linking them to reducing input costs, improving regulatory compliance, or increasing sustainability indices seems a sensible stratagem.

The range of environmental conditions, production models and procurement choices varies widely across dairy farms in SA. The approach of this study is to focus industry attention on those 10 key areas responsible for the most negative impact, and to frame an outcome for each that reflects the objective of any improved practice or technological change. It is not possible in most instances to stipulate a hard target or objective of any improved practice or technological change. Where possible, different indicators/metrics and response strategies are given for stall vs. pasture feeding.

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Table 1:
Ten key outcomes, 21 progress indicators and potential responses for good dairy practice

<table>
<thead>
<tr>
<th>Desired outcome / principle</th>
<th>Indicator/ metric/ target</th>
<th>Potential response strategy – specifics would need site- or region-specific development</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LAND</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Threatened ecosystems are protected &amp; well-managed</td>
<td>1. Farm plan &amp; layout, includes a management plan for natural veld to remove invasive plants &amp; control fire</td>
</tr>
<tr>
<td></td>
<td>No new pastures established on virgin veld</td>
<td>2. Fence off remnant natural ecosystems and water resources</td>
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<tr>
<td></td>
<td>A 32m well-vegetated buffer is maintained around all water resources.</td>
<td>3. Animal density on natural veld grazing doesn’t exceed stocking limits</td>
</tr>
<tr>
<td>2.</td>
<td>Feed and fodder production and use has minimal impact on the environment</td>
<td>4. “Precision agriculture” using accurate measurement of requirements and applications of water and nutrients</td>
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<tr>
<td></td>
<td>Maximum of 100kg N/ha/yr applied in artificial fertiliser on pastures.</td>
<td>5. Understand environmental impacts associated with bought fodder and well improved digestibility (and, hence, less methane)</td>
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<tr>
<td></td>
<td>Feed is produced under accepted good practice for field crops and/or in non-water stressed catchments.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Pastures, sheds and cow holding areas avoid concentrating manure runoff into natural veld or water resources.</td>
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<tr>
<td></td>
<td>N-levels in natural water resources don’t exceed 20mg/l.</td>
<td>6. Biogas digester installation to remove possible pollution of water resources and natural veld</td>
</tr>
<tr>
<td></td>
<td>All practically available manure and runoff is captured for processing.</td>
<td>7. Feed &amp; pasture design facilitate efficient cleaning and manure capture into a digester</td>
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<tr>
<td></td>
<td>Wastewater does not leave site “unmolested”</td>
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<tr>
<td></td>
<td>No irrigation or fertilisation with NO3 fertilisers within 50m of a water resource</td>
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<tr>
<td>4.</td>
<td>Water abstraction for irrigation, drinking and washing does not compromise the river’s “Ecological Reserve” (minimum flow requirements).</td>
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<td></td>
<td>All-water use and waste discharge is registered and authorised with Dept. Water Affairs and Local Water User Association.</td>
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<td></td>
<td>No run-off of river abstraction is used if the river’s ecological reserve is not met (River health/reserve status determines pumping options).</td>
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<tr>
<td>5.</td>
<td>Water use efficiency maximised</td>
<td>8. Plan for optimal capture and storage of rain on farm and from rivers in high-flow conditions</td>
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<td></td>
<td>Field sensors or direct measurement indicate irrigation requirements.</td>
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<td></td>
<td>&lt; 400m3 blue water used per ton FPCM.</td>
<td>9. Make every drop of water work several times on the farm, before returning it to the soil (NOT the river)</td>
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<tr>
<td>6.</td>
<td>Demand on municipal water minimised</td>
<td>10. Install meters on water pumps, supply lines</td>
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<td></td>
<td>Maximum of 10 litres municipal water/l FPCM is used for all drinking and washing</td>
<td>11. Minimise water use for manure removal</td>
</tr>
<tr>
<td></td>
<td>“Precision agriculture” using accurate measurement of requirements and applications of water and nutrients</td>
<td>12. Digester Supernatant mixed with polishing to stabilise fields for fodder production</td>
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<tr>
<td>7.</td>
<td>Electricity demands reduced by timing and soil moisture metering.</td>
<td>13. Non-essential washing done with ground/recycled water</td>
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<tr>
<td></td>
<td>Electricity draw for pumping &amp; irrigation, timing avoids morning and evening peak demand.</td>
<td>[1] Farm layout (refers to response 1 above)</td>
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<tr>
<td></td>
<td>On-farm energy production approaches 40% of total need</td>
<td>14. Select appropriate pasture species mix</td>
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<tr>
<td></td>
<td>No direct use of fuel oil or coal for heating</td>
<td>[4] Monitor soil moisture</td>
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<td></td>
<td></td>
<td>15. Install efficient irrigation &amp; use gravity</td>
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<tr>
<td>8.</td>
<td>Fuel demands reduced for milking, storing and primary processing.</td>
<td>16. Efficient cooling and effective insulation</td>
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<td></td>
<td>Energy intensity of milk safety/ pasteurisation is reduced through heat exchangers or UV photo-purification, and is less than 300kJ/l.</td>
<td>17. If milk pasteurised on site, use alternative low energy methods (e.g. UV, gas, RE)</td>
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<td></td>
<td></td>
<td>18. Water heating aided by solar input or CHP from other sources</td>
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</table>

**“the actual metric is not as crucial as promoting system thinking and integration.”**
Many of the potential responses are already being implemented or have been considered by dairy farmers. However, two areas with significant public benefit (but usually only cost to a farmer) that haven’t penetrated the dairy industry (in many countries unless strict regulation or incentive schemes exist) are biogas digesters and irrigation/nutrient measurement.

1. Encourage installation of manure (biogas) digesters wherever possible

In the past, when energy was cheap (or even free), there was little inducement to make the most of farm resources or to minimise waste or other emissions. Now that electricity is expensive, and costs are rising fast, many farmers are trapped by old, inefficient technologies, and milk sheds that are difficult to clean and impossible to collect manure from. These and other constraints prevent the quick uptake of new technologies. It is possible to take a regulatory approach that demands farmers deal with all on-site issues and efficiencies, but a more durable solution would be for economics to drive the wide uptake of better technologies, such as digesters.

The cost of installing good technology that would most benefit the broader environment by reducing greenhouse gas emissions and water pollution, displace fertiliser use, and generate electricity is often too substantial for all but the largest dairies. Private carbon investment looking for attractive returns concentrate on farms with over 2500 cows (if pastured) or 1200 head (if feedlot/stall based), and choose the large feedlots and piggeries for investment. However, the numerous benefits, and potential to reduce long term input costs, should sway any decision in favour of installation at all dairy farms, providing suitable finance can be arranged. Of the potential funding sources to offset the direct cost, carbon funds will likely be the easiest to leverage.

Water quality and pollution is a big and growing issue in South Africa. Although solid data on the contribution by non-point sources of nutrients and pathogens from agricultural run-off is hard to come by, most of the prominent media focus has been on failing municipal sewerage infrastructure.
Nevertheless, there may be strong arguments for water management authorities to require better water quality protection measures, such as treating all manure and reducing nitrate or ammonium pollution potential.

A by-product of good digesters is the production of pathogen-free, slow-release compost for either sale or application on pastures where nutrient runoff could cause eutrophication. In some dairies in the U.S.A it appears that this income stream is sufficient to justify digester installation. Any carbon tax or fertiliser price spike could spur the use of digester technology to produce good quality, high-value compost.

All new dairies should be carefully designed and constructed to maximise manure collection from feeding, holding and milking areas, for water-efficient, gravity-powered transfer into digesters. This is a lower cost option than retrofitting existing facilities, and could be better regulated. Many technologies and responses currently exist (covered lagoons, sludge spraying etc.) that can deal with the waste, but don't address energy, water or pollution concerns. To effectively address the range of environmental issues, many farms will need consultant expertise to build a suitable system with proven local application and low familiarity with operation and maintenance. Finding economies of scale, and simple, scalable construction will be a key to facilitating uptake.

Milk margins are low, buying power is concentrated and opportunities abound for competitors to avoid compliance, preventing the market sending appropriate signals. Consumer pressure may change some suppliers, but the dispersed nature of the farms and the relative opacity of the production process will make this a difficult route. Although it is interesting to see how bovine growth hormone (rBST) rapidly became a consumer issue, environmental impacts and concerns are less likely to drive consumer action than personal health concerns.

Ideally the entire value-chain should invest in the mitigation of impacts before the farm gate. This could either be through the milk price or through direct investment by processors and/or retailers on suppliers’ farms and sharing the risks and benefits (inter alia carbon reduction, catchment stewardship, sustainable agriculture, farm energy security).

There is a possible role for the Milk Producers Organisation and Deps of Agriculture, Water, Science & Technology and Energy to assist with the development of locally-produced, scalable digester systems for deployment at small and medium dairy farms (and schools, small municipal sewerage works etc.), to bring down the production cost and improve understanding and familiarity with the technology.

Any carbon tax or fertiliser price spike could spur the use of digester technology to produce good quality, high-value compost.

2. Require regular measurement of irrigation water use and nutrient run-off.

Several related impacts of dairy pastures result from the need to produce substantial fodder for lactating cows. This often results in excessive irrigation and over-fertilisation, just to ensure that neither of the factors is limiting feed crop production. However, this results in significant water abstraction from natural systems, electricity use for pumping, increased fertiliser-, soil- and manure-gas emissions from saturated fields, and unnecessary runoff of nutrients into water sources. Improving the accuracy of measuring the actual fodder crop’s water and fertiliser requirements and the efficacy of delivering them would benefit farmers, the atmosphere and freshwater systems hugely.

Many farmers don’t have the ability to meter just how much water they pump and irrigate, and rely on processes such as the length of time to fill a storage dam, or the duration of irrigation. Irrigation is often scheduled, regardless of the soil moisture status. Indeed, water rights are often allocated for a land area, with only a rough approximation of actual volume to be abstracted. In an era of limited water supply and quality, any effort that increases agricultural efficiency and provides assurance of the environmental and social reserve is worthwhile.

There is an obvious role for water regulation and compliance enforcement to drive the uptake of more efficient and measured irrigation water use. Several States in the dry south-western U.S.A require metered irrigation pumps. It would seem sensible to require by law that all irrigation pumps over a certain rating (e.g. 2 kW or 50 litres/hr. throughput) should be a mandatory flow-meter installed. Water User associations and irrigation boards could assist farmers to understand the catchment yield and water reserve requirements, and how to optimise irrigation water without compromising ecosystem integrity. Compulsory water use licensing in stressed, over-allocated catchments is coming, and will be a contentious and difficult process. If farmers were proactive and self-regulating this could pre-empt farmers to better handle any licensing changes and/or expedite the new licence regime.

Given that unnecessary water pumping is a real cost to a farmer through electricity use, there may be an opportunity for Eskom to provide better access to efficient pumps with pay-back periods for installing energy and water efficiency technologies would also help farmer choice.
The dairy industry is fortunate in that significant opportunities for improving environmental performance exist, with results that should increase farm economic sustainability and reduce input costs. Finding sites to test the veracity and efficacy of the indicators and guidelines with farmers would be required to fine tune any site or catchment specific guidance. Developing effective monitoring mechanisms for farmers’ ultimate financial benefit would be key to ensuring that durable and viable good practice emerges.

Incentivising the uptake of the better practices and technologies is likely to be required for the majority of dairies in SA. Although the Carbon market will play a large role, water and catchment regulation and climate emissions targets might be needed to secure compliance and uptake. Retailers and large processors have a unique opportunity to drive better practice by aiding farmers to adopt better practices through long term supply agreements, risk sharing, production guidelines and even direct investment on farms in priority catchments.

Imagine an ideal dairy farm in future: one that internalises all of its waste and costs; only buys easily digestible fodder produced locally under good practices; whose pastures are predominantly rain-fed with small supplemental gravity irrigation from well sited farm dams only when necessary; with large natural pastures left intact along all streams and wetlands; with a well-designed easily cleaned dairy that’s pleasant to work in; capturing almost all manure for efficient digestion to produce most of the farm’s electricity needs, and more than half its fertiliser needs; with almost no run-off of nutrients to pollute the water supply. This is kind of place that most farmers, processors, retailers and consumers would like to see their milk coming from.

Reducing nutrient run-off could be further enhanced by voluntary withdrawal of all production pastures to at least 32m from all water resources, including wetlands and drainage lines without permanent standing water. This distance is the legally required minimum in environmental impact regulations and is a crucial buffering preventing NO3 and topsoil run-off. The buffer area could still be grazed, but only such that water resource and stream bank integrity are not compromised. A barrier with one or two-strand electric fencing is often sufficient to keep cows out of sensitive areas at very low cost.

Responsible retailers and production standards or guidelines would need to include requirements for at least complying with regulatory water and current environmental requirements, but should go further into verifying water consumption efficiency and minimal nutrient run-off in stressed catchments that don’t meet water resource classification objectives.

CONCLUSION

GLOSSARY

Blue water — water abstracted directly from a water resource and used in a production system. This therefore excludes water taken into the production system in plant or other matter, and is usually excluded from footprint calculations.

GHG — methane: A nasty greenhouse gas, at least 21 times as effective as CO2.

CHP — Combined Heat and Power (making most use of the energy available from a generator).

Eutrophication — elevated nutrient levels in water bodies that often result in toxic pollution or harmful algae blooms.

FPCM — Fat & Protein Corrected Milk (a useful common reference unit for life cycle analysis).

N2O — Nitrous Oxide: A potent greenhouse gas more than 310 times as powerful as CO2.

NOX — Nitrates and nitrates.

NH3 — Ammonia.

NEMA — The National Environmental Management Act (Act 101 of 1998) and its associated regulations. There are specific environmental management acts under NEMA dealing with Protected areas (57 of 2003), Biodiversity (10 of 2004), Air Quality (39 of 2004), and Waste Management (59 of 2008).

“Watercourse” means —
(a) a river or spring;
(b) a natural channel in which water flows regularly or intermittently;
(c) a weir, lake or dam into which, or from which, water flows; and
(d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks;

“Water Resource” — includes a watercourse, surface water, estuary, or aquifer.

Notation and Units

Standard SI units and elemental symbols are used throughout. Thus “kg N/ha/yr” means kilograms of nitrogen applied per hectare per year.

Units used are those likely to be intuitive to or readily grasped by a farmer or lay person. Thus “300kJ/l” means that 300 thousand joules are used per litre of milk.

Some units could be expressed in other ways. Thus, 20mg/l means 20 milligrams per litre and is equivalent to 20 parts per million. A very small number, but still dangerous enough to cause damage if the wrong substance is involved.

1 Both definitions from the National Water Act (Act no. 36 of 1998).
There are no sustainability commitments or objectives on the MPO website.

action” which is an industry pledge to reduce carbon emissions and support the long-term sustainable supply of milk and dairy products.

not appear viable to keep milk longer than 1 day before collection, resulting in substantial transport implications. The eastern & southern


• Thorough, solid example of industry commitment to sustainability.
• Member communications and motivation tool

• The sensible comprehensive standard reference. Of the 45 Principles, over a third are directly relevant to improving environmental outcomes
• Recommends practices but we would need to localise the recommendations, develop some more detailed outcome metrics, and better understand the obstacles to adoption
• Needs to be turned into an audit/checklist

• Comprehensive standards for everything a dairy farmer might need to consider
• Not useful for SA environment

• Useful outline of how to approach an industry/value chain to see where to intervene to find most value, generate buy-in, and get commitment to collective action
• Prioritised the most likely areas for improvement in reducing GHG emissions
• Readable and clear

• The US EPA partnership to help farmers decide on biogas and other technologies available

• Insightful paper on the macroeconomic and architectural problems associated with the dairy industry

• Has easily accessible info on most aspects of dairy safety, but very little on farm and environmental regulations (would be a good place to house any Guidelines)

SA Industry structure and commitment

There are roughly 2700 milk producers in SA, and just over 700 in W Cape. Membership of MPO is about 84%. 400 lines is the minimum consignment a milk buyer will likely collect = equates to min hand size of 30 productive cows (at awe of 13/14/day/cow). It does not appear viable to keep milk longer than 1 day before collection, resulting in substantial transport implications. The Eastern & Southern African Dairy Association, which the SA Milk Producers Organisation joined in 2007, has committed to the “Global Dairy Agenda for Action” which is an industry pledge to reduce carbon emissions and support the long-term sustainable supply of milk and dairy products. There are no sustainability commitments or objectives on the MPO website.

Some listed activities and geographic areas requiring environmental Authorisations from a competent authority under the NEMA EIA regulations. Please consult the relevant government notices and an accredited Environmental Assessment Professional before commencing any activity which may be listed below:

List 1: Basic assessment
4: the construction of or 31: the expansion of facilities or infrastructure for the concentration of animals for the purpose of commercial production in densities that exceed —
• 20 square metres per large stock unit and more than 500 units, per facility;
11: The construction of or 39: the expansion of—
• canals;
• channels;
• bridges;
• dams;
• weirs;
• buildings exceeding 50 square metres in size, or
• infrastructure or structures covering 50 square metres or more
where such construction or expansion occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line.

12: The construction or 41: the expansion of facilities or infrastructure for the offstream storage of water, including dams and reservoirs, with a combined capacity of 5000 cubic metres or more, unless such storage falls within the ambit of activity 19 of Notice 545 of 2010;

26: Any process or activity identified in terms of section 53(1) of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004). Pertaining to the protection of threatened ecosystems which are prevalent in dairy farming areas)

35: The expansion of facilities for agri-industrial purposes outside industrial complexes, where the development footprint of the facility will be increased by a 1 000 square metres or more

55: The expansion of a dam where:
• the highest part of the dam wall, as measured from the outside toe of the wall to the highest part of the wall, was originally 5 metres or higher and where the height of the wall is increased by 2.5 metres or more, or
• where the high-water mark of the dam will be increased with 10 hectares or more.

List 2: Full assessment
16: The physical alteration of virgin soil to agriculture, or afforestation for the purposes of commercial tree, timber or wood production of 100 hectares or more.
19: The construction of a dam, where the highest part of the dam wall, as measured from the outside toe of the wall to the highest part of the wall, is 5 metres or higher or where the high-water mark of the dam covers an area of 10 hectares or more.

List 3: Listed activities requiring authorisation in specific Geographic areas
2: The construction of reservoirs for bulk water supply with a capacity of more than 250 cubic metres in specific geographic areas (W Cape, entire province outside of Urban areas; E Cape, KZN - Outside urban areas, in—
(a) National Protected Area Expansion Strategy: Focus areas
(b) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority;
(cc) Sites or areas identified in terms of an International Convention;
(dd) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;
(ee) Core areas in biosphere reserves;
(ff) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NDMPAO or from...
12: The clearance of an area of 300 square metres or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation. Within:
   (a) any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004;
   (b) Within critical biodiversity areas identified in bioregional plans;

13: The clearance of an area of 1 hectare or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation within:
   (a) Critical biodiversity areas and ecological support areas as identified in systematic biodiversity plans adopted by the competent authority;
   (b) National Protected Area Expansion Strategy Focus areas.

And in the In Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape and Western Cape:
   i. In an estuary;
   ii. Outside urban areas, the following:
      (aa) A protected area identified in terms of NEMPAA, excluding conservancies;
      (bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority for a conservation purpose;
      (cc) Areas seawards of the development setback line;
      (dd) Areas on the watercourse side of the development setback line or within 100 metres from the edge of a watercourse where no such setback line has been determined.

14: The clearance of an area of 5 hectares or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation, except where such removal of vegetation is required for purposes of agriculture or afforestation inside areas identified in spatial instruments adopted by the competent authority for agriculture or afforestation purposes, within all areas outside urban areas:
   (ff) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve;
   (gg) Areas seawards of the development setback line or within 1 kilometre from the high-water mark of the sea if no such development setback line is determined.

iii. In urban areas, the following:
   (aa) Areas zoned for use as public open space;
   (bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority for a conservation purpose;
   (cc) Areas seawards of the development setback line;
   (dd) Areas on the watercourse side of the development setback line or within 100 metres from the edge of a watercourse where no such setback line has been determined.

iv. Core areas in biosphere reserves;