Executive Summary

The science is confident and the truth is definitely “inconvenient” – global temperatures are rising, extreme events are increasing in frequency and intensity, and industrial development is to blame. 11 of the past 12 years have been the hottest in recorded history (since 1850) - and this warming is directly attributed to increases in atmospheric Greenhouse Gas (GHG) levels due to human-activities. The science indicates that if global warming is to be limited to within 2°C above pre-industrial values, global emissions need to peak between 2015 and 2020 and then decline rapidly. Recent reports show that due to the continued increase in atmospheric GHGs, a 4°C temperature shift is highly likely, having grave consequences for human living conditions and food security in particular.

The most prominent biophysical impacts of climate change on the South African agricultural sector include a decrease in water availability, a shift in seasonal temperatures and climatic patterns, and an increase in the prevalence of pests and diseases. The indirect impacts of climate change are equally threatening and include an increase in energy and fuel costs, an increase in market pressure and retail demands, and the likelihood of carbon pricing in the near future. Possible responses to these impacts depend on the availability of resources such as knowledge, technology and available finances.

Southern Africa has been identified as one of the most vulnerable regions in the world due to a relatively low capacity to respond to climate change. For South Africa in particular, the greatest development challenge is finding the best development pathway that ensures energy security and access to electricity, at the same time as laying a foundation to a low carbon economy. In response, the South African government has committed to undertake mitigation actions that would result in a 34% decrease in emissions relative to a ‘business as usual scenario’ by 2020, followed by a steeper 42% decrease by 2025. This commitment was formalised in the Cancun Agreements at the end of COP 16 in 2010. Being the host nation for the COP 17 negotiations in Durban during December this year, South Africa’s commitments and, more importantly, the implementation plans for mitigation and adaptation action throughout all sectors of the economy, will be on display for the international arena to support or scrutinize.

The agricultural sector holds a double-edged sword - although a noteworthy contributor to the global greenhouse gas (GHG) emissions (14% of the total, mainly through land-use change and livestock management), it is unique in its potential to mitigate substantial greenhouse gas emissions through improved efficiencies and management practices. Many industry members have been utilizing sustainable farming practices and energy efficiency measures for several years, in an effort to keep their business costs down and the production levels positive. However, very little has been done to better direct these efforts in a way that could be measured, monitored and reported on.

It is against this backdrop that the South African Fruit and Wine industry has decided to take the initiative and develop an industry-wide response to climate change. The Confronting Climate Change Initiative aims to provide an information resource for the industry to better understand the relevant direct (physical) and indirect (market-related) climate change impacts, and a carbon footprint measurement tool to help equip and empower the industry to better respond to these impacts.
The project is now in its fourth year of implementation, and a significant outcome of which included the technical training of the online carbon calculator tool, through which over 200 industry members have been trained. The support from the industry is increasingly positive, particularly following a technical training workshop, as is monitored through the monthly website usage figures. However, usage of the online carbon calculator tool remains relatively low and not evenly distributed through the various fruit and wine industry sections. As a result, the industry data analysis undertaken as part of the Confronting Climate Change project illustrates a snapshot into the profiles of the industry members using the online tool, rather than a representative industry “benchmark”, as was initially the goal. Even still, the results show some valuable trends that can assist the industry in prioritizing production and processing activities where technology and management changes can greatly reduce both the carbon footprint of the product and the financial costs of producing it.

Notably, electricity usage dominates the majority of carbon footprints included in the industry sample group. This is to be expected due to the fact that the South African grid supplied electricity is coal based and is thus inefficient and dirty. On a farm level, the electricity usage is mainly used for irrigation pumping, which highlights a double risk in terms of increased electricity and water rates. A combination of options exist to mitigate these risks. By using renewable energy to power the pumping, such as solar powered pumps or gravity fed systems, together with precision farming methods that monitor the exact soil and water requirements, improved efficiencies will reduce the carbon footprint and the internal risk of inflating input costs. In post-production, electricity usage is mainly for cooling in packhouse, coldstore or winery operations. Within South Africa, utilizing solar energy could easily negate the use of grid electricity for thermal heating and cooling purposes and there are several service providers available to give expert advice in this regard. Additional technologies in this area deserve thorough investigation within the industry to avoid future risk with increasingly costly and erratic electricity supply in the coming years. Other “big hitters” include the usage of nitrogen-based synthetic fertilizer and diesel consumption on a farm level; and packaging and freight options (particularly air and road transport) on the post-production level. Mitigation options include implementing precision farming practices that improve efficiencies and soil health, thereby reducing the amount of fossil-fuel based inputs required. Packaging has been highlighted as an area where small changes (in terms of the percentage of recycled material used for example) can make a significant difference to the overall carbon footprint of the product, while also serving as the “face” for product, showcasing the environmental values of the business. The role of economies of scale was highlighted in the local study, particularly in the wine industry, where trends indicate that with larger production volumes, comes more efficient the usage of resources, although this is not always the case. Finally, the transportation of the products to market is an obviously carbon intensive section of the supply chain, particularly when air and inefficient road freight options are used. Not much can be done to change the distance from the South African ports to international markets, however, as is highlighted in this report and in international literature, many opportunities exist throughout the supply chain that can offset the transportation leg of the chain while improving efficiencies and reducing costs.

In conclusion, the South African producers are continually faced with difficult challenges, both in terms of producing in the changing natural growing conditions, and in terms of selling in a highly competitive and unpredictable market place. However, history is proof that the industry is successful at adapting to change and rising to new challenges. The Confronting Climate Change project aims to provide an informative and supportive role to catalyse the necessary change required for the industry to maintain, enhance and surpass its market position in the coming years in a way that is sustainable, ethical and profitable.

“Change will not come if we wait for some other person, or if we wait for some other time. We are the ones we've been waiting for. We are the change that we seek.”
— Barack Obama
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Introduction

Climate change and agriculture seemed to be the new favourite couple on the block, particularly in the past year or so with an increase of debate around the inclusion of agricultural practices in the international negotiations and greenhouse gas accounting mechanisms. But for businesses in the agricultural sector, a changing climate is nothing new. Working on the land, and within environmental parameters, requires a certain level of unpredictability and thus adaptability in order to make the best of each season.

But thanks to industrial development, the change is happening at a faster rate than in the past — and so the adaptation needs to be progressive and pre-emptive in order to be effective in the long term. Access to the right information is essential to making long term decisions and beginning the journey of behavioural change. Much information is available on the subject of climate change, yet it is often overwhelming and over-complicated in nature, making it inaccessible or unappealing to the average individual.

The aim of the Confronting Climate Change project is to make the subject matter readily available and tangible, so the information can be more easily accepted and the necessary changes adopted, allowing the industry to progress on a successful and sustainable pathway in a carbon constraint future. The project has various elements to catalyse this change – information sharing through the website and information documents such as this one; technical skills transfer through industry workshops; and the development of effective tools such as the online carbon calculator to measure, monitor and report on the change.

This document forms one of the project’s knowledge resources and serves as a strategic reference document for the South African fruit and wine industry. It is the aim of the document to provide relevant information that will enable the various industry stakeholders to better understand the climate change related risks and opportunities that exist, and identify high-level starting points based on international and local case studies. It is not the mandate of this project to provide specific goals and targets for the industry, but rather to provide information from which to initiate management decisions and response strategies at both an individual and industry level.

It is the aim that through knowledge transfer and engagement, the South African fruit and wine industry will be able to develop a considered, appropriate and positive RESPONSE to the various impacts of climate change, rather than an uninformed and unfortunate REACTION.

The target audience for this reference document is the industry bodies within the South African fruit and wine sector. Side editions of this document have been developed to address specific needs identified within the industry. These include the Growers Information Resource: Mitigation Options, Growers Information Resource: Carbon Stocks at a Farm level, Industry Information Resource: Recent Climate Change Policy Developments, and Retailers Information Resource: Industry Response, all of which are available on the project website.

The document is structured in a manner that introduces the subject (Section 1 – Setting the Scene), highlights the predominant impacts for the fruit and wine industry and potential responses (Section 2 – Climate Change Impacts and Related Responses), before placing the information in context of established trends within the industry (Section 3 – Industry Trends). The document concludes with a summary of key risks and opportunities that were highlighted through the research and analysis of the project.

Various authors were involved in the compilation of this report and the project team is very grateful for the time and effort they gave in developing this document. Should you have any comments, suggestions or queries on the project or any details contained herein please contact Shelly Fuller (shelly@climatefruitandwine.co.za).
SECTION 1: Setting the scene

Highlights of this section:

- A changing climate is a reality and it is now undisputed that the cause of this change is human-induced.
- If global warming is to be limited to within 2°C above pre-industrial values, global emissions need to peak between 2015 and 2020 and then decline rapidly.
- At the 2009 Conference of the Parties (COP) South Africa made a commitment to undertake mitigation actions that would result in a 34% decrease in emissions relative to a ‘business as usual scenario’ by 2020, followed by a steeper 42% decrease by 2025. This commitment was formalised in the Cancun Agreements at the end of COP 16 in 2010.
- One of South Africa’s greatest development challenges is to ensure energy security and access to electricity, at the same time as laying a foundation to a low carbon economy.
- Of the sectors, the agricultural sector has been identified as being particularly vulnerable to climate change impacts; yet it also has the greatest potential to mitigate substantial greenhouse gas emissions through improved efficiencies and management practices.
- The South African Fruit and Wine Industry Initiative – Confronting Climate Change – aims to provide an information resource for the industry to better understand the relevant direct (physical) and indirect (market-related) climate change impacts, and a tool to help equip and empower the industry to better respond.

1.1 What is happening – The Science

“Climate change is a global challenge, which will take a combination of the full range of available interventions, technologies, policies and behaviour changes to resolve. It will also demand massive investment in new low-carbon technologies” (the South African government at the COP 15 meeting in Copenhagen, 2009).

The global climate is changing. Over recent years, there has been a notable increase in the frequency and severity of storms and flood events, extended droughts have occurred on all continents, and seasonal patterns are shifting, to name a few examples. It is now clear that the planet is warming - 11 of the past 12 years have been the hottest in recorded history (since 1850)- and this warming is directly attributed to increases in atmospheric Greenhouse Gas (GHG) levels due to human-activities. Recent reports show that due to the continued increase in atmospheric GHGs, a 4°C temperature shift is highly likely¹. This is a 50% increase from the initial, more conservative predictions. Since the initial Intergovernmental Panel on Climate Change (IPCC) report was published in 1990, the science of climate change and its implications for human welfare and economies has continued to improve in accuracy and detail.

Recent improvements on previous predictions include:

**A continued surge in greenhouse gas emissions:** Global carbon dioxide emissions from fossil fuels in 2008 were 40% higher than 1990 levels. Even if global emission rates were stabilized, 20 more years of emissions at the current level would lead to a 25% probability of global warming exceeding 2°C. Even with zero emissions after 2030. Every year of delayed action increase the chances of exceeding a 2°C target.

**Recent global temperatures demonstrate human-induced warming:** Over the past 25 years temperatures have increased at a rate of 0.19°C per decade, in good agreement with early models and predictions based on greenhouse gas increases. Natural, short term fluctuations may be occurring as usual but there has been no significant departure from the underlying warming trend predicted in earlier IPCC models.

**Acceleration of melting rate of ice-sheets, glaciers and ice-caps:** A wide array of satellite and ground measurements now confirm that both the Greenland and Antarctic ice-sheets are losing mass at an increasing rate. Melting of glaciers and ice-caps in other parts of the world has also accelerated since 1990 and has accelerated far beyond the expectations of climate models. The area of summertime sea-ice during 2007-2009 was about 40% less than the average prediction from IPCC AR4 climate models.

**Sea level prediction revised:** By 2100, global sea-level is likely to have risen at least twice as much as projected by earlier IPCC models. If current emissions trends continue unchecked, the sea level rise may well exceed 1 metre, and could even be as high as 2 metres sea-level rise by 2100.

**Delay in action risks irreversible damage:** Several vulnerable elements in the earth-climate system (e.g. continental ice-sheets, Amazon rainforest, West African monsoon and others) could be pushed towards abrupt or irreversible change if warming continues in a business-as-usual way throughout this century. The risk of transgressing critical thresholds ("tipping points") increases strongly with increasing GHG emissions and a lack of mitigation activities. Thus waiting for higher levels of scientific certainty could mean that some tipping points will be crossed before they are recognized.

**The turning point needs to occur soon:** If global warming is to be limited to within 2°C above pre-industrial values, global emissions need to peak between 2015 and 2020 and then decline rapidly. To stabilize the global climate, a decarbonized global society – with near-zero emissions of CO₂ and other long-lived greenhouse gases – needs to be reached within this century. More specifically, the average annual per-capita emissions will have to decrease to under 1 ton CO₂ by 2050. This is 80-90% below the per-capita emissions in developed nations in 2000.

Within this changing environment, a developing **South Africa** finds itself in a quandary. South Africa is one of the highest emitters of GHGs in the world, ranked 19th in 2005 if emissions from land-use change and forestry are excluded, as is illustrated in Table 1 below. South Africa contributed 1.12% of global GHG emissions and 48% of Sub-Saharan Africa’s emissions. In terms of GHG emissions per capita, South Africa was ranked 54th in 2005 and emitted 9 tonnes of CO₂ per person compared to a global average of 5.8 tonnes per person. Yet South Africa holds incredible potential to increase our sink capacity and decrease our GHG emission rates. In addition, South Africa is a country that has been highlighted as being exposed to the impacts of climate change due to our geographical location as well as our low level of coping capacity.

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2 Allison, I. et. al. (2009) The Copenhagen Diagnosis: Updating the world on the Latest Climate Science
4 Climate Analysis Indicators Tool (CAIT) Version 8.0. (Washington, DC: World Resources Institute, 2011).
Of all the sectors, the agricultural sector has been identified as being particularly vulnerable to climate change impacts. Decreasing water availability in the southern and western parts of the country, increases in the frequency and severity of storms causing extensive crop damage and soil loss, and seasonal shifts and the prevalence of pests and diseases are already affecting crop quality and production. In addition to the direct physical impact of climate change, the indirect impact of retailer pressure and consumer awareness have increased substantially in recent years, with many leading retailers launching aggressive GHG emission reduction initiatives and promoting locally-produced foodstuffs over imported goods.

It is against this backdrop that the South African Fruit and Wine industry has decided to take the initiative and develop an industry-wide response to climate change. The Confronting Climate Change project was initiated in 2008 with the aim of providing: 1) an information platform to inform the industry on climate change and related topics, 2) a transparent and open discussion network to assist the industry in deciding how best to deal with the realities of climate change, and 3) a united voice through which the industry can communicate and champion climate change issues and responses.

A central component of the project was the development of a freely available, on-line carbon calculator that is calibrated to the production processes of the South African fruit and wine industry and related supply chains. The calculator was successfully launched in September of 2009 and has since received positive interest and support, both locally and internationally. Although similar initiatives have been undertaken in other countries; this initiative is the first collaborative effort that has been attempted both across- and within-industry levels.

The next step in the Confronting Climate Change project process is the development of a strategic framework for the industry. This reference document aims to highlight the key findings of this collaborative industry process, through examples of GHG emission profiles and possible emissions abatement opportunities available to the industry, and outlining the role that both the individual entities and the industry as a whole can play in initiating meaningful action to mitigate against the future direct and indirect impacts of climate change on the local fruit and wine industry.

This document aims to provide the basic information necessary to

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**Table 1:** Top 25 Greenhouse gas (GHG) emitting countries based on Megatonnes of carbon dioxide equivalents (MtCO2e) figures as for the year 2000.

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>MtCO2e (MtCO2e)</th>
<th>% of World GHGs</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>6,928</td>
<td>20.6</td>
</tr>
<tr>
<td>China</td>
<td>4,938</td>
<td>14.7</td>
</tr>
<tr>
<td>EU-25</td>
<td>4,725</td>
<td>14.0</td>
</tr>
<tr>
<td>Russia</td>
<td>1,915</td>
<td>5.7</td>
</tr>
<tr>
<td>India</td>
<td>1,884</td>
<td>5.6</td>
</tr>
<tr>
<td>Japan</td>
<td>1,317</td>
<td>3.9</td>
</tr>
<tr>
<td>Germany</td>
<td>1,009</td>
<td>3.0</td>
</tr>
<tr>
<td>Brazil</td>
<td>851</td>
<td>2.5</td>
</tr>
<tr>
<td>Canada</td>
<td>680</td>
<td>2.0</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>654</td>
<td>1.9</td>
</tr>
<tr>
<td>Italy</td>
<td>531</td>
<td>1.6</td>
</tr>
<tr>
<td>South Korea</td>
<td>521</td>
<td>1.5</td>
</tr>
<tr>
<td>France</td>
<td>513</td>
<td>1.5</td>
</tr>
<tr>
<td>Mexico</td>
<td>512</td>
<td>1.5</td>
</tr>
<tr>
<td>Indonesia</td>
<td>503</td>
<td>1.5</td>
</tr>
<tr>
<td>Australia</td>
<td>491</td>
<td>1.5</td>
</tr>
<tr>
<td>Ukraine</td>
<td>482</td>
<td>1.4</td>
</tr>
<tr>
<td>Iran</td>
<td>480</td>
<td>1.4</td>
</tr>
<tr>
<td>South Africa</td>
<td>417</td>
<td>1.2</td>
</tr>
<tr>
<td>Spain</td>
<td>381</td>
<td>1.1</td>
</tr>
<tr>
<td>Poland</td>
<td>381</td>
<td>1.1</td>
</tr>
<tr>
<td>Turkey</td>
<td>355</td>
<td>1.1</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>341</td>
<td>1.0</td>
</tr>
<tr>
<td>Argentina</td>
<td>289</td>
<td>0.9</td>
</tr>
<tr>
<td>Pakistan</td>
<td>285</td>
<td>0.8</td>
</tr>
<tr>
<td>Top 25</td>
<td>27,915</td>
<td>83</td>
</tr>
<tr>
<td>Rest of World</td>
<td>5,715</td>
<td>17</td>
</tr>
<tr>
<td>Developed</td>
<td>17,355</td>
<td>52</td>
</tr>
<tr>
<td>Developing</td>
<td>16,310</td>
<td>48</td>
</tr>
</tbody>
</table>

Note: Data is for 2000. Emissions includes gases CO2, CH4, N2O, HFCs, PFCs, SF6, excluding emissions from land use change and forestry, and international bunker fuels.


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5 Pers comms with various industry members
6 See [www.climatefruitandwine.co.za](http://www.climatefruitandwine.co.za) for more details
7 The Australian Wine Carbon Calculator, International Wine Carbon Calculator, various New Zealand Fruit industry initiatives, to name a few.
understand the challenges posed by climate change in the fruit and wine industry, while at the same time pointing out strategies and solutions to start addressing these challenges. Given that this is the first round of industry analysis, it aims to provide the platform for future research and development.

The format of the document is as follows: Section 1 briefly introduces the global and local climate change political landscape. Section 2 explores the environmental scenarios and potential response strategies of particular relevance to the industry. Section 3 concludes the document by providing examples of emission profiles within the industry to highlight the key future research and development goals required to support sustainability in the industry (Section 3).

1.2. What is being done to curb the global emissions?

1.2.1 Background on international climate change negotiations

The Kyoto Protocol (KP) to the United Nations Framework Convention on Climate Change (UNFCCC) was established with the aim of "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". Adopted in December 1997, the Kyoto Protocol recognizes a 'common but differentiated responsibility' between parties, where developed nations (also called Annex 1 countries) are required to limit their net emissions to an average 5.2% below 1990 levels within the first commitment period (2008-2012). Developing countries (called Annex II countries), of which South Africa is one, are not 'capped' within the first commitment period. As the first commitment period of the Kyoto Protocol draws to a close at the end of 2012, global climate change policy negotiators are concentrating on a new post-2012 agreement.

Running alongside the emission reduction targets aimed at the Annex 1 countries and outlined in the KP, a separate mechanism of the working group on Long Term Co-operative Action (LCA) aims to reach a shared vision for all countries, including those in Annex 1, the USA, the middle- and low-income countries such as China, India, Brazil and South Africa (colloquially termed the BASIC countries). The working group is focusing on four main thematic activity areas: mitigation, adaptation, finance and technology.

The first real negotiations regarding a post-2012 climate change policy agreement started at the 15th Conference of the Parties (COP) meeting in Copenhagen December 2009. Although prior expectations regarding firm emission reduction target commitments were not met, the majority of parties did agree to the Copenhagen Accord (explored in a separate box below). The proposed Copenhagen Accord attempts to align these two mechanisms (KP and LCA), by effectively addressing the activity areas (mitigation, adaptation, finance and technology), and requesting signatory countries to commit to emission reduction targets and specific activities that can be measured and monitored. Maintaining the average temperature increase to below 2°C requires global emission reductions of between 40-45% below 1990 levels. Many suspect that even once all the pledges to the Accord have been submitted, the global reduction will fall short and leave the world heading for a warming of over 3°C by 2100.

Building on the Copenhagen Accord, the Cancun Agreements was signed by all countries (with the exception of Bolivia) at the 2010 climate change negotiations in Cancun Mexico (COP 16). This official UNFCCC document brought the main elements of the Copenhagen Accord (which was not an official document) into the formal UNFCCC process and locked in emissions reductions targets for more than 80%8 of global emissions, including China and the US9. In addition, the establishment of the “Green Climate Fund” was noted to be significant progress with richer countries committing to contribute as much as $100 billion annually to the fund by 2020. The Green Climate Fund is a financing mechanism aimed

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8 USCAN believes that countries accounting for about 87% of global emissions engaged with the Copenhagen Accord (see http://www.usclimatennetwork.org/policy/copenhagen-accord-commitments)
at providing assistance to poorer countries enabling them to mitigate and adapt to climate change impacts while developing in a carbon efficient manner. The world now looks forward to the subsequent COP meeting which is to be hosted in Durban during the first week in December, with the hope that a significant move towards agreement and finalization of post-2012 agreement will be made.

1.2.2. Closer to Home - National Policy Milestones

The South African climate change and environmental policies have moved forward considerably in the last few years. In 1994, a National Committee on Climate Change (NCCC) was established to advise Government on climate change related issues. In 2002, South African acceded to the Kyoto Protocol, thereby acknowledging and committing to a level of shared responsibility and to undertake national action that contributes to the global effort of reducing GHG emissions. South Africa’s first national GHG inventory was compiled in the late 90’s, based on 1994 data, and aimed at guiding early national climate change strategy. This inventory provided that basis for South Africa’s First National Communication to the UNFCCC in 2000 - ‘National Communications to the UNFCCC’ – which presents a means for each nation to communicate their national emissions as well as national climate change policy and mitigation and adaptation initiatives to the United Nations body. This information is typically used by global climate change policy makers and negotiators. Following the initial communication, a Second National Communication is currently being developed, based on updated national GHG inventory data as well as new climate change initiatives.

In 2004, the Department of Environmental Affairs (DEA) developed the Climate Change Response Strategy, a high level approach to the major predicted impacts of climate change on the country. This Strategy initiated the Department of Science and Technology (DST) Technology’s Needs Assessment for climate change in 2005 which resulted in a Cabinet endorsing a prioritised list of environmentally sound technologies. That same year, a National Climate Change Conference was held, which initiated the Long Term Mitigation Scenario (LTMS) research and development process (ERC, 2009). The process lasted two years (2006-2008) and has been since used to inform policy choices that aim to allow South Africa to aggressively tackle climate change in a way that allows for job creation and sustainable development. The LTMS process also formed the basis for the adoption of Climate Change Resolution at the ANC Polokwane Conference and the subsequent adoption of the peak, plateau and decline emission trajectory in to climate change policy at the 2008 July Cabinet Lekgotla. The emission trajectory indicates that the countries’ emissions are to peak between 2020 and 2025, plateau for about a decade, and then decline in absolute terms thereafter.

In October 2011, following on from the publication of National Climate Change Response Green Paper in 2010, the Department of Environmental Affairs (DEA) published the National Climate Change Response White Paper (NCCR WP). The DEA (2011a:5) emphasises that the NCCR WP is the culmination of a policy process that “involved ground-breaking modelling and research activities, two national conferences, numerous workshops and conferences in every province, hundreds of bilateral and key stakeholder engagements, a NEDLAC review and Parliamentary hearings”10. The NCCR WP aims to guide South Africa’s climate change response in a coordinated manner, and its overriding objective is stated as (DEA, 2011:11)11:

“South Africa will build the climate resilience of the country, its economy and its people and manage the transition to a climate-resilient, equitable and internationally competitive lower-carbon economy and society in a manner that simultaneously addresses South Africa’s over-riding national priorities for sustainable development, job creation, improved public and environmental health, poverty eradication, and social equality.”

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South Africa in the international negotiations

In December 2009 at the Copenhagen Conference of the Parties (COP) 15, South Africa made a commitment to undertake mitigation actions that would result in a 34% decrease in emissions by 2020, followed by a steeper 42% decrease by 2025\textsuperscript{12}. This statement was in line with the countries emissions target of a peak, plateau and decline trajectory, as outlined in the climate change policy plan of 2008. This commitment, however, is subject to the condition that secured international financing and technology transfer becomes available to assist South Africa to develop in a cleaner and more sustainable manner. This follows the acknowledgement of the need and commitment from the UNFCCC, to fast track funding to developing countries in the order of at least $10 billion a year until 2012 to enable developing countries to immediately plan and launch growth strategies aimed at moving towards low-carbon economies. Developing countries, however, need to indicate how they intend to raise the predictable and sustainable long-term financing and what their long term commitments would be.

South Africa’s plan is to adopt an integrated approach to adaptation and mitigation, and to improve the balance between development and climate imperatives. This is especially important as South Africa’s greatest development challenge is to ensure energy security and access to electricity, at the same time as laying a foundation to a low carbon economy – a conundrum since almost 90% of the nation’s electricity is generated from coal-fired power stations and this is likely to be the case for at least the near future.

“In the short-to-medium term, we have an immediate energy supply challenge, which alternative energy supply options cannot meet at affordable cost and at the scale needed, therefore, we are aggressively pursuing carbon-efficient coal technology, in the medium term.” the South African Presidency at COP 15, December 2009

Recognising the substantial funds required to kick-start the low carbon economy, South Africa has successfully applied to the Clean Technology Investment Fund (CTIF) – the multi-lateral funding mechanism managed by the UNFCCC – for an amount between $ 500 million to $1.6 billion in order to support the following technological developments:

- the establishment of a 100MW utility scale wind power generation;
- a 100 MW concentrated solar power plant;
- the conversion from electric water heating to solar water heaters for one-million households; and
- the scaling up of energy efficiency projects as leverage from commercial and industrial sectors.

It is now more important than ever that the government must be clear on climate policy and specifically, on the practicalities of implementing the policy. As host of COP 17 in Durban, and part of the influential BASIC grouping (Brazil, South Africa, India and China) - which was one of the main driving forces of the Copenhagen Accord – South Africa is expected to play a leading role in the international negotiations that commences at the end of November 2011 in Durban\textsuperscript{13}.

1.2.3. The Realities - Energy in South Africa

The recent 2010/11 budget speech highlighted that climate change and energy supply issues presented both challenges and opportunities for the country. Industries must be helped to manage scarce resources more efficiently and to reduce GHG emissions through the appropriate pricing of energy. The Budget speech followed the recent approval of South

\textsuperscript{12} Using current levels as the baseline
\textsuperscript{13} A summary of the BASIC grouping’s common position to the negotiations at COP17, agreed at a ministerial meeting in Beijing during November 2011, can be found at \url{http://www.indianembassy.org.cn/newsDetails.aspx?NewsId=267}. 
African power utility, Eskom’s, proposed electricity tariffs hikes of roughly 25% each year for the next three years. This equates to a Rand value increase per kWh 10c this year, and an additional 10c increase in 2011/2012, followed by an additional 13c/kWh increase in the 2012/2013 year. In total, this represents an approximate 300% increase since 2008, which will have a major impact on production costs and is therefore being strongly opposed by various sectors and industries.

In addition to the electricity price hikes, the 2010 Budget speech included a fuel levy increase of 25.5c/ litre which equates to roughly a R12.75 increase in price to fill a 50-litre tank. The 2011 Budget further increased the fuel levy by 10c/litre. Treasury has stated that the fuel levy is an attempt to cut carbon emissions from vehicle usage and promote fuel efficiency. Linked to this drive, Parliament announced that a flat-rate carbon emission tax was planned to become effective from September 1, 2010 and will be involuntarily imposed on all new passenger vehicles. 

The NCCR supports the use of a range of economic instruments to guide South Africa towards a low carbon future. In addition to carbon pricing (which is likely to put upwards pressure on energy costs), it also envisages the use of economic incentives to assist firms to cope with the costs of transitioning to a low carbon economy. While a number of incentives are already in place, the NCCR seems to suggest that the set of available incentives may be broadened. Current incentives are skewed towards tax incentives (like, for instance, sections 12K, 12L, 12I and 11D of the Income Tax Act of 1962), with limited direct grants being available for energy-related projects.

Direct grants that are available include: the existing grants include, amongst others, the critical infrastructure programme, which offers between 10% and 30% on infrastructure linked to investment projects; the Technology and Human Resources for Industry Programme (THRIP) whereby R1 of funding is provided for every R2 of industry funding to reduce the cost and risk of developing commercial technology, and the Support Programme for Industrial Innovation (SPII) - a fund administered by the Industrial Development Corporation which can be used to fund innovative technology and therefore potentially renewable and energy efficient technologies.

It is expected that the private sector is likely to shoulder much of the cost associated with South African’s transition to a low carbon economy and as such, it is the aim of these mechanisms to incentivize and assist businesses to develop carbon efficient systems in the near future. Carbon efficient production methods will be critically important to maintain the competitiveness of South African industry in a carbon-constrained world.

In a time such as this, it is imperative that businesses be educated on the facts, implications and opportunities brought about by climate change and energy use, and should use the currently evolving legislative environment to engage in the policy making process. In order to do so, business must assess their own climate change risks and opportunities internally, to ensure that the proposed legislative structure for carbon reduction is realistic and appropriate.

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14 See Section 2.1 for more details on the carbon tax
15 The Income Tax Act was amended in 2009 to make income from carbon credits or Certified Emissions Reductions (CERs) exempt from income tax
16 Section 12L allows firms to appropriate the full benefits or increased profit resulting from investments in energy efficiency, without being taxed on that profit. The Department of Energy released the regulations to operationalise this on 16 September 2011 for public comment. See Government Gazette No 34596 available [online]: http://www.polity.org.za/article/national-energy-act-342008-regulations-allowances-for-energy-efficiency-savings-2011-09-21.
17 Section 12l of the Income Tax act provides incentives for investments which correspond to industrial policy objectives such as skills development and energy efficiency. Tax allowances up to 55% are available against investments of R30 million (expansion projects) to R1.6 billion (new projects), based on a points system.
18 A tax allowance of 150% of expenditure incurred is provided in respect of technological research and development. Expenditure on energy efficiency and renewable energy technology would qualify for support, even though the incentive has no specific application to investments in renewable energy and energy efficient applications.
Companies should start addressing climate change related issues immediately, and all new projects should aim to qualify for carbon credits, capital grants and incentives, research and development tax allowances, and energy savings allowances.”  Duane Newman, Deloitte Tax director
The 'Copenhagen Accord' was developed during the December 2009 Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC). The Accord is a political document which emphasises the strong political will required to combat climate change, and accepts the scientific view that global warming should be kept below 2°C.

The development of the Accord was initiated by political leaders of the BASIC countries (Brazil, South Africa, India and China) and the United States senate and was eventually accepted by 188 of the 194 member nations (only Bolivia, Cuba, Nicaragua, Venezuela and Sudan refused the accord). Countries accounting for more than 87% of global greenhouse gas emissions subsequently ‘associated’ with the Accord (see footnote 8).

Of significance, the wording in several paragraphs of the Accord signified a shift in the recognition of the role of land-use change in tackling climate change, specifying the need for incentive-based mechanisms such as REDD plus (reduced emissions from deforestation and degradation in developing countries, with strong co-benefits for local communities) to "enable the mobilization of financial resources from developed countries". It also spelled out the investment required for developing countries to achieve the outlined targets, in the range of an initial $10 million outlay during 2010.

85 Countries, including all industrialised nations, submitted emissions reductions pledges under the Accord (UNEP, 2010)*. Some of the countries’ targets include:

- **South Africa**: a 34% decrease below current baseline by 2020, and a 42% decrease by 2025, subject to significant capital investment from developed countries.
- **EU**: The 2020 goals include a European Union goal of a 20% cut from 1990 levels, or 30% if other nations step up actions.
- **US**: President Barack Obama plans a 17% cut in US emissions from 2005 levels, or 4% cut from 1990 levels.
- **China**: said it will "endeavour" to cut the amount of carbon produced per unit of economic output by 40% to 45% by 2020 from 2005 levels. The "carbon intensity" goal would let emissions keep rising, but more slowly than economic growth.
- **Brazil**: a 36-39% emission reduction by 2020 which, if achieved, would bring Brazil's emission to their 1994 levels. In addition, they have committed to an 80% reduction in deforestation rates by 2020.
- **Australia**: 5-25% reduction below 2000 levels by 2020, depending on commitments from rest of world
- **New Zealand**: a 10-20% reduction (below 1990 levels) by 2020, subject to a series of conditions, including comparable cuts by other countries, and access to a broad and efficient carbon market.
- **Chile**: a 20% reduction below business as usual (from 2007 levels) by 2020.

A number of Non-Annex 1 Parties submitted emissions reduction targets that included agriculture. This may be an indicator that agriculture is likely to become an important component of Nationally Appropriate Mitigation Actions (NAMAs) in developing countries. Some of these submissions include:

<table>
<thead>
<tr>
<th>Country</th>
<th>Activities specified</th>
<th>Emission Reduction by 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>Restoration and conservation of pastoral land management</td>
<td>83-104 MtCO₂e</td>
</tr>
<tr>
<td></td>
<td>Improved livestock management</td>
<td>18-22 MtCO₂e</td>
</tr>
<tr>
<td></td>
<td>No tillage</td>
<td>16-20 MtCO₂e</td>
</tr>
<tr>
<td></td>
<td>Nitrogen fixing species</td>
<td>16-20 MtCO₂e</td>
</tr>
<tr>
<td>Republic of Congo</td>
<td>Conservation farming</td>
<td>Figures not specified</td>
</tr>
<tr>
<td></td>
<td>Nitrogen fixing species</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improved irrigation efficiencies</td>
<td></td>
</tr>
<tr>
<td>Ethiopia</td>
<td>Agro-forestry increased to</td>
<td>261,840km²</td>
</tr>
<tr>
<td></td>
<td>Soil sequestration on</td>
<td>80,000km²</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Improved peat land management</td>
<td>Figures not specified</td>
</tr>
<tr>
<td>Jordan</td>
<td>Restoration and conservation of pastoral land management</td>
<td>Figures not specified</td>
</tr>
<tr>
<td></td>
<td>Efficient fertilizer application</td>
<td></td>
</tr>
<tr>
<td>Republic of</td>
<td>Improve irrigation efficiencies</td>
<td>Figures not specified</td>
</tr>
<tr>
<td>Macedonia</td>
<td>Improved crop residue and animal waste management</td>
<td></td>
</tr>
<tr>
<td>Madagascar</td>
<td>Improved livestock management</td>
<td>Figures not specified</td>
</tr>
<tr>
<td></td>
<td>Introduction of fodder crops to reduce livestock management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Efficient fertilizer applications</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crop improvements</td>
<td></td>
</tr>
<tr>
<td>Mongolia</td>
<td>Improved livestock management</td>
<td>Figures not specified</td>
</tr>
<tr>
<td></td>
<td>Increase agro-forestry capacity</td>
<td></td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>Activities not specified</td>
<td>15-27 MtCO₂e</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>Conservation farming</td>
<td>Figures not specified</td>
</tr>
</tbody>
</table>

(Source for table: UNFCCC listing at time of writing- see [http://unfccc.int/home/items/5262.php](http://unfccc.int/home/items/5262.php)

The Copenhagen Accord was never a formal UNFCCC document, since the parties merely “took note” of rather than formally agreed it as an outcome of COP15. This created a lot of uncertainty in the international climate change negotiations. The Cancun Agreements, the formal outcome of COP16 in Mexico, provided certainty on a number of important issues that will form the basis for the negotiations at COP17 in Durban.

The Agreements:

- Formalised key elements of the Copenhagen Accord within the UNFCCC process, including:
  - Recognition of the target of limiting the average increase in global temperatures to a maximum of 2°C above pre-industrial levels;
  - Support for a ‘Green Climate Fund’ that will channel the majority of the USD 100 billion per year (the portion related to funding adaptation – and possibly also mitigation) that developed countries promised to mobilise by 2020;
  - The promise by developed countries to mobilise USD 30 billion for the period 2010-2012 as ‘fast-track finance’ (giving priority for adaptation funding to least developed countries, Africa and small island developing states);
  - Recommendations made by the High-Level Advisory Group on Climate Change Financing, including recommendations on new sources of public finance as well ways of using public finance to leverage private finance.
- Initiated a ‘Cancun Adaptation Framework’ that would assist least developed countries to develop and implement national adaptation plans with financial, technological and capacity building support from developed countries.
- Urge developed countries to increase emission reduction ambition and require them to report more frequently and in an improved and standardised way on their emissions reduction efforts.
- Advance the issue of emissions reduction efforts in developing countries through the creation of a centralised registry aimed at compiling ‘nationally appropriate mitigation actions’ (NAMAs) that can be matched with developed country financial, technological and capacity building, Consensus was also reached regarding the extent to which the effectiveness of NAMAs should be subject to international scrutiny through MRV (measuring, reporting, verifying).
- Advance REDD plus (reducing emissions from deforestation and forest degradation) by agreeing what constitutes REDD plus activities and how REDD should be measured, and outlining how important issues relating to conservation of biodiversity and natural forests and rights of indigenous people should be dealt with.
- Call for the development of new market mechanisms (including the continuation of the CDM under the Kyoto Protocol and the addition of scaled-up versions of the CDM like programmatic CDM or sectoral approaches)
- Establish, under the guidance and fully accountable to the COP, a formal Technology Mechanism under the Convention, to support the development, deployment and diffusion of climate-related technologies in developing countries.
- Endeavour to avoid a gap between the first and second commitment period of the Kyoto Protocol

The 17th Conference of the Parties (COP17) took place in Durban during December 2011. Although much scepticism surrounded the event, the outcome was generally seen as being a success on most fronts, with many strong statements of collaboration and commitment coming from countries previously excluded from the negotiations. Most notably, the following progress was made during the 2 week long negotiation period:

- The EU showed support of the extension of the existing Kyoto Protocol until 2020, from when the second commitment period officially begins.
- The treaty associated with the second commitment period (called Kyoto II) will be agreed upon and signed by 2015 and will come in to force from 2020.
- The new agreement will, for the first time, include emission targets for both developed and developing countries.
- The United States, previously opposing, is now positively involved and in support of a new international legally binding agreement.
- Two major emitters, India and China, agreed on a deal to be signed by 2015 that will put a cap on emissions post-2020.
- Following suit, South Africa and Brazil also agreed on a deal to be signed by 2015 to cap their own emissions from 2020.
- Australia and New Zealand have also committed to being part of the new treaty, from 2020.
- This means that all countries, specifically the major developing countries responsible for large emissions such as India and China, and the developed US, are now committed to working together in addressing global climate change through emission reduction targets.
- The Green Climate Fund, set to be valued at $100 billion per year by 2020, is now operational with South Korea providing the initial capital funding.
- The CDM market (Clean Development Mechanism) now includes Carbon Capture and Storage (CCS) and Reduced Emissions from Deforestation and Degradation (REDD), thereby expanding the portfolio of projects that can be funded through the financing structure.
- The AdHoc Working Group on the Durban Platform for Enhanced Action is the new body established to negotiate the global agreement.

While the above points show positive steps towards a global agreement, scientists warn that delay in concreting emission reduction targets will make meeting the 2°C warming (the initial goal of the Kyoto Protocol) nearly impossible. The predictions show a 3.5°C warming is more likely, bringing with it devastating impacts on food security, human health and ecosystem functioning, to name a few.

The next COP (COP 18) is to be hosted by Qatar, an environment already stretched well beyond its natural limits. Let’s hope the context will bring home to the negotiators the urgency required for meaningful and mandatory emission reduction commitments from the global arena at large.

# SECTION 2: Climate change impacts and possible responses

<table>
<thead>
<tr>
<th>Highlights of this section:</th>
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<tbody>
<tr>
<td>- The most prominent biophysical impacts of climate change on the South African agricultural sector include a decrease in water availability, a shift in seasonal temperatures and climatic patterns, an increase in the prevalence of pests and diseases.</td>
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<tr>
<td>- The indirect impacts of climate change are equally threatening and include an increase in energy and fuel costs, an increase in market pressure and retail demands, and the likelihood of carbon pricing in the near future.</td>
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<tr>
<td>- Possible responses to these impacts depend on the availability of resources such as knowledge, technology and available finances.</td>
</tr>
<tr>
<td>- Although southern Africa has a relatively low coping capacity, the culture of agricultural production has a long history of adapting to a changing environment and is therefore relatively well resourced to survive the impacts, provided both mitigation and adaptation action is taken.</td>
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</tbody>
</table>

Southern Africa has been identified as one of the most vulnerable regions in the world due to a relatively low capacity to respond to climate change. The agricultural sector and related industries, being so integrally dependent on micro- and macro-climatic conditions, are therefore particularly exposed to the impacts of a changing climate.

This section highlights the prominent and likely impacts on the South African fruit and wine industry. The information provided is intended to describe scenarios that could face the industry in the near future. It also explores response options at an individual and industry level, outlines target areas for research and development, technology transfer, and policy engagement.

The following key potential impacts are described:

- Impact 1: Changes to regional climatic patterns
- Impact 2: Changes in distribution of pests and diseases
- Impact 3: Changes in energy and fuel prices
- Impact 4: Increase in market pressure
- Impact 5: Impact of carbon pricing

For each impact, the following questions are explored:

- What to expect?
- What can I do about it?
- What role can industry play to support?
- How are others adapting?
- Where can I find more information?
The information is based on popular and scientific literature as well as practical case-studies from within the industry. The aim is to assist industry stakeholders in understanding specific impacts that are important to their region and production systems. Thereby enabling industry to initiate internal strategies that better address climate change related issues.

"South Africa is already a water-stressed country and we face future drying trends and weather variability with cycles of droughts and sudden excessive rains." National Climate Change Response White Paper 2011

2.1 Impact 1: Changes to regional climatic patterns

What to expect? 19

A decrease in water availability, specifically in the southern and western parts of the country: CESA (Consulting Engineers South Africa, February 201020) predicted that South Africa’s demand for water will exceed available supply by 2025 if no alternative action is taken. The National Climate Change White paper released in 2011 goes further, and mentions that current projections indicate that by 2050 South Africa will exceed the limits of economically viable land-based water resources21. This dire prediction is supported by more recent research showing that South Africa is expected to have a 6% water supply deficit by 2013 and a further 11% deficit by 201922. According to the predictions described in the National Climate Change Response Strategy (2004), net water requirements for crops in the summer rainfall region are projected to increase by between 10 and 30% by 205023. The southern part of South Africa that is home to some of the major fruit and wine growing regions of the country is expected to receive less rainfall with less predictable times during key seasons. According to the Climate Change Strategy and Action Plan for the Western Cape24, the water resources of the region are under threat from a variety of factors including: an overall reduction in annual rainfall, salt-water intrusion in groundwater tables due to sea-level rise, increased water demands from both agricultural and urban development, and increased evaporation rates as a result of increased warming and drying. Some models for the region suggest a decrease in winter rainfall of as much as 10% over the next few decades25. This drying trend has a direct effect on the frequency and intensity of fire events – currently wildfires are occurring nearly twice as often in the Western Cape in comparison to thirty years ago – and this trend is likely to continue7.

20 Engineering News Article: http://www.engineeringnews.co.za/topic/consulting-engineers-south-africa
24 Department of Environmental Affairs and Development Planning (DEADP) 2008. Available at: www.capegateway.gov.za
Increased frequency and intensity of extreme events: The National Climate Change Response White Paper highlights that while the net effect of climate change on water availability is relatively uncertain, this is not the case with respect to extreme weather events. Rainfall is likely to become more variable, which will lead to an increase in extreme weather events like flooding and droughts - resulting in a much more variable runoff regime. According to the World Health Organisation, droughts and floods affect more people than all other natural disasters combined. China has experienced recent flooding and landslides, and earlier this year south-western China was hit by extensive drought, described as the worst in a century. The Beijing climate centre says extreme weather events have increased in recent years, with longer droughts and rain falling in more intense and damaging bursts. Pakistan’s monsoon floods have been described as the worst since 1929, and the recent heat wave in Russia during their summer raised temperatures as high as 42°C in Moscow and St Petersburg leading to over 600 run-away fires covering an estimated 125,000 hectares. Southern Poland has suffered its worst flooding in decades during May this year, and the UK has experienced the driest first 6 months of the year since 1929, followed by exceptionally warm and dry summers. On the African continent, Niger has been highlighted as being the worst affected country, with over 7.1 million people suffering from hunger due to the extensive drought, preceded by last year’s exceptionally heavy rainfalls which destroyed the current season’s crops, intensifying the food shortages in the country.

Regions all over South Africa have experienced significant floods in recent years (Western Cape, 2006/2007, KZN in 2007, Eastern Cape in 2007/2008, Gauteng in 2009/2010) as well as extended drought periods (KZN 2009/2010). The cost of rebuilding the infrastructure incurs a great cost to government and private land/home-owners alike. Significant amounts of soil erosion occur during flash floods, the value of which cannot be fully recovered with fertilization and man-made processes. The variability of the rainfall events impacts the water table recharge capabilities and increases the reliance on irrigation systems. Current infrastructure and storage capabilities may not be suitable to cope with the intensity and/or frequency of rainfall, resulting in excessive water run-off (wastage) and damage to infrastructure. The predictability of seasonal rainfall patterns is also expected to change, which will have a major impact on agricultural production.

27 The World Health Organisation publication available at http://www.who.int
Figure 1: Predicted changes in temperature and precipitation for Africa generated by the MMD-A1B simulations. The top row depicts changes in temperature and the second row illustrates predicted changes in rainfall over the annual, summer (DJF-December, January, February) and winter periods (JJA- June, July, August). The change is calculated between 1980 to 1999 and 2080 to 2099 and averaged over 21 models. The change in temperature is expressed as a change in degrees Celsius, whereas the change in precipitation is expressed as a percentage to avoid the calculation of nonsensical negative values (source IPCC 2007).

Seasonal pattern shifts and general warming: Temperature extremes, both hot and cold, have a significant impact on agricultural production. Evidence indicates that in the past four decades, South Africa is not only getting hotter, but that the number of warmer days during autumn, winter and summer are increasing\(^29\). Higher temperatures increase evapotranspiration and amplify the demand for irrigation. This trend has been recorded across most of the country, particularly within the Western Cape, as well as large proportions of the Eastern Cape, Northern Cape and Free State. The frequency of frost events appears to be declining, particularly in the Northern Cape, Free State and Gauteng regions\(^8\). In addition, the same study indicated that in the majority of regions (Northern Cape, Eastern Cape, Free State, North West and Mpumalanga) the length of the frost season has decreased (i.e. an earlier date of the last frost event), indicating an earlier commencement of the growing season. For the fruit-growing regions, the Western Cape in particular, has experienced mean warming of around 1°C in all seasons, rising to more than 1.5°C in some months since the 1970s, notably in autumn and spring. This has resulted in a significant reduction in the frequency of chill units (-26%, Midgley and Lötze, unpublished), and has possibly contributed to increased heat stress and sunburn on fruit surfaces\(^7\). Fruits such as apples and pears are highly vulnerable to a change in chill units, especially in warmer production areas.

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Citrus, stone fruit and grapes are less vulnerable to warming. All fruit species however are vulnerable to heat stress during critical fruit development periods during pollination, bud burst, fruit set and harvest, and such events can lead to low cropping.

Potential immediate effects of temperature and seasonal changes include:

- Fruit quality damage due to sun spots and sun-burn has been increasing over the past few years as a result of higher temperatures during ripening periods.
- Temperature shifts during budding periods causes premature flower set which is then vulnerable to later chill spells.
- There has been an increase in dry season veld fire events, particularly in the South Western Cape and KZN, which has lead to an increase in crop insurance requirements and costs.
- Due to the predicted increase in evaporation of between 10-20%, soils are predicted to become drier, which will increase the demand for supplementary irrigation to avoid plant stress and decreased crop yields and quality.

*Figure 2a-c:* Diagram illustrating the manifestation of increased mean temperatures as well as increased variance in temperature. Such a pattern ultimately leads not only a shift in the mean temperature but also a shift in the probability and intensity of extreme events such as droughts, heat-waves or floods (IPCC 2007).
WHAT CAN WE EXPECT FOR THE WINE INDUSTRY?

**Summer temperature increase during the growing season**
- Warmer September = better and more even budding
- Warmer spring/early summer = better fertility
- Warmer flowering period = depending on regions and cultivars, set can be better or worse
- Warmer harvesting period = sunburn grapes, quick sugar accumulation, lower acid — vines under stress during the harvest period, more irrigation required, weak colour expression with some red cultivars, lack of character expression with certain cultivars (red & white)

**Winter temperature increase during dormant season**
- Sooner uplift of dormancy
- Higher temperature during May/June causes delayed budding

**Rainfall**
- Dry spring = Control growth of vigorous growing cultivars better, control berry size
- Dry summer = Less disease problems (Botrytis, more irrigation requirements, low production for dry land
- Dry winter = Not enough irrigation water, less rainfall in mountain ranges to fill dams, competition with other crops for limited irrigation

**Possible positive climatic aspects**
- Dry conditions before and during harvest
- Limited rainfall during flowering
- Enough sunshine hours
- Winters in continental regions are colder than near the coast

**Cultivar adaptation to climate change:**
- Both rootstock and scion cultivar selection should be site specific to best respond to climate change (increased temperature, less availability of water, changes in pest and disease patterns, etc.)

**Winery adaptation to climate change**
- Improved insulation and heating/cooling exchanges will reduce the energy requirements
- Utilize gravity-fed systems where possible to minimise energy-intensive pumps
- Installation of solar panels which, depending on the scale, can supplement or completely replace the reliance on expensive and carbon-intensive grid-electricity for both heating and cooling requirements, resulting in cost and carbon savings and allowing a relatively fast pay-back rate of 5 to 10 years.

Sources: Pers comms from several industry experts: J. Booysen (Winetech), J. Rossouw (Distell), J. Wiese (presentation at Wine Info Day, 2009)
What can I do about it?

Although individuals may not be able to alter the geographic or climatic conditions that reflect South Africa’s natural water supply, much can be done on an individual scale that will lessen the load on the limited resource. With more than half of the South Africa’s water supply being used by irrigated agriculture, there is great pressure on producers to increase efficiency in their systems. Agriculturalists have a long history of dealing with climate variability. The use of traditional and new techniques and technologies can assist individuals in adapting to the changing weather patterns.

Be aware of the predicted changes within your region and stay informed as to how best to adapt your current practices by liaising with scientists and local agricultural specialists.

Regular monitoring of water usage and soil moisture content will enable a better understanding the precise water requirements of your crops and can prevent excess water run-off, leaching of nutrients and downstream water pollution. In addition, utilizing the most efficient water distribution models of irrigation best suited for the specific environment and crop conditions will reduce water wastage. Irrigation water loss through current agricultural irrigation practices in South Africa is recorded to be as high as 30-40%. This is higher than the global averages of 15% for on-farm distribution losses and 25% for on-field application losses\(^3\). Much of the water that is irrigated is not absorbed by the roots effectively and returns to the river systems by overland flow or return seepage. This return water is often highly polluted with herbicides, pesticides and nutrients which can be detrimental to the water quality downstream.

Enhancing drought resistance in soils through soil conservation techniques such as improved soil organic matter (SOM), of which carbon is the primary component, results in enhanced water and nutrient holding capacity and improves soil structure\(^3\). With the predicted increased frequency of droughts and extreme events such as flooding, increasing the soils capacity to capture and store water will go a long way in reducing run off and soil erosion as well as decreasing the reliance on irrigation and reducing fertilizer requirements. Studies have shown that improving the organic matter content by just 1%, can increase water storage capacity by 3.7% (equivalent to roughly 24,000 litres per hectare)\(^3\). Reducing the amount of exposed land through cover-crop and ground-cover utilization also increases the water infiltration rate while lowering soil water evaporation and enhancing the natural microbial activity within the soil.

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\(^3\) National Sustainable Agricultural Information Services: [www.attra.ncat.org](http://www.attra.ncat.org)
Be responsible with your ground water reserves. Ground water plays a pivotal role in water availability in South Africa and ineffective or illegal abstraction of this finite resource increases the risk of water shortages in future. Dam building, river channelling or borehole construction should be done through the appropriate legislated processes and approved through national or regional authorities. The goal of this process is to ensure that adequate quantities remain for both current and future downstream requirements. Should the processes in place not be adequate, policymakers should be engaged through industry bodies to have these systems improved.

Reduction of water consumption and reuse of grey water on site will not only assist in increased water availability, but will decrease water pollution, thereby increasing water quality and decreasing the financial cost of fresh water supplies. Many wine farms in the Western Cape have water treatment facilities such as effluent reed bed filtration systems, which recycle all the effluent and waste water from their wineries, homesteads, offices, workshops and restaurants. Once treated, the water is stored in an irrigation dam and used when demand requires. Although initially capital intensive, implementing such a system makes financial sense when weighed against proposed increased water tariffs hikes and increased water availability risks.

Design your water trapping and storage facilities to be aligned with natural water flows and drainage as much as possible. Increase your water storage capacity by using additional rain water tanks for example, to allow for increased variability, thereby reducing your risk of during the dry season.

Get involved with research. Much work is still needed to fully understand just how the South African agricultural industry can deal with the impact of water scarcity. This is highlighted by the fact that the National Climate Change Response White Paper lists one of the priorities for building resilience to climate change in agriculture as increasing investment in and improving research into nutrient, water and soil conservation technologies and technologies. Be innovative and experimental in the way you store, conserve and use your water, and utilize existing research programmes to pilot your methods.

The Cape Land Use Expert System (CLUES) is a web-based tool, developed by the University of Stellenbosch, and integrates GIS software with climate change data and modelling. It is not yet freely available, but is worth keeping an eye out for as a useful tool for regional crops vulnerability assessment under certain climate predictions. The Department of Geography and Environmental Studies plans to make the system available in the near future – visit their website to keep up to date: http://www.sun.ac.za/geography/

Some additional adaptive measures include:

- Calculating water supply and demand conservatively in order to be able to cope with possible restrictions
- Using protection against excessive heat such as shade structures and companion plantings
- Choosing suitable sites to meet the chill unit requirements
- Utilize plant breeding and genetic research (rootstocks and cultivars) when selecting cultivars that would be suitable in projected conditions (i.e. more drought tolerant), and that require low/lower input (i.e. have a lower carbon footprint and are more marketable)

See Appendix 1 for a more comprehensive list of adaptive measures for the fruit industry (Table 1a)

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34 http://scholar.sun.ac.za/handle/10019.1/1360 - Developed by student: Adriaan van Niekerk
What role can Industry play to support?

While individuals can physically improve water efficiencies at their homes, in their business and on their farms, industry bodies need to play the role of communicating the relevant water issues to policy makers, specifically highlighting the needs required to deal with these issues. There are no viable options to increase water supply in South Africa in the short to medium term, therefore demand management through water pricing is currently considered the only response strategy open to government. The Industry bodies’ input in this process is vital in order to result in an appropriate pricing strategy that evaluates water consumption within the industry effectively without excessively penalizing certain users while exempting others.

Get involved through Water User Associations (WUAs) to initiate technological improvements. The legal requirements of the National Water Act , 1998 (Act36 of 1998), state that in order to successfully manage and licence water use, it is necessary to verify water use. While there is definite interest from producers to implement water measurement, overnight introduction of appropriate water monitoring is neither economically nor physically possible. Water user associations are responsible for supervising and regulating the distribution and use of water according to the relevant water use entitlements. Being members of WUAs, producers can get involved and initiate the utilization of acceptable measuring techniques specific to each region.

Producers introduce practices at a local or micro level, based on physical climate considerations and within fairly short term time frames. It is the role of industry to inform government on the appropriate practices to implement at a national scale, taking into account more long term changes in climate, market and political conditions.

Promote research and development (R&D) at a regional scale, together with industry-wide capacity building, on effective ways to adapt to a changing climate. The following considerations have been highlighted as priority areas for research and development:

1. Identify priorities – these will differ between crop types and sub-regions, depending on crop sensitivities and current and projected climate risk on a local level
2. Take a risk reduction and risk management approach, in the face of uncertain climate futures
3. Identify resources and capacity (scientific, technological, financial, consultants), and gaps
4. Start with the “low-hanging fruit” - in the short-term, adaptation responses should be aimed at the best possible cost-benefit ratio and ease of implementation
5. Simultaneously, initiate and support sustained R&D towards longer-term adaptation requirements, such as breeding and new crops.
6. Ensure continuity as some R&D for climate change adaptation requires a long-term commitment, for example in terms of staffing and funding
7. Develop monitoring and evaluation programs as well as predictive capacity to ensure that strategies are effective
8. Develop good communication and R&D collaboration (synergies) with the wider agricultural sector and other sectors, for example water resources.
9. Keep up to date on market and trade dynamics in a changing world and study the implications of any changes
10. Work with banks and insurance companies to develop innovative approaches and products in support of climate change adaptation, and support to farmers following crop losses
11. Work with suppliers, for example the agro-chemical industry, to help develop products in support of adaptation needs
12. Develop agro-climatological capacity for the fruit industries, and value-add of information

35 According to State of the Environment - South Africa: Fresh Water Systems and Resources: Responses, desalination is currently too expensive and importation of water supplies from neighbouring countries has large political implications.
Whilst maintaining and further developing research and development capacity in South Africa, strategic alliances with overseas agricultural researchers and industries will become increasingly important. Particularly in the fields of breeding and evaluation, and other long-term and costly research programmes, targeted information exchange can fast-track adaptation.

**How are others adapting?**

The **Australian government** has recognised the importance of water conservation in the face of global climate change and has implemented an AUS $10 billion *Water for the Future* programme that includes several on-farm irrigation efficiency projects\(^{37}\). As part of the adaptation measures planned, specific focus is on assisting irrigation water providers (both public and private) to develop modernisation plans and upgrading of irrigation infrastructure at a water basin and/or district level. Through the initiative, payment is provided to the irrigation water providers to implement relevant water efficiency technologies including, amongst others, desalination, water recycling, improved irrigation and storm-water harvesting technologies. As part of the agreement, a portion of the water savings must be returned to the local government for municipal use.

Predictions for the **United States** forecast as much as an 81% decline in wine grape production throughout the winegrowing areas in this century as a result of climate change\(^{38}\). In response, the California Sustainable Wine Growing Alliance and Partners have initiated several projects which address irrigation, tillage, cover crop management and the role of carbon footprint assessments\(^{39}\).

**Where can I find more info?**

**South African National Water Research Commission** ([www.wrc.org.za](http://www.wrc.org.za)) publishes a variety of different information documents, from policy briefs to media releases and freely available software.

**The Department of Environmental Affairs** has several useful documents available on their website ([www.environment.gov.za](http://www.environment.gov.za)), specifically the report on the *State of the Environment – South Africa: Fresh Water Systems and Resources* which highlights over-arching issues related to environmental resource management in South Africa.

**The National Weather Service Climate Prediction Centre** offers regional maps including total precipitation, minimum and maximum temperatures and temperature anomaly on a weekly, monthly or tri-monthly timeframe. ([http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/africa.html](http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/africa.html))

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\(^{39}\) [www.sustainablewinegrowing.org](http://www.sustainablewinegrowing.org)
THE PRICE OF WATER

The major challenge for the producers is to effectively find ways of producing the same quality of product with less water, or preferably increase production per unit of water.

More crop per drop

Historically, water has been undervalued and not priced according to full service prices, which is the complete cost of getting potable water to the consumers tap. Despite plenty of public debate and as yet, no clear strategy forthcoming from the Department of Water Affairs and Forestry, the sign indicate that the current pricing system is due to change. And significantly so for both the private and industry consumer.

Both internationally and locally, the integrity of drinking water and wastewater infrastructure is at risk without a concerted effort to improve the management of key assets – such as pipelines, treatment plants, and other facilities – and a significant investment in maintaining, rehabilitating, and replacing these assets. Reports in the press have stated that over 60% of our dams are at toxic levels as a direct result of ineffective wastewater management and increased nutrient levels. The South Africa government estimates that R30 billion will need to be spent on all water infrastructure over the next few years and that the focus will be on building seven new bulk raw water augmentation projects between 2010 and 2014. In addition, four “special water courts” are to be set up across the country and would run as pilot projects from next month in a bid to crack down on those who committed water abuses. The State-owned Trans-Caledon Tunnel Authority (TCTA) has stated that over the next two decades there will be a substantial shift in emphasis away from merely building new dams that increase water supply to projects that improve the efficient use of water. The test will be in finding a cost-effective balance between demand and supply.

HOW MUCH?

In the of April of 2010 there was significant talk throughout all industries of the proposed water tariff increases for potable fresh water as some reports mentioned a increase as much as 43%, depending the municipality. More recently, a 9% average increase has been confirmed, which is in keeping with inflation. The range of increases stated was from 6.2% for the tropical region of Umgeni Water (a price increase from R3.24 to R3.47) to 43% in the water scare Namakwa municipality (a price increase from R6.37 to R9.11).

It is difficult to evaluate the full extent of that the water pricing will have on the fruit and wine industry until exact figures are finalized. One local scenario based study found that an increase in the water user charges causes a shift of crop choice from field crops to high value horticultural crops. This was due to the fact that horticultural crops were able to buffer the cost increases and thus the irrigation requirements did not decrease with an increase in water price. The study, however, was exploratory. The reality of the water tariffs is still to be seen. What is clear is that there will be a price increase and that this increase will cause substantial cost implications for heavily irrigated crops, particularly in a warming climate as is predicted.

i) Statement made by Minister of Water Affairs, Buyelwa Sonjica. Documented in Engineering News, August 13-19, 2010
ii) Farmers Weekly article, Author Sean Christie, 24 September 2010
iii) Several media reports during April/May 2010
2.2 Impact 2: Changes in distribution of pests and diseases

What do we expect?

The impact of climate change on pests and disease outbreaks is difficult to predict because it involves changes in both the vigour of the predator and the vulnerability of its host. Predictions show that certain pests and diseases associated with specific crops may increase in their distributional range, and may become more active, with an increase in temperature. In addition, the short life cycles of insects, their mobility, high reproductive potential and sensitivity to temperature means that even small changes in climate can result in a rapid and prolific response.**

Increased levels of atmospheric CO₂, coupled with increased temperatures, may increase the growth of certain weed species and/or reduce the nutritional value of the plant tissue.** Therefore, on the one hand some insects may need to eat more to develop, which may result in increased damage levels on crops. On the other hand consumption may not increase and the performance of the insect may decrease leading to less damage.

It is predicted that with the temperature increase, insect pests with a distribution from sub-tropical to Mediterranean climates will become more serious. These include bollworm, Helicoverpa armigera, Mediterranean fruit fly, Ceratitis capitata, false codling moth, Thaumatotibia leucotreta, and possibly antestia stink bug, Antestiopsis orbitalis. If this is accompanied by a drier climate pests like two-spotted mite, Tetranynchus urticae, will also become more of a problem.

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However, pests like Natal fruit fly, *Ceratitis rosa*, which seems to be limited by low humidity, will become less of a problem, as will pear leafroller, *Epichoristodes arcebella*, which cannot tolerate high temperatures. Local expert experience\(^42\) has found that codling moth, *Cydia pomonella*, becomes a lot more difficult to control during hot seasons. In addition the pheromone dispensers used for mating disruption become depleted before the end of the season, leaving the fruit exposed to late season infestations.

In addition, the efficacy of control methods is likely to be affected by climate change. For example, the number of days that will be suitable for spraying is likely to increase in areas of increased dryness and decrease in the wetter regions. The predicted increase in rainfall may result in an increase in herbicide and fungicide requirements, while the increase in temperature may mean more insecticide is needed to combat the increased pest numbers\(^43\). The increased application rates may cause some invertebrate pests to become resistant to certain chemicals\(^44\) and will impact the natural enemies within the local ecosystem, further exacerbating the problem. Changes in temperature could affect the synchrony between herbivores and their natural enemies\(^45\). Extinction of the natural enemy could occur if it appears before the host is present, and the pest could escape biological control if its population increase precedes that of the natural enemy\(^37\). An example of this is the woolly apple aphid, *Eriosoma lanigerum*, which is attacked by a parasitic wasp, *Aphelinus mali*. The parasitoid can tolerate higher temperatures than the woolly apple aphid. Therefore, increases in temperature may favour biological control in this instance. However, hot, dry conditions are detrimental to microbial biological control agents such as fungi, viruses (used against codling moth at present) and nematodes\(^36\).

This change costs money. On an active ingredient per hectare basis, this increase in chemical input requirements translates to as much as a 60% increase in input costs\(^46\). The external costs in terms of the indirect costs like human health, water contamination, destruction of beneficial organisms should increase for all three classes of pesticides (fungicides, insecticides, herbicides), but the highest increase is predicted to be for insecticides. This increase in external costs due to insecticides is predicted to be highest on pome fruits, berries and stone fruits in that order\(^38\).

**What can I do about it?**

Agricultural ecosystems serve as important habitats for many biological control agents which can maintain the pest/crop balance. **Utilizing integrated crop management practices** which incorporate a wide portfolio of measures such as soil and nutrient management, crop choice and protection, biodiversity enhancement, together with water, energy and landscape management, can improve the health and functioning of the ecosystem and reduce the risk of pest invasions. Many studies in invasion biology have shown the early precautionary action is considerably more efficient than waiting to eradicate established alien invasive species and pests. The establishment of **appropriate monitoring systems** aimed at providing early warning of pest and diseases is therefore prudent.

**Keep in touch with the latest research** to ensure your pest control practices are optimal and are not exacerbating the problem (through over use of agro-chemicals, for instance). Follow any available forecasting models on diseases and pests, which will assist in addressing key response strategies based on high-risk trends.

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\(^{42}\) Dr. K. Pringle. University of Stellenbosch. klp@sun.ac.za


What role can Industry play to support?

Industry bodies can play a role in the promotion, standardization and monitoring of pest, weed and disease-control programmes. In addition, the prioritization of prolific or newly identified species should be pushed to the forefront of research programmes within the various research institutional industry organisations as soon as identified or outbreaks are suspected.

Lessons learnt and information services should be expanded through the current models of training and communication that exist within the industry, such as the extension officer networks.

How are others adapting?

An unanticipated outbreak of Mediterranean fruit fly during the 2010 season was recorded at South Brighton, Australia threatening certain pome fruit species during critical harvesting period. A 1.5 km quarantine area was declared around the detection site and the removal of any fresh fruit or vegetable within the area was banned to avoid further threat to the $480 million fresh fruit and vegetable industry. PIRSA Biosecurity Compliance and Surveillance manager Bruce Baker reported that the plan was to implement a two-week program of organic bait spotting, followed by the release of sterile fruit flies into the area. The full eradication program was anticipated to take 12 weeks.

In 2002, Pierce’s Disease caused $13 million worth of damage to the Californian grape industry within the Riverside County alone. The outbreak was due to the fact that the northern and coastal grape-growing regions, which in the past experienced sub-optimally cool temperatures for Pierce’s Disease, is increasingly experiencing warmer temperatures conducive to the Disease. Moreover, the glassy-winged sharpshooter, is a vector of Pierce’s Disease whose range has expanded due to warmer temperatures, spreading the threat to not only the grape industry, but almonds, citrus, peaches and plums as well.

In California, several crop disease models have been developed and are in use. Downy mildew in lettuce is an example of a disease whose incidence can be predicted by a very simple model; morning leaf wetness after 10 a.m., influenced by low midday temperature and high relative humidity, directly affect disease incidence. For powdery mildew on grapes and tomatoes, interactive risk assessment and forecast models are currently available through the University of California Integrated Pest Management Program. It has been found that fungal mildew is closely linked to temperature and precipitation, with severe disease outbreaks occurring in relatively wet winters with mild temperatures. Esca, a fungal disease in California table and wine grapes, appears to respond to above-normal rainfall and summer temperatures. Several other crop disease climate models have been developed for the area, including fire blight (apple and pear), scab (pear) and brown rot (stone fruit).

Where can I find more info?

The Council for Scientific and Industrial Research (http://www.csir.co.za/) and the Agricultural Research Council (http://www.arc.agric.za) are the two leading scientific and technology research bodies that are actively involved in pests and disease research in collaboration with the Department of Agriculture. The Department Conservation Ecology and Entomology at Stellenbosch University (http://www.sun.ac.za/) is also involved in several research programs linking pest prevalence with climate change, as well as the development of Integrated Pest Management programmes for various crops.

47 Fresh Plaza, www.freshplaza.com, March 2010
The University of California State-wide Integrated Pest Management Program covers extensive IPM programs for the main agricultural and horticultural crops, including avocados, citrus, stone fruit, pome fruit and grapes (http://ipm.ucdavis.edu/).

Mitigating the impacts of invasive alien species, a research report compiled by Moses T.K. Kairo and Julien Lamontagne-Godwin, highlights some of the global issues surrounding invasive alien plants, specifically those with great impact on agricultural systems. It is available at: http://knowledge.cta.int/en/Dossiers/S-T-Issues-in-Perspective/Biodiversity/Articles/Mitigating-the-impacts-of-invasive-alien-species

2.3 Impact 3: Changes in energy and fuel prices

What do we expect?

The agricultural industry is highly dependent upon fossil-fuel based products such as fuel, fertilizers, chemicals and plastic based packaging products. Together these inputs can make up 30%-50% of the total farm costs in cropping operations. Escalating costs of these products and the related activities, specifically fertilizer and transport, will have a direct impact on the profit margins of producers. A study done by the University of Florida found that production costs of their orange industry had increased by 61% since the 2002-2003 season (measured in 2008), bringing the cost from $775 per acre to $1,246 per acre, with the majority of the costs related to increased fertilizer costs. In all likelihood, the bulk of these costs increases will be pushed back onto farmers and to some extent, the consumers as well.

Locally, Eskom’s approved electricity tariff hikes have already been felt, with the first price increase of 10c per kWh earlier this year. Over the next two years, an additional 25% increase is expected to be added, until 2013. Fuel prices are expected to continue to fluctuate with movements in the Rand/Dollar exchange rate and global oil reserves. Carbon pricing in South Africa is also likely to lead to an increase in the cost of both fuel and electricity (see Section 2.5 below).

What can I do about it?

Undertaking a carbon footprint assessment can highlight key areas on which to focus development resources and technological implementation. Initial industry trends show that roughly 80% of those will be within the energy and fuel used during production and processing. To further refine the assessment, an energy audit of pack-houses, cold-stores and irrigation pumps, will identify site-specific energy reduction options that can decrease energy inputs and increase efficiency within the supply chain without impairing the economics of crop production. Implementing regular services on all vehicles and equipment, replacing older models with more efficient (often smaller) versions where possible, may also improve efficiencies and the economics of upgrading the business infrastructure.

The results from these on-site assessments should feed in to an Energy Management Plan which outlines the combined approach to achieving energy saving and energy producing options. By aligning identified efficiency measures with alternative energy sources (such as biomass and renewable energy) most producers can achieve a superior level of energy self reliance. Implementing the combined strategies creates more benefits than each factor could alone.

51 Department of Agriculture Fisheries and Forestry, 2009; Benchmarking analysis in Section 3 of this document
Irrigation presents a significant opportunity to save energy- and money- saving within the agricultural sector. Both local and international research note that irrigation pumps use considerable amounts of energy relative to other farm production processes. Investigating alternative energy sources for irrigation pumps, such as hydroelectric, gravity fed, or solar powered pumps could equate to substantial water, energy and cost savings. Request a local provider to assess your specific irrigation requirements, limitations and potential for alternatives, as well as the financial assessment of the payback period\textsuperscript{54}.

Make use of Eskoms increased rebate for solar water heaters to make the conversion to renewable energy more feasible. The rebate aims to enable consumers to have a pay-back period of 5 to 10 years for the solar water systems and can save between 30-50\% of energy costs\textsuperscript{55}.

What role can Industry play to support?

Government’s reporting obligations under the UNFCCC mean that it needs to be supplied with information which shows tangibly how South Africa is addressing mitigation and adaptation. Industry bodies and stakeholders should not only respond to regulations (compliance) and proposed instruments (e.g. taxes), but also keep government informed of proactive industry initiatives. Positive mitigation actions and results (preferably against a baseline) would provide a great tool with which the industry could engage government and influence policy development in its favour. For example, if justified, industry bodies can motivate for interim incentive-based programmes which would enable producers and exporters to switch to more energy efficient methods while still maintaining profitability and assisting the country in meeting its targets.

With the aim of reducing the impact of the fuel and energy price hikes on producers, the Western Cape provincial government has recently announced its Mainstreaming Sustainability and Optimizing Resource Use Efficiency plan\textsuperscript{56}. The plan consists of six priority areas in which the province will focus its efforts: climate change, water management, pollution and waste management, biodiversity management, agricultural land use management and the built environment.

The main emphasis of the Plan is to:

- Have 15\% of all electricity generated from renewable energy sources (such as wind, wave and solar) by 2014.
- Reduce the carbon-intensity of output in the province by 10\% by 2014.
- Reduce electricity usage in selected provincial buildings including schools and hospitals by 5-10\%.
- Improving agricultural, industrial, commercial and household water use efficiency by 5-10\% by 2014 through the implementation of a provincial Integrated Water Resource Management Plan.
- Increase the percentage of waste diversion from landfill sites to 15\% by 2014.
- Increase conservation farming practices by 5\% by 2014.
- Reduce the number of veld fires through a prescribed burning program.
- Rehabilitate 40 000ha of invasive alien-infested land each year.
- Increase the number of conservation stewardship sites from 50 to 78 by 2012.

These targets will be further defined within the various industries of the Western Cape, placing pressure on the various members to contribute within their own sphere of operations.

\textsuperscript{54} Contact your local industry association and extension officers to find out who is the expert in your area.
\textsuperscript{55} Cedric Worthmann, Eskom Renewable Energy Portfolio Manager
\textsuperscript{56} Strategic objective 7: Mainstreaming sustainability and optimising resource use efficiency. Issued from Western Cape Environmental Affairs and Development Planning Department, 13 Jul 2010. \url{http://www.info.gov.za/speech/DynamicAction?pageid=461&sid=11421&tid=11979}
Although the Western Cape Province is leading the way in this regard, it is highly likely that other provincial governments are also working on specific targets in order to comply with the national energy efficiency and climate change policies and plans. Industry bodies in other provinces can initiate similar processes that would encourage incentives for change management and ensure that the various needs of their industry are heard and validated.

INDUSTRY EXAMPLE:

CLIMATE CHANGE AND ENERGY EFFICIENCY PROJECTS IN SEVERAL FRUIT EXPORT FARMS, PACKHOUSES AND COLDSTORES

Climate change related research in the fruit industry commenced on a large scale in 2007 when a high level carbon footprint study was completed on the supply chain of large fruit exporters. The purpose was to summarize the potential impact of climate change on the business and to determine the major contributors towards the supply chain carbon footprint. A high level carbon calculator was developed to simulate the impact of supply chain variables on the overall carbon footprint. The results indicated that the shipping leg had the biggest impact, followed by farming operations, refrigeration and inland transport activities. Energy consumption was by far the biggest contributor to GHG emissions, especially in the post-harvest chain.

In the beginning of 2008 the country faced electricity shortages and very high fuel prices. Energy costs had become a motivator for energy efficiency improvement. A project was launched as part of the PHI program to develop a benchmarking system for energy consumption on farms, packhouses and cold stores. An energy audit approach was adopted, and an analysis of energy consumption for each facility was done to enable benchmarking on a detailed energy intensity level for each function. The quantitative output were used to indentify improvement opportunities and to set improvement targets.

Developing a green supply chain also drove further research. Studies have shown that going green also improves the competitiveness of the supply chain, purely by more analysis and attention to detail on the applicable variables. A more detailed carbon calculator was developed for the local supply chain of a citrus exporter from packhouse to port. The major options in such a supply chain were road or rail transport, containerization, route choice and cooling options. A detailed carbon calculator was compiled to simulate the impact of various supply chain

Continued on the next page...
Some of the large pome packhouse have recognized the potential impact of supply chain emissions benchmarking and requested that the approach be applied to a sample of large pome packhouses, operating similar packing- and cold storage facilities. This project was done at 6 participating packhouses during 2010 with support from the packhouse action group. A detailed analysis of the packing lines and cold storage facilities was undertaken and recommendations for improvements were made. One aspect unique to pome fruit is the cooling of fruit in bins before packing, and also the long term storage under controlled atmosphere (CA) conditions. This exercise demonstrated the huge difference in energy required for the refrigeration of packed fruit (pallets), fruit in bins (RA) and fruit in CA-storage. The newly acquired information can be used to optimize the planning of packing and cold storage operations towards minimum energy requirements.

The cycle of energy analysis and benchmarking have been applied to many farms, packhouses and cold storage facilities so far, and each application contributed to a database of information enabling more accuracy and confidence in emissions and energy reduction options. The value of the approach is that it creates a baseline of quantitative measurable outputs, and current performance levels which highlight possible efficiency improvements and which can for the basis for practical efficiency enhancing actions. The most important lesson learned in this process is that there is no quick fix: Sustainable energy efficiency is the result of a holistic energy management process, inclusive of technology, people and operational practices. To achieve this, the energy consumption and operational parameters need to be visible and manageable for appropriate action. An energy model has been developed to assist packhouses and cold stores by calculating all the necessary performance parameters and energy metrics required to manage the energy efficiency process.

The pome packhouse action group is currently implementing an initiative investigating what energy efficient packhouses and cold stores will look like in future. All the criteria will be listed with the importance and relative impact of each, together with ideas to improve each application area. A conference will also be arranged that will involve packhouse operators as well as the suppliers of packhouse- and refrigeration equipment to stimulate the development of new technology and operational practices for the fruit industry.

CONDUCTED BY KOOS BOUWER CONSULTING – contact koosbouwer@iib.ws for more details or log on to the Energy Efficient Packhouses and Coldstores project website http://www.eepacs.co.za
Distribution costs are set to increase

Linked to the increase in fuel prices and the global requirements for reduction in carbon emissions, the distribution section of the supply chain has been under increasing pressure to improve efficiencies as it represents a sizable portion of most products’ footprints. Not much can be done about the physical distance between South African ports and international retailers. The transport mode chosen, however, has been shown to have a significant difference in the GHG footprint of the product.

Transport emissions have increased substantially over the past three decades as global trade has grown by leaps and bounds, especially long-haul shipments of goods. The pressure for industry action on its emissions has grown substantially in the last two years and there is general acceptance in the shipping industry of the responsibility to reduce emissions. The issue is how to do so equitably across the breadth of shipping industry and for freight transport in particular. There is growing support to do this through economic measures and market-based instruments. These have been identified as a fuel levy, an emissions cap and trade scheme or credit trading scheme centred on an energy efficiency improvement index. At the same time there is the straight technological push for new design and operational solutions to lower emissions. Although it is still under consideration as to which legislative option to adopt, the European Commission may decide to move ahead with a separate directive for EU shipping, as it did for the aviation sector, by capping GHG emissions generated by shipping in to and out of the EU. Similarly, the stalled US climate and energy bills propose taxes that would draw in bunker fuels. Such taxes would have major cost implications for importing industries, such as the South African fruit and wine industry.

Maersk has had success with their initiative of “slow steaming” - by halving the cruising speed of many of its container ships and bulk carriers resulted in a reduction of 30% in fuel consumption and carbon emissions. The initiative was initially prompted by rising oil prices in mid-2008. Some other carriers initially resisted the idea of slowing down, arguing that speed was indispensable to serving their clients. However, more recently, carriers from Germany, Israel and China are starting to embrace the slow strategy. Today more than 220 vessels are practicing “slow steaming”, cruising at 20 knots in open water instead of the standard 24-25 knots, or like, Maersk’s vessels, “supper slow steaming” at 12 knots.

Rail transport is significantly more efficient than other land-based freight options, specifically trucking, yet it is relatively under-utilized in South Africa. The Fresh Produce Exporters Forum’s (FPEF) Tonnage off Tar initiative has been investigating options to improve this uptake and is currently running a pilot study with Colors Fruit. In a similar vein, the Chemical Allied Industry Association (CAIA), are strongly supporting the road-to-railway strategy and are in discussions with the Department of Transport (DoT) to find ways of improving the current state of the rail service which will allow industries to utilize rail for the transport of raw and export-bound materials.

How are others adapting?

Over the past few years, Backsberg Wine estate has improved the efficiency on their farm in many innovative ways. In their vineyards, the change from standard vineyard design to a Lyre system improved the size ($m^2$) of canopy per hectare of vineyard and decreased the operating meters/hectare (dropped from 4,500 operating meters/hectare to 2,700 operating meters/hectare). This means that the requirement of tractors and operator time is almost halved. Although the
Lyre system is not necessarily suitable for all situations, Backsberg found the system resulted in substantial savings. **Equipment and vehicle down-sizing** has been implemented when vehicles were due for replacement, particularly on-farm pick-up trucks (bakkies) and spray tractors which are used on a regular basis for on-farm activities. The replacement of this equipment not only costs less than conventional larger equipment, but due to their size, are more fuel efficient, thereby reduce associated farms costs and GHG emissions. With the conversion from 65hp to 24hp tractors and a modified spray rig (with two nozzles), spray efficiency has improved significantly and fuel consumption was reduced by 40% as only every second row now needs to be sprayed.

**Villiera Wines** in Stellenbosch is “putting sunshine in to each bottle”\(^{57}\). The estate undertook the “largest roof-mounted solar installation in South Africa”. With the help of local company enerGworx, 539 solar modules have been installed across the three Cellar’s roofs. The installation hopes to provide 726 kWh of electricity per day - enough energy to power the business’s entire daytime requirements (excluding peak harvest periods) by supplying electricity to staff house, offices, kitchens, processing and bottling facilities, cellars and the cooling and irrigation systems. To put this in perspective, an average family of four consumes in the region of just 30 to 35 kWh per day.

> “Investing in a solar solution can empower an enterprise to secure its profits in the long term, while providing a clean, renewable source of power.”

enerGworx MD André Potgieter

In 2010 the **French government** launched a significant renewable energy investment programme called: «*Démonstrateurs et plates-formes technologiques en énergies renouvelables et décarbonées et chimie verte*»\(^{58}\). The programme aims to provide €1.35bn (£1.1bn) of financial support to the renewable sector over the next four years aimed specifically at a renewable energy investment programme (offering €450m in subsidies) and a further €900m in low-interest loans to cutting-edge technology projects. The main focus of the investment programme is on supporting emerging clean technologies, specifically those that have high development costs such as solar, marine and geothermal energy, advance biofuel development, as well as carbon capture and storage (CCS) projects. The government of France previously targeted more established technologies such as nuclear and wind energy. This new focus on cutting-edge technology is a therefore a bold suggestion of their future plans. With the new renewable energy investment, the French Environment and Energy Management Agency is now seeking applications for funding from the private sector and research bodies to undertake demonstration projects and testing of new technologies. In addition, the government is wishing private sector investment, to the tune of about €2bn, to complement the renewable energy investment programme.

Under **New Zealand’s Climate Change Programme**, the government has outlined the New Zealand Energy Strategy\(^{59}\), which is currently being updated. It states that energy efficiency is a priority for the country, and provides detail on the measures to increase the uptake of energy efficiency, energy conservation and renewable energy programmes across the country.

The **University of California’s** Davis campus now hosts a state of the art research winery which aims to become self sustainable in water and energy use once all the features are complete. The winery, part of the Robert Mondavi Institute for Wine and Food Science, is adjacent to a new 12-acre research vineyard and is designed to be a testing ground for new,


environmentally friendly production processes and techniques. It claims to have the world’s first wireless fermentation system, including automated temperature and pump-over controls on its 152 fermentation tanks, as well as sensors to measure sugar concentrations every 15 minutes and to a precision of 0.25 brix. Other features include solar power generation and a large-capacity system for capturing rainwater and conserving process water, with a planned expanded system targeting the reuse of 90% of captured rainwater volume. The winery is also designed to capture carbon dioxide emissions during the fermentation process via a port in each of the fermentation tanks, removing the gas and reducing the need to use energy to improve air quality and temperature control. “We want to demonstrate a self-sufficiency model that is applicable to any business with limited water,” said Roger Boulton, winery engineering expert and chair in enology at UC Davis. 

Where can I find more info?

People wishing to know more about the Eskom rebate scheme and approved suppliers can obtain more information on www.eskom.co.za/dsm, or by calling Eskom’s solar help desk on 011 800 4744.

Lessons learnt and shared technological advances from research institutions in the United States and Australia provide several examples of specific examples of irrigation and energy efficiency technologies, available at:

- Integrated Approaches to Farm Energy – A Case Study Series  
  http://attra.ncat.org/attra-pub/farm_energy/studies/irrigation.html

2.4 Impact 4: Increase in market pressure

What do we expect

As public awareness of human-driven climate change has emerged, consumers have increasingly placed pressure on retailers to consider the implications of their operations on climate change and to reduce the GHG emissions generated through the production and supply of commodities. Such pressure is been supported by emerging Government policies and the need for developed nations to meet Kyoto Protocol emission allowances.

The UK has taken the lead with a Climate Change Bill aimed at reducing national GHG emissions by 60 per cent between 1990 and 2050. Similarly, the EU has proposed to reduce emissions by 20% by 2020 and by between 60 and 80% by 2050. The US has agreed to reduce emission intensity (that is the ratio of emissions to economic output) by 18% by 2012 and individual states have introduced their own targets. California, for example, is aiming to reduce emissions to 1990 levels by 2020 and 80% by 2050. The Eastern US and Canada aim to reduce emissions by 10% by 2010. Japan also has announced a 50% reduction in emissions by 2050.

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60 http://wineserver.ucdavis.edu/index.php
The growing concern regarding climate change within the retail sector has resulted in development of labelling schemes. The Carbon Trust in 2006 introduced the Carbon Reduction Label with the proviso that products need to reduce emissions by 20% over two years. Tesco is carbon footprinting 70,000 of its products and this has been followed by other major supermarket chains. The UK Government has established an enquiry into the environmental labelling under Environmental Audit Committee this is to focus on issues around labelling including feasibility of an international labelling scheme. This is an important initiative that shows that carbon footprinting is not just desired in the private sector, but that government involvement may well lead to regulation as has been seen with other labelling schemes.

Carbon footprinting and requirements to reduce embodied-emission in exports seems likely to become standard for export markets and likely to be introduced in the next few years.

**What can I do about it?**

**Inform the retailer and customer of the co-benefits** of South African agricultural products. Analysing a product based purely on food miles is not an effective measure as it does not equate the social and local environmental aspects, such as growing conditions and supporting livelihoods. Promote the use of Fair Miles over Food Miles, as it takes in to account a more holistic approach to the production of food products.\(^{62}\)

**Know your carbon footprint** and publically inform the consumer/retailer how you are actively reducing it. At the same time ensure that the targets are realistic and measurable. Nothing can be more damaging to brand and reputation than unrealistic statements that cannot be met.

Packaging has been highlighted globally as a major focus area for carbon footprint reduction potential. **Investigate different packaging options.** Shifting to more environmentally friendly packaging options has an immediate “face-value” to the customer and retailer and could often reduce costs.

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The South African wine industry is taking a number of steps to maintain its status as one of the world’s most eco-progressive winemaking nations. One such step is assessing packaging options available in an effort to reduce the carbon footprint of the product. Earlier this year, Wines of South Africa (WOSA) announced the availability of a newer lighter bottle (weighing 350g as opposed to the original 500g/750ml bottle) available for all 750ml screw top bottles in the country. At the same time, the average weight of bottles sealed with corks has been reduced in weight from 570g to 460g. Both initiatives have been piloted with Distell (see below) in association with Consol glass. The sturdy, lightweight bottles will not only assist export producers in meeting the demands of leading international retailers who are demanding more eco-friendly packaging, but will strengthen South Africa’s reputation for environmentally responsible wine production. More recently, the Wine and Spirit Board approved the bottling of certified natural wine in plastic PET (polyethylene terephthalate) bottles in an effort to reduce the weight of packaging. In the past PET bottles have conventionally been used for bottled water, soda beverages, sports drinks etc. but plastic wine bottles are starting to appear on supermarket shelves in South Africa and abroad. The PET bottles are significantly lighter (a 750ml PET weighs 54g versus 400g in glass) and a more suitable size, thereby causes savings in transport requirements and storage space. In addition, they are fully recyclable. There are disadvantages, however, which include the effect on wine quality as PET allows more oxygen to ingress than glass, leading to shorter shelf-life. Plastics also have an increasingly negative image in the eyes of consumers, and there may be possible negative health implications of using plastic in the long term storage of drinkable liquid. Backsberg wine estate appears to be the first to trail and test the small plastic bottles in the local retail market.

Distell’s Give Back Get Back initiative aims to accelerate glass bottle returns and, in the process, reducing waste, GHG emissions, and electricity usage. The project is being implemented on large scale spanning all product categories in which Distell is involved – 63 different products and nearly 150 bottle sizes. The Give Back Get Back initiative works through retail outlets and a network of over 1 600 bottle merchants nationwide, who return the intact bottles to the company. The key to the programme is the greater involvement of retail and own-consumption trade, through incentive-based process that pays between 80c and R1.50 for every bottle returned, dependant on the type and size of the bottle. The initiative has helped to contain the operating costs and maintain the company’s competitiveness as each bottle can be re-used repeatedly. Through the program, which has been running since July 2009, Distell has been able to reuse 132,3 million bottles, which equates to saving 73 268 t of virgin glass production, representing a 111 079 tCO2e reduction over the full year period (July 2009 – July 2010). The Give Back Get Back programmes compliments the improved lightweight packaging initiative which has already saved 333,5 t of glass from 2,9 million bottles of wine being converted since June 2010 which equates to 733,7 tCO2e reduction. Distell is also aiming to begin using a recently available lightweight 350g bottle, with the aim of further reducing their packaging GHG footprint.

Bulk exports may threaten job security. Although the alternative wine packaging of bag-in-box wines is gaining support in the international markets, specifically Scandinavia, the option of bulk exporting wine and bottling overseas reduces local employment opportunities within the bottling process. Su Birch, CEO of WOSA (Wines of South Africa) stated that information gathered through the SA Wine Industry Information Systems has calculated that for every 10-million litres of wine shipped in bulk, just over 107 direct jobs would be lost. Last year, South Africa exported 389 million litres of wine. Of that total, less than half – 150.5 million litres – were exported in bulk. The role of employment and economic empowerment within the South African wine industry needs to be raised and promoted to the retailers, together with addressing the necessary packaging efficiency programmes within local shores.

Continued on next page.
What role can Industry play to support?

Collaboration between different industry bodies is key to effectively addressing climate change issues. The *Confronting Climate Change - Fruit and Wine Industry Initiative* is a good example of this collaborative approach, which through shared resources and a common goal is assisting the industry stakeholders to better understand, begin addressing, and find most suitable response strategies for the relevant climate change risks facing the industry.

In addition, industry bodies may also play important roles in governing and controlling the standards that are used for measuring and monitoring GHG emissions and related resource management (such as water and energy).

Industry bodies and related networks have a vital role to play in effectively engaging and communicating with the international retailers and ensuring that the South African fruit and wine industry is shown in a positive light, particularly in relation to the Food Miles concept.

How are others adapting?

**Australian focuses on legislation.** In 2007, South Australia enacted the *Climate Change and Greenhouse Emissions Reduction Act*, making it the first state in Australia to legislate targets to reduce greenhouse emissions. The legislation set out three targets based around reducing greenhouse gas emissions and increasing the proportion of renewable energy generated and consumed in the state. In addition, it seeks to promote business and community understanding about issues surrounding climate change and facilitates the early development of policies and programs to address climate change.
change. As part of the Act, the South Australian Wine Industry Association and the Wine Grape Council South Australia entered into the first Sector Agreement with the State Government in 2008. The “Climate Change Wine Sector Agreement” is a two year project which aims to inform the wine industry of issues regarding climate change while encouraging and assisting industry to measure and report their GHG footprint. Grape-growers and wine producers have shown their commitment for the project by signing up to measure their GHG footprint for 2009/2010.

The South African wine industry has recently released a new seal which certifies that the product has been produced in an environmentally sustainable way. The new seal, issued by the Wine and Spirits Board, will appear only on bottled wine and be supported by a sophisticated tracking system that tracks the bottle through every stage in the wine-production chain can be traced with a unique number. The voluntary system, which will start with the 2010 harvest, is available to those wineries that comply, - at farm-, cellar-, and bottling-level, with the sustainability guidelines laid down by the Integrated Production of Wine (IPW) scheme. At present, South African appears to be the only country that has implemented and certified this concept across the wine industry.

California Association of Winegrape Growers (CAWG) Association is focussed on bringing recognition to the California wine industry as a change leader in the global marketplace and serve as a model for other industries. Their pilot project - Code of Sustainable Winegrowing Practices Self-Assessment Workbook – was established in 2002 and updated in 2006, the system has currently assessed roughly 68% of California’s 526,00 wine acres (1,566 vineyard and winery organisations) and 63.5% of the state’s 240 million case shipments evaluated through the system.

Where can I find more info?

Various industry body websites:

- The South African Confronting Climate Change fruit and wine industry initiative [www.climatefruitandwine.co.za](http://www.climatefruitandwine.co.za)
- Sustainable Wine South Africa [www.swsa.co.za](http://www.swsa.co.za)
- Winetech South Africa [http://www.winetech.co.za](http://www.winetech.co.za)
- Experico [http://www.experico.co.za](http://www.experico.co.za)

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64 Sustainable Wine South Africa - Available at: [www.swsa.co.za](http://www.swsa.co.za)
The Colors Fruit Carbon Measurement and Labelling project was initiated in 2007 with the aim of responding from a position of knowledge to the UK retail challenge of addressing the “Food Miles” debate.

The first step was to measure the carbon intensity of the supply chain through a Life Cycle Assessment (LCA) study. It was important that the study incorporated scientific rigour and yielded credible results. It was therefore decided to use the PAS2050 protocol published by British Standards and Carbon Trust. PAS2050 is seen as the leading carbon footprint LCA protocol for measuring, certifying, comparing, and communicating LCA results, as well as labelling products. The study has helped Colors understand how carbon emission intensity is distributed across the supply chain.

**Impact of the process:**

Colors has, through the Carbon Trust, certified carbon footprints for four fruit categories, namely Citrus, Topfruit, Stonefruit and Grapes. The results show that fruit export supply chains are carbon intensive with specific “hotspots” where carbon emissions can be avoided or reduced. The knowledge gained from the study has provided a solid foundation on which to build a carbon management strategy. The major factors contributing to carbon emissions are electricity use on farms (pumping) and packhouses (cold chain), packaging and transport.

The results from such a study have also provided the opportunity to label products. This is not common in the fruit export supply chain, but all the major UK retailers are looking into the concept of communicating carbon performance to consumers at product level. Tesco has travelled the furthest down this path with strategic commitments to carbon labelling. Colors currently supplies two products to Tesco that carry a carbon label. Carbon management is likely to become a market access requirement in future, especially for specific retailer programs. It is expected that being asked to calculate and display the embodied emissions of products is going to become an important capability of business.

**Plans going forward:**

Colors is currently busy with the second round of primary data collection and footprint calculation. This data will be used to expand the current set of carbon footprints. For example, the Citrus carbon footprint is being expanded to detail the specific Orange, Easy Peeler, Lemon and Grapefruit carbon footprints. While ongoing measurement is important, Colors realises that developing and implementing a reduction strategy is critical. Lastly, where it makes commercial sense, carbon labelling opportunities will be pursued.

TEXT PROVIDED BY EDDIE VIENINGS DURING HIS POSITION AT COLORS FRUIT. Contact details: eddie@blunorth.com
2.5 Impact 5: Potential impact of carbon pricing

What to expect?

There is a broad consensus that South Africa will need to implement a broad-based carbon tax if it is to remain on the emissions path adopted by cabinet as an outcome of the Long Term Mitigation Scenario (LTMS) process, and formalised in the targets put forward in the Copenhagen Accord and subsequently in the Cancun Agreements. The use of economic instruments (like carbon taxes) is highlighted as a key element in South Africa’s overall approach to reducing its greenhouse gas emissions in the National Climate Change Response White Paper. The National Treasury is currently investigating the implementation of such a broad-based carbon tax in South Africa, and published a discussion paper on the possible use of a carbon tax in South Africa during December 2010. The paper was structured as a technical paper that provides a broad overview of the theory underlying carbon taxes and their use internationally. As such it makes only broad and preliminary comments on the form that a carbon tax in South Africa may take. It also did not explicitly address the local context in which a carbon tax would need to be implemented, and in particular does not deal with a number of issues that could complicate the implementation of a carbon tax in South Africa. These issues will be addressed in a policy paper that is expected to be released during early December 2010. While the level and design of the tax has thus not been finalised yet, the discussion paper did indicate a preference for an upstream fuel input tax on the carbon content of fossil fuel inputs (in order to simplify the administration of the carbon tax) rather than a tax that is levied directly on the amount of CO2 emitted by firms, at a rate of round R75 per tonne of CO2 increasing to around R200 per tonne of CO2 over time. The indicative tax value was provided in 2003 prices, which equate to a carbon tax of roughly R100 per tonne of CO2 increasing to roughly R200 per tonne of CO2 over time at current prices. The indicative time lines put forward in the discussion paper suggested that the implementation of a carbon tax could be announced in the February 2012 budget, with the legislation that will enact a carbon tax being published for public comment in May 2012.

Given the high carbon content of energy in South Africa, energy markets are likely to be the main conduit through which a carbon tax will impact the rest of the economy. A carbon tax at the R100/t rate mentioned in the press would translate into an increase in the cost of electricity of around 10c/kWh, and an increase in the cost of liquid fuels of around 23c/litre. If tailpipe emissions from the combustion of liquid fuel is included in the tax base, that would add approximately another 25c/litre to the price of liquid fuels. R100/t is at the lower end of estimates of the size of carbon tax required in order to change behaviour and investment decisions in South Africa to facilitate a move to a low-carbon economy. The LTMS, for instance, modelled a carbon tax starting off at R250/t in 2008 and ending at R750/t by 2050. The proposed tax can thus be expected to increase significantly above the current indicative level of R100/t in future. Apart from increasing the direct cost of energy usage, a carbon tax is also expected to increase the cost of energy-intensive products relevant to the food...

69 The carbon tax will thus be levied on primary fuels like coal, oil and gas which are used to produce other fuels (or used directly in other production activities), and not on transport fuels like diesel and petrol when they are bought by final consumers.
70 These timelines may, however, be subject to change since the Treasury originally indicated the carbon tax policy paper would be released during November 2011. At a recent carbon tax debate the National Treasury also indicated that they may be open to further consultation on the issue before a final decision regarding the implementation of a carbon tax in South is made (op. cit.).
and wine industry (like agro-chemicals and fertilizers, for instance) and transport and distribution costs. The impact on transport and distribution costs will increase even more once sectors like the aviation (included in the EU Emissions Trading Scheme (EU ETS) from 2012) and the shipping (likely to be included in EU ETS after 2012 unless a global agreement is reached to cap shipping emissions) are subject to an international carbon price.\(^{74}\)

In addition to a broad-based carbon tax, specific taxes may also be used in sectors like transport. An example of this is the new tax on the CO\(_2\) emissions of passenger cars implemented in South Africa on the 1\(^{st}\) of September 2010. The tax is applicable to all new passenger cars sold in South Africa. The tax is levied as a specific tax of R75 for every gram of CO\(_2\) emitted per kilometre (g/km) driven above a threshold of 120g/km. The tax will be collected directly from the producers and importers of cars and will thus be factored into the purchase price of new cars.\(^{75}\) Given that the tax is levied before VAT is applied, the actual amount with which the tax is expected to increase the price of new vehicles is R85.5 for every g/km above the threshold. At present the tax excludes light commercial vehicles, but they will be included in future. The tax was extended to double-cab bakkies on the 1\(^{st}\) of March 2011. The tax on double-cabs is levied at R100 (R114 including VAT) for every g/km above a threshold of 175g/km. The date at which other light commercial vehicles like single-cab bakkies and vans are to be included under the new tax is yet to be decided. Minibus taxis are currently excluded from this tax since they are predominantly used for public transport. The inclusion of minibus taxies in the tax will be reviewed once the tax has been extended to all other light commercial vehicles. At the time of implementation, the tax increased the average cost of cars by about 2.5%\(^{76}\), but the average price increase will be higher once light commercial vehicles are included. The price of a Nissan NP300 Hardbody 2.5 (Tdi lwb SE) for instance, would have gone up by 7.5% had light commercial vehicles been subject to the tax when it was introduced (in increase of R14 706 relative to a current retail price of R196 400).\(^{77}\)

The vehicle emissions tax, once extended to all light commercial vehicles (it already covers double cab bakkies – making single cab bakkies relatively more attractive), could increase the cost of replacing or expanding vehicle fleets. In order to make the tax more effective in incentivising a switch to more fuel- and carbon-efficient vehicles, National Treasury is currently also considering extending car CO\(_2\) taxes to old cars through the use of differentiated annual vehicle licence fees based on CO\(_2\) emissions ratings. In addition, National Treasury also mentioned the possibility of either supplementing or replacing the current tax by an additional fuel levy in future to future support a move to more fuel-efficient vehicles. Thus, apart from a once-off penalty when purchasing light commercial vehicles, the proposals under consideration may also increase the ongoing cost of owning and using these vehicles.

**What can I do about it?**

In order to minimise the impacts of carbon taxes, it is important to **stay abreast of current proposals** to adapt purchase and investment decisions in a way that will minimise the impact once these taxes are implemented (by starting to buy smaller, more efficient bakkies before the measures under consideration that could lead to an increase in the cost of owning and operating larger, more inefficient bakkies are implemented, for example). Understanding the carbon footprint of one’s business is also important in order to indentify the ‘high-carbon’ areas that are likely to be significantly impacted on by a carbon tax. Based on the analysis in **SECTION 3: Industry trends** these hotspots seem to be, in order to importance, the use of electricity, fertilizers and fuel.

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The recommendations on how to **minimise the impact of rising energy and fuel prices**, as well as transport and distribution costs, and the **use of agro-chemicals** mentioned above will help to reduce the impact of carbon taxes along the fruit and wine value chain.

**What role can Industry play to support?**

Industry bodies can keep their members up to date on what carbon taxes are likely to be implemented (both in South Africa and overseas), what the impact of these taxes are expected to be on their members, and when these measures are expected to be implemented. This should provide their members with sufficient warning to plan accordingly and reduce the impact of these taxes on their bottom lines. Industry bodies can also engage with government to make it aware of the sector-specific factors that may complicate the implications of a carbon tax along the fruit and wine value chain or may make it difficult for firms to adapt to these taxes. This should enable government to consider the need for special assistance (in the form of technology development support measures, for instance) or transitional arrangements to help firms cope with the burden of carbon taxes.

**How are others adapting?**

Internationally firms have adapted to carbon taxes by adapting their behaviour and evaluating new technologies and production methods in order to not only make their operations more carbon efficient (and thus reduce the amount of carbon tax to be paid) but also to identify efficiencies elsewhere that can lead to cost savings that can offset the impact of carbon taxes. The potential impact of the EU ETS on the competitiveness of European firms, for instance, is believed to have largely been offset by the development and adoption of new technologies and production processes.

**Where can I find more info?**

The National Treasury is expected to publish a policy paper on the use of carbon taxes to reduce greenhouse gas emissions in South Africa in December 2011. This should provide a useful overview of what is in store on the horizon in terms of carbon taxes. [http://www.treasury.gov.za/](http://www.treasury.gov.za/).

The National Climate Change Response White Paper and forthcoming Green Paper on climate change by the Department of Environmental Affairs should also provide a useful overview of the future use of climate change mitigation policies (including carbon taxes) in South Africa. [http://www.environment.gov.za/](http://www.environment.gov.za/)

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OVERVIEW OF POSSIBLE LOCAL CARBON TAX DESIGN

In the National Treasury carbon tax discussion document published in December 2010, and the consultation process that followed it, has indicated an initial preference (which is subject to change) for a number of carbon tax design features. These include:

- A CO$_2$ tax rather than a tax on all significant greenhouse gas emissions. The tax will most likely cover direct CO$_2$ emissions from energy-related and non-energy (industrial) processes.

- An upstream fuel input tax on the carbon content of fossil fuel inputs rather than a tax that is levied directly on the amount of CO$_2$ emitted by firms, in order to simplify the administration of the carbon tax. The carbon tax will thus be levied on primary fuels like coal, oil and gas which are used to produce other fuels (or used directly in other production activities), and not on transport fuels like diesel and petrol when they are bought by final consumers.

- Universal coverage of sectors. As large a number of South African sectors as administratively feasible will be subject to the tax.

- Revenue neutrality. The Treasury will endeavour to match the revenue generated by the carbon tax with a decrease in taxes elsewhere in the economy and/or an increase in direct transfers. In particular, the Treasury intends to use the revenues generated by the tax (a process known as ‘revenue recycling’) to reduce the impact of the carbon tax (in the form of higher prices) on the poor and to assist firms and sectors that may see their competitiveness negatively affected as a result of disproportionately high carbon tax payments.

- No hard earmarking of revenues. Revenue recycling will happen through the normal government budget process (and funds can thus be committed to climate friendly initiatives through ‘soft earmarking’), and the revenues raised by the carbon tax will not be earmarked for specific purposes.

- Low and escalating carbon tax trajectory. The carbon tax is to be implemented at a relatively low level initially and then escalated to a more significant level over time to provide firms with time to adjust to the impact of carbon pricing.

- Relief to firms should be minimal and temporary. Since the low and escalating nature of the carbon tax should provide sufficient time for firms to adjust to a carbon tax, the number of sectors exempted from the scheme, and the number of firms receiving support to protect their competitiveness, will be limited and exemptions or support will only be provided for as short a period as feasible.
SECTION 3: Industry trends

Over the past number of years, reducing Greenhouse Gas (GHG) emissions and improving efficiency issues has swiftly moved from merely being a marketing opportunity for businesses, to being an integral part of strategic management decisions. Largely due to consumer awareness in a highly competitive market, fresh-produce retailers have committed to significant GHG reduction goals and are increasingly placing stringent guidelines on their suppliers. This pressure has lead to the fruit and wine industry reviewing the climate change implications of their operations and, in some part, establishing initial emission reduction targets.

This section serves to evaluate the different GHG emission inventory’s that have been undertaken in the fruit and wine industry; firstly at an international level, and secondly within the context of selected local case studies. For the analysis of each GHG or carbon footprint study, the following questions were used as a guideline to establish common criteria and key outcomes:

1.) What is the average greenhouse gas (GHG) emission per product for the relevant commodity groups?
2.) What is the scope of the study – where were the boundaries drawn that define which emission sources are excluded and that which are included?
3.) Within the study, which operations or activities account for the majority of emissions?
4.) What emission reduction options or efficiency improvement actions have been highlighted?

Data availability and the varied scope of analyses were notable restrictive factors to this baseline analysis. Relatively few studies have been undertaken internationally and those that are publicly available are difficult to compare – studies often use different units of measure, define the scope of audit differently (include or exclude certain activities) and do not clearly describe the auditing methodology. Such discrepancies make direct comparisons between studies problematic. Moreover, the distribution of emissions is likely to differ considerably from one product to another due to a diversity of farming management practices (variation in fruit variety, climate and soil type) and post-production processes and management choices, such as packaging options and distribution networks. Given this level of variability, the results of the studies should be viewed as indicative and prescriptive.

It is the aim that this first stage analysis will assist the South African fruit and wine industry by highlighting trends within similar operations, identifying technologies and reduction opportunities that may be relevant to the local industry, and to illustrate relevant lessons learnt which may guide the further research and development of this and other industry projects.
3.1 International Wine Industry Case Studies

The wine industry has long since been at the forefront of implementing and monitoring sustainable production practices. California has the Sustainable Wine Growing Alliance\textsuperscript{79} created by the Wine Institute and the California Association of Winegrape Growers, New Zealand has its own group of Sustainable Wine Growing NZ\textsuperscript{80}, and here at home we have the Integrated Production of Wine (IPW) scheme and the recent Sustainable Wine South Africa, an alliance between the Wine and Spirit Board’s Wine of Origin and the IPW scheme and the Biodiversity and Wine Initiative (BWI) and Wines of South Africa (WOSA)\textsuperscript{81}.

With growing focus on reducing greenhouse gas emissions, wineries face increasing pressure to demonstrate their commitment to minimizing the environmental impact of their product and one way of measuring this environmental impact is through a “carbon footprint” assessment. Klassen and McLaughlin\textsuperscript{82} show that companies often benefit financially from improving their environmental performance, especially in industries that are already categorized as environmentally friendly, as is the case with the wine industry both globally and in South Africa. As wine is often viewed as a premier product in a highly competitive market, product differentiation is vital to retain consumer interest and support. In recent years, businesses have been showcasing their efforts of sustainability and environmental integrity to differentiate themselves. Undertaking a carbon footprint assessment is one such method of measuring the environmental impact of production, processing and distributing the end product to the consumer. The following international studies offer a look at the various carbon footprint assessments that have been done in the international wine industry to date, and the results show just how varied the impact can be, depending on the boundaries of the assessment.

A South Australian study investigating the total emissions from vineyard (in South Australia) to shelf (UK market) found relatively low emissions occurring downstream (i.e. retail and final consumption) but that on-farm viticultural activities and winery processes (particularly bottling and packaging) account for more than half of the total emissions from the supply chain\textsuperscript{83}. This result was mainly due to the fact that the study was a full Life Cycle Assessment (LCA) and included “infrastructural” production emissions, resulting in the trellising structure of the vineyards (i.e. the production of the wooden structures and the energy required to put them in place) contributing significantly to the viticulture emissions. Most of the other studies reviewed did not include emissions from “infrastructure” and only included inputs that are “consumed” on an annual basis for the production of grapes (for example, fertilizers), therefore causing very different results.

Interestingly, within this study, winery processes, bottling, packaging and labelling accounted for more than 15\% of the total GHG footprint, indicating an area where potential modifications could make an impact in reducing the footprint of the product. However, in the Value Chain Analysis (VCA) section of the study, it was noted that consumers find the appearance of the bottle and label as “value adding” and therefore changes to this appearance should be done with caution. Another interesting result from the VCA analysis is that the concept of sustainability\textsuperscript{84} remains poorly understood in the UK retail shoppers’ minds. Although there is a strong trend of more sustainable production and packaging being requesting by suppliers to the major UK retailers, very few UK shoppers value sustainability as an attribute of the wine they purchase from the supermarket and are more interested in attributes such as vintage, cultivar, colour and price.

\textsuperscript{79} http://www.sustainablewinegrowing.org/aboutcswa.php;
\textsuperscript{80} http://wineinf.nzwine.com/swzabout.asp;
\textsuperscript{81} http://www.swsa.co.za/sustainability.php;
\textsuperscript{84} In terms of this study, sustainability refers to the environmental sustainability of the procurement, production and distribution practices that are involved in getting a product on to a retail shelf.
In contrast, a LCA study done by the American Association of Wine Economists found that the largest source of variability in GHG emissions was the mode of transport used to transfer wine from the farm to the final customer. The main purpose of the study was to compare different production, packaging and transport options available with the aim of evaluating which is the most important factor in determining the environmental value of the bottle of wine. The study included emissions from the cultivation of grapes (including inputs of production of agri-chemicals and fuel combustion), processing (including fermentation, production & transport emission of French barrels and wine bottles) and distribution (the transportation mode) to retail shelf. A comparison of several different supply chain options was made, within the same scope: from farm to retail outlet in Chicago, USA. Tables 1 and 2 summarise the resulting averages of American wine production as well as the emission factors used in the study (Table 1 and 2). The results of the comparative study are summarized in Table 3.

A key emerging lesson from the American case-study is that the GHG emissions from the transport of wine to market are affected by numerous factors including the **distance to market**, the **type of transport**, the **efficient use of transport** (the size of vehicle and whether the vehicle is fully or partially loaded), as well as the **size and shape of the bottle used**.

As expected, the distance travelled to market did favour the French wines over the Australian and even over the Argentinean bulk wines. Of particular interest, was the influence of ‘transport efficiency. Although Napa Valley wine is considered ‘locally” grown, it had the second highest GHG emission footprint overall due to fact that the wine was delivered in small orders and in vehicles that were not fully loaded.

In addition to the influence of distance to market, the particular mode of transport can significantly influence the volume of generated emissions. For example, the locally grown Napa Valley wine which was utilized inefficient trucks (not fully loaded) on a frequent basis resulted in a significantly higher total carbon footprint per bottle of wine (Table 3).

Packaging, specifically the size and weight of the container, had a considerable impact on the footprint. For example, of all the wines analysed, the 1.5litre Australian wine had a third of the embodied emissions of the “locally” grown Napa Valley wine. Typically, the larger the bottle the smaller the surface area relative to the volume contained. The smaller the bottle, the higher the glass/wine ratio, and thus also the amount glass and corresponding embodied GHG emissions per unit of wine delivered to the customer. This was the case with the Bordeux wine in 375ml bottles.

### Table 2: American averages of wine production

<table>
<thead>
<tr>
<th>Parameter</th>
<th>American Averages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average production</td>
<td>400-800 kg/ha</td>
</tr>
<tr>
<td>Agri-chemical usage</td>
<td>50-100 kg/ton grapes</td>
</tr>
<tr>
<td>Water used for final product</td>
<td>1.2-2.5 megal/ha OR 550 000 litres per ton grapes</td>
</tr>
<tr>
<td>Fuel consumption (on farm activities)</td>
<td>130 litres per ton grapes</td>
</tr>
<tr>
<td>Electricity &amp; Natural gas used in wineries</td>
<td>100gCO2e/bottle of wine</td>
</tr>
</tbody>
</table>

### Table 3: Emission factors used in calculations of the study

<table>
<thead>
<tr>
<th>Emission factors used in the study:</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Container shipping</td>
<td>0.052 kgCO2e/t-cargo/km</td>
</tr>
<tr>
<td>Trucking</td>
<td>0.252 kgCO2e/t-cargo/km</td>
</tr>
<tr>
<td>Train</td>
<td>0.2 kgCO2e/t-cargo/km</td>
</tr>
<tr>
<td>Refrigerator container shipping</td>
<td>0.0671 kgCO2e/t-cargo/km</td>
</tr>
<tr>
<td>Air freight</td>
<td>0.57 kgCO2e/t-cargo/km</td>
</tr>
<tr>
<td>Virgin glass</td>
<td>0.716 kgCO2e/kg glass</td>
</tr>
<tr>
<td>Recycled glass</td>
<td>0.44 kgCO2e/kg glass</td>
</tr>
</tbody>
</table>

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86 based on California electricity grid 0.51tCO2e/mWh
### Table 4: Summary table from American comparative study

<table>
<thead>
<tr>
<th>Wine region</th>
<th>Production</th>
<th>Viticulture practices</th>
<th>Packaging</th>
<th>Transport mode</th>
<th>Total embodied kgCO2e/bottle</th>
<th>Summary notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>New South Wales, Australia</td>
<td>Large scale</td>
<td>Conventional</td>
<td>750ml &amp; 1.5l bottles</td>
<td>Shipped to Los Angeles, then train or truck to Chicago</td>
<td>3.44kgCO2e/bottle Average of: (2kgCO2e/750ml 4kgCO2e/1.5l)</td>
<td>Because of the 1.5l bottles, much less glass is transported = lower embodied C footprint overall</td>
</tr>
<tr>
<td>Loire, France</td>
<td>Boutique wine estate</td>
<td>Biodynamic</td>
<td>750ml bottle</td>
<td>Refrigerated truck, shipped to New Jersey, trucked to Chicago</td>
<td>2.12kgCO2e/bottle</td>
<td>Biodynamic farming practices do not make a large impact on C footprint when transport distances are still high.</td>
</tr>
<tr>
<td>Napa Valley, California</td>
<td>Limited production</td>
<td>Sustainable agriculture (limited petro-chemical inputs)</td>
<td>750ml bottle</td>
<td>Trucked overnight express delivery</td>
<td>4.5kgCO2e/bottle</td>
<td>Sales via mailing list, express delivery directly to customer = high emissions due to frequent inefficient deliveries</td>
</tr>
<tr>
<td>Bordeaux, France</td>
<td>Limited production</td>
<td>Conventional</td>
<td>375ml bottle</td>
<td>Shipped and trucked</td>
<td>4.6kgCO2e/375ml bottle</td>
<td>Because of wine:glass ratio = high C footprint. The bigger the bottle, the lower the C footprint</td>
</tr>
<tr>
<td>Mendoza, Argentina</td>
<td>Large scale</td>
<td>Conventional</td>
<td>Shipped in bulk, bottled in California</td>
<td>Shipped to California, then trucked to Chicago</td>
<td>2.23kgCO2e/bottle</td>
<td>Transporting in bulk and bottling closer to market substantially lowers the footprint.</td>
</tr>
</tbody>
</table>

Investigating the impact of different transport and logistical options available for delivering wine to the consumers across the US, Cholette and Venkat (2009) found that different supply chain configurations on the winery’s outbound supply chain (i.e. from winery door to customer) can have a major impact on the overall energy and emissions associated with the wine product. The unit of analysis in this study was a half case of wine and the scope of the study focussed on distribution of the wine from winery door to the consumer’s house. This study found that emissions associated with transportation from winery to consumer are as much as ten times greater than the emissions generated through the refrigeration and storage of wine (0.46kgCO2e/half case and 0.04kgCO2e/half case respectively). These results are supported by a further study by Van Hauwermeiren et al. (2007) which found that transportation emissions were greater than those associated with storage and processing for most plant-derived foods in their study. This finding highlights that when determining GHG emission efficiency of the distribution of wine and produce in general, the utilization and type of vehicles is often as important as the distance travelled. These results underscore the value of wineries focussing on easy-to-implement transportation efficiencies as a means of significant reducing the net GHG emissions wine.

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87 Cholette & Venkat 2009 The energy and carbon intensity of wine distribution: A study of logistical options for delivering wine to consumers. Journal of Cleaner Production 17_ 1401-1413
In terms of the affect of organic farming on GHG emissions, an Italian study\textsuperscript{89}, which excluded the international distribution leg, found that practicing organic farming methods and re-using organic waste helped reduce the GHG footprint of the wine as a result of less fertilizer input requirements. The study was done on a small sized winery with an annual production of 1,269 tonnes of grapes per year from roughly 180 hectares of vineyards. A LCA analysis was undertaken which included emissions from grape cultivation, transport to wine-making facilities, wine production and storage, bottling and packaging, and transfer of finished product to local distribution centres. The results found that the total embodied carbon per 0.75l of wine was 1.6kgCO\textsubscript{2}e. The direct consumption of energy (LPG, electricity and diesel) accounted for only 30% of the total GHG footprint, while 60% of the emissions came from indirect activities, such as the production of bottles and other packaging products. The electricity used for cooling the wines during fermentation was highlighted as being a particularly significant contributor to the GHG footprint. A breakdown in terms of energy use (GJ) per activity is summarized in Table 4 below.

At first glance, the GHG footprint of this wine appears to be relatively low. However it is important to note that it does not include international distribution, and is therefore not directly comparable to the other studies mentioned.

An additional comparison of organic with conventional viticultural practices, a study in Greece found that emissions were significantly lower in organic vineyards, mainly due to the energy inputs required\textsuperscript{90}. The study looked only at on-farm energy requirements and found that plant protection production, irrigation and fertilizer application in conventional (39.1%, 17.2% and 16.4% respectively) and in organic vineyards (36.6%, 15.5% and 12.1% respectively) required the highest energy inputs. Although in this study, irrigation energy inputs were only slightly lower in organic farming than in conventional, other researchers have reported a significant difference between organic and conventional irrigation requirements, due to soil health and moisture storage capacity\textsuperscript{91}. This finding is important for both the Mediterranean and South African wine growing regions, as both are predicted to have increased water shortages due to climate change\textsuperscript{92}.

Table 5: Breakdown of energy inputs for Italian winery\textsuperscript{53}

<table>
<thead>
<tr>
<th>Energy: Overall energy used</th>
<th>(in GJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diesel</strong></td>
<td></td>
</tr>
<tr>
<td>Agricultural machines</td>
<td>2870</td>
</tr>
<tr>
<td>Transports</td>
<td>66</td>
</tr>
<tr>
<td>Transport (input products)</td>
<td>346</td>
</tr>
<tr>
<td>Transport (output products)</td>
<td>1013</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4295</td>
</tr>
<tr>
<td><strong>Electricity</strong></td>
<td></td>
</tr>
<tr>
<td>Agriculture (irrigation)</td>
<td>84</td>
</tr>
<tr>
<td>Process</td>
<td>5814</td>
</tr>
<tr>
<td>Bottling</td>
<td>275</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6173</td>
</tr>
<tr>
<td><strong>LPG</strong></td>
<td></td>
</tr>
<tr>
<td>Hot water production</td>
<td>121</td>
</tr>
<tr>
<td>Steam production</td>
<td>33</td>
</tr>
<tr>
<td>Plant heating</td>
<td>88</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>242</td>
</tr>
</tbody>
</table>


Table 6: Summary table of all international studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Focus</th>
<th>Scope</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fearne et al. (2009)</td>
<td>Assessing which element of the supply chain accounts for greatest proportion of the total footprint</td>
<td>Vineyard (S. Australia) to market shelf (UK)</td>
<td>Viticulture practices &amp; packaging account for &gt;50% of total emissions Included production emissions from infrastructure</td>
</tr>
<tr>
<td>Colman and Päster (2007)</td>
<td>Different production and processing methods (packaging), transport distances, and transport modes</td>
<td>Grape production, processing, transport, packaging, &amp; distribution to market shelf</td>
<td>Range of 2 - 4.5kgCO2e/750ml bottle 4.6kgCO2e/375ml bottle Distance to market matters, but transport mode is key. Size and weight of bottle matters</td>
</tr>
<tr>
<td>Cholette and Venkat (2009)</td>
<td>Transport emission only – different supply chain options</td>
<td>Winery door to customer door</td>
<td>Transport emissions = 0.46kgCO2e/ half case Large variation exists – efficiency, utilization and type of vehicle makes a significant difference</td>
</tr>
<tr>
<td>Ardente et al. (2006)</td>
<td>Organic vs conventional</td>
<td>Grape production, transport to winery, processing &amp; storage, packaging, transport to local distributor</td>
<td>1.6 kgCO2e/ 0.75l bottle. 60% of emissions came from indirect processes (packaging and bottling production).</td>
</tr>
<tr>
<td>Kavargiris et al. (2009)</td>
<td>Organic vs. conventional farming energy inputs (i.e. not GHG emissions)</td>
<td>Within farm gates – grape production</td>
<td>Irrigation, fertilizer application and agrochemical production were the highest energy inputs. Energy inputs were higher in conventional than organic farming, due to higher fossil-fuel usage.</td>
</tr>
</tbody>
</table>

The results of these and other studies are assisting the wine industry to become actively involved at a policy level through the engagement and development of effective climate change response strategies and relevant legislative targets. Of the wine growing regions, the South Australian government has been most proactive and serious in its approach. In 2007 the South Australian government enacted the **South Australian Climate Change and Greenhouse Emissions Reduction Act**, which legislates targets for GHG reductions within various industries. Following the signing of this Act, the South Australian wine industry initiated a project which seeks to measure the carbon footprint of the regions wine industry. The project aimed to create a thorough understanding of climate change related issues and published several information briefs on the topic. The development of the Australian Wine industry carbon calculator, based on the International Wine carbon calculator but calibrated to Australian conditions and using Australian data, was completed in 2009. Several training workshops were held across the regions to encourage the producers to use the tool. A first round of data analysis has recently been done on the limited data that had been generated to date. The preliminary results show that grape growing (i.e. viticultural practices) **appeared to have higher emissions** and energy intensity than the other processing activities. It is noted, however, that due to the small sample size and the fact that these results are highly averaged, they mask the variation that exists within the industry. The other major finding from the analysis was that **GHG intensity decreased as the scale of production (of both wineries and vineyards) increased**, showing a positive impact on emissions by economies of scale.

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In summary, the following points are drawn from the above mentioned case studies and provide an outline of possible mitigation options within the wine industry.

- Packaging choices make a big difference to the total footprint – the larger (1.5l versus 750ml) and lighter (thinner glass or PET options) the bottle, the lower the footprint.
- Redesign the packaging options used to improve recycled material ratio.
- Biodynamic farming reduces financial costs and energy requirements of crop production.
- Reduce the use of fertilizers by utilizing cover crops and nitrogen fixing legumes between rows.
- Distance is important but transport mode key: sea freight can be up to 6 x more efficient than air freight.
- Utilizing bulk shipping and bottling closer to market reduces the distribution related emissions, but can have social implications in the country of origin by reducing the employment requirements.
- Reduce external transport by selecting nearer suppliers or choosing different transport options (shipping or train versus air or road transport).
- Improve efficiency within vehicle and equipment usage – downscale tractors and bakkies and ensure they are properly tuned.
- Using a wine tank with improved insulation will reduce the electricity required and thereby lower the carbon footprint of the wine processed.
- Utilization of more efficient irrigation systems like drip irrigation will reduce electricity and water usage as well as improve soil moisture storage capacity, further reducing the electricity and water requirements.
- If irrigation pumping is required, investigate using an “off-the-grid” energy source that is renewable and clean such as solar or gravity-powered.

Many of the above-mentioned mitigation options are mutually beneficial in that the one action will result not only in emission savings, but also financial savings, and often improved soil health and crop quality as well. It makes business sense therefore to start by measuring the carbon intensity of your business practices and then implement practices or technologies that can reduce the carbon intensity throughout the supply chain.

### 3.2 International Fruit Industry Case Studies

In a similar manner to the wine industry, the fruit industry is highly competitive market. Many fruit producers and exporters have begun internalizing and measuring the impact of the production and distribution of their product as part of their business management practices. The following international case studies illustrate how the variability of different measurement tools, production methods and storage conditions can significantly impact the energy and/or carbon intensity of a product.

In the fruit industry, and in fact the agricultural export industry as a whole, New Zealand is leading the way in terms of carbon footprint assessment. This is mainly due to the fact that New Zealand is responsible for approximately 50% of the UK’s apple imports, and yet is located relatively far from this important export market. As a result, distance from market and pressure from UK retailers in response to the Food Miles debate are important drivers of the proactive response of the New Zealand industry to carbon footprinting.

New Zealand’s apple production is specifically known to be dominated by producers that practice environmentally sustainable methods\(^{94}\) and there have been a number of studies quantifying the positive impact of sustainable production in relation to the “food miles” debate.

\(^{94}\) According to the study (footnote 95), over 90% of the growers use the Pipfruit Integrated Fruit Production (IFP) programme and the balance (9%) use the Organic Fruit Production (OFP) methods (during the 2000-2001 season).
The first study focuses on a cradle to gate assessment of emissions, excluding distribution, cool storage and consumption. It covered all inputs and activities related to apple production (including production of products and capital goods use). The aim of the study was to identify the environmental impact associated with Integrated Fruit Production (IFP) across 5 orchards within two regions of New Zealand. The study shows that fuels (energy), fertilizers and pesticides generate an important share of many impact categories. Thus, using diesel, petrol or electricity as an energy source determines the magnitude of emissions. Similarly, the type, application rate and timing of application play a significant role in the level of environmental impact of fertilizers and agrichemicals. The bulk of direct energy consumption is from field operations (“mechanisation”) (64-71%), particularly harvesting. In terms of indirect energy consumption, the contribution of pesticide production is significant - 10-20% of the total energy consumption. Energy consumption related to machinery production contributes 7-12% of total energy consumption and fertilizer production represents 5-11%.

Large variation was evident between the different IFP sites as a result of differences in irrigation and frost fighting requirements (water used) and machinery efficiencies. Direct GHG emissions were dominated by energy related CO$_2$ emissions relating to fuel usage (34-50%) and fertilizer use (25-51%). N$_2$O emissions from mineral fertilizers depend on the time of application and the composition of the fertilizer (rate of ammonia-and nitrate-N) which explains the variation in contribution at different sites.

Evaluating transport in isolation, although valuable to assess different modes and distances, is not seen as a meaningful quantification of the total environmental impacts of products to market. Results favour the locally produced products, if based purely on distance. For example, Mason et al. (2002) calculated the carbon emissions due to transport of the three possible sources of apples to be consumed in the UK: local, Europe, and New Zealand. The results were 31, 85, and 167 gCO2/kg apples respectively. Sim et al. (2007) studied imported and local (UK) food systems (including production to shelf) to determine the relative significance of transport. For the case of apples, transport contributed 72% and 90% of the carbon footprint of imports from Chile and Brazil as compared to 30% for Italian apples and 6-21% for UK ones. The research emphasized the importance of origin of apples in determining the transport energy, but didn’t include other life cycle burdens in the analysis, for example cultivation or storage energy, which are country specific and have been shown to play a significant role in the overall energy requirements.

Cradle to shelf (UK market): A LCA study was conducted in 2007 with the aim of evaluating whether the concept of “food miles” was a useful tool to measure the environmental impact of foods. The study looked at supplying 1 kg of apples to the UK market on a year-round basis and specifically focussed on variability in primary energy requirements, seasonality (timing of consumption) and loss of produce during storage. The results show that primary energy use (PEU) for apple production ranges from 0.4-3.8MJ/kg apples for European and Southern American countries, and 0.4-0.7MJ/kg for New Zealand apples. Similar results were found with respect to the size of the differentials in more recent study, although the absolute total energy figures were higher (2.98MJ/kg New Zealand fruit compared to 5.03MJ/kg fruit for UK apples). This variability is related to the different yields and producer management practices in the different countries. Storage conditions was shown to have a significant effect on the results, for example, by increasing the PEU by 8-16% when stored for 5-9 months in Europe (for European apples) compared to negligible storage losses in New Zealand and South America. The study found that the timing of consumption (seasonality) and related storage losses are vital in an assessment as this

affects the order of preference for locally versus imported apples. The variability in energy requirements, and energy sources, particularly during the fruit production stage, is also an important element to include in such assessments.

**Cradle to shelf (German market):** Blanke (2008)\(^{100}\) did a LCA which assessed the PEU of providing apples (Braeburn and Golden Delicious) to the market in the Rhein-Ruhr area in Germany by comparing locally-grown produce with fruit imported from New Zealand and South Africa. The home-grown apples were harvested in mid-October and stored in CA storage for 5 months on site, until mid March. The Southern Hemisphere apples (Hawke’s Bay, New Zealand and Grabouw-Elgin, South Africa) were picked in March and shipped on reefers (taking 28 and 14 days respectively) to Antwerp, and trucked to Germany for sale in April. The results showed that the primary energy required for fruit production of the **New Zealand Braeburn apples was 0.7MJ/kg** fruit, which represented approximately 11% of the overall PEU, while that of the **South African apples was 1.0MJ/kg fruit.** It is noted, however, that these figures are not directly comparable, as the South African producer had much smaller production levels than the New Zealand producer (40t/ha and 90t/ha respectively), which will impact the energy requirements.

The study found that **locally grown fruit had the lowest total energy requirement (cradle to shelf), of 4.1MJ/kg fruit,** of which 0.8MJ/kg was required for the 5 month CA storage during the winter. By comparison, the **total energy footprint for the Southern Hemisphere imports was 6.8MJ/kg and 6.4MJ/kg**\(^{101}\) for New Zealand and South Africa respectively. This means that although the energy requirements of the production of the fruit are significantly lower in the Southern Hemisphere countries, the energy used in the transport leg required to get the fruit to market makes the total energy requirements for the locally produced apples lower overall. However, the study does mentioned that to fully compensate for fruit imports from South Africa and New Zealand, the home-grown apples would need to be stored for 9-19 months respectively, which was a much longer timeframe for CA storage than was used in the study.

The impact of **storage on wastage, end fruit quality and total tonnage of fruit required versus sold** is also an important aspect to consider in such a comparison, which was neglected in the Blanke (2008) study. L. Mila’i Canals et al. (2007)\(^{103}\) highlighted it as being an important indirect contribution to the total impact per kg of apples consumed. In addition, the above Blanke (2008) study makes little reference to the social elements of the importing countries and the role of supporting **socio-economic development** in developing economies (specifically South Africa). Brenton et al. (2008)\(^{104}\) discuss the recent explosion of carbon accounting activities and carbon labelling schemes in light of their impact on small stakeholder, specifically within low income countries. The paper centres around transportation, and how exports from low income countries typically depend on long distance transportation, and the popular belief that trade by definition is problematic since it necessitates transportation, which is a major source of emissions. The paper points out that the **carbon efficiencies elsewhere in the supply chain can more than offset the emissions associated with transportation.** Furthermore, the inclusion of low income countries in labelling schemes may offer opportunities for carbon emission reductions due to their favourable climactic conditions and their current use of low energy intensive production techniques. In South Africa, however, this may not always be the case due to the energy mix being predominately coal-based, whereas other countries such as Brazil or Argentina have more renewable energy options available.

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\(^{101}\) There are 3.6MJ/kWh. Based on Carbon Trust database, New Zealand emission factor is 0.21kgCO2e/kWh and Eskom’s (South Africa) is 1.03kgCO2e/kWh therefore this equates to 5.14kgCO2e/kg New Zealand fruit and 23.73kgCO2e/kg South African fruit. This difference is due to the fact that 64% of New Zealand’s energy is from renewable sources.

\(^{102}\) Note: this calculation assumes the shorter transport leg is from South Africa, and the longest from New Zealand, therefore the figure of 5.4MJ/kg fruit was applied to South African fruit and 6.1MJ/kg to New Zealand fruit, based on the transport range within the study.

\(^{103}\) See footnote 98

US produced and sold Orange Juice

In 2007 PepsiCo, which owns the orange juice brand Tropicana, did a carbon footprint assessment of a half-gallon carton of their orange juice. The result was 3.75lbs, or 1.7kgCO2e per carton of juice. The study was full LCA and covered aspects relating to the production, processing, use and disposal. The production of the juice accounted for 60% of the total emissions, of which fertilizer production and application was the single biggest contributor (58% of production and 35% of total), dominating electricity or transport related production activities. The remaining non-production contributions to the total footprint were distribution (22%), packaging (15%) and use/disposal (3%). The study highlighted the excessive amounts of nitrogen-based fertilizer used within the US citrus industry, and has resulted in two pilot studies by the leading fertilizer suppliers (Yara International and Outlook Resources) to the PepsiCo group and associated producers. If successful, the low-carbon fertilizers could lower the carbon footprint of Pepsi-Co’s citrus growers by as much as 50% and reduce the carbon footprint of Tropicana orange juice by up to 20%. Yara is experimenting with calcium based fertilizer in an attempt to move away from natural gas and other fossil fuel based derivatives as inputs and is also looking at internal manufacturing efficiencies. Outlook Resources, on the other hand, are looking to produce their fertilizer from renewable resources, specifically locally sourced feedstocks, thereby reducing transport-related emissions and fossil-fuel dependency. Outlook also states that their product is more effective, so less is required to sustain a similar yield, which will also reduce the water pollution associated with fertilizer runoff. PepsiCo is running a 5-year trial and if successful, will start using the greener fertilizers throughout their agricultural supply chain.

Zespri New Zealand Kiwi fruit production

As early as 2001, Zespri International Ltd. conducted an energy audit of 41 hectare kiwifruit farms, including field operations, contractor fuel use, transport of fertilizer and the embodied energy of inputs (fertilizers, agrichemicals and capital infrastructure). Results showed the total energy footprint to be 2013 GJ/yr or 49GJ/ha, with direct energy usage contributing 550GJ/yr or 13.4GJ/ha – 27% of the total energy use. Indirect energy, (embodied in the manufacture and transport of fertilizers and agrichemicals) represented the most significant energy cost, 51% of the total or 25GJ/ha. Capital energy use, embodied in the manufacture of machinery, buildings, support structures and irrigation systems contributes 438GJ/yr or 10.7GJ/ha – 22% of the total energy use. Diesel fuel was 85% of the total direct energy (465GJ/yr), while electricity was only 15% (85GJ/yr). Recommendations for improvement include focussing on optimizing the inputs of fertilizer and agrichemicals, as well as improving efficiencies within diesel usage through reduced tractor hours and a shift to renewable fuel sources.

Conclusion from the international case studies

Due to the varied scope (cradle to gate, transport only, or cradle to shelf) and measuring units (kgCO2e/kg fruit or MJ/kg fruit), direct comparisons of the international studies is a challenge. The studies are valuable, however for evaluating trends for energy requirements through the supply chain, most of which is concentrated within on-farm activities. Furthermore, many studies pointed out the important role of different producer management practices and primary energy sources in relation to the total footprint results. Given that New Zealand, for example, has an energy mix of roughly 60% renewable, the GHG emissions relating to energy usage will be lower than most comparative countries (such as South Africa and the UK). The role of individual producer practices (specifically activities such as mowing, thinning, pruning and harvesting) can result in up to a 30-fold variance in energy consumption, thereby significantly impacting the

total energy footprint of the product. Furthermore, the type, application rate and timing of application play a significant role in the level of environmental impact of fertilizers and agrichemicals.

Evaluating the environmental impact of a product based purely on distance is no longer an acceptable assessment. A full LCA paints a more realistic and holistic picture of the total impact of a product, and should include the social implications together with the full suite of environmental indicators. Furthermore, many environmental impacts are linked to financial results, with environmental impact reductions associated with reductions in production costs. For most of the studies, as more than 50% of the impact categories were linked to energy – therefore the cost reductions provide a strong incentive for producers to improve efficiency and limit environmental impacts.

Table 7: Summary table of fruit industry studies reviewed above

<table>
<thead>
<tr>
<th>Study</th>
<th>Focus</th>
<th>Scope</th>
<th>Summary of Findings</th>
</tr>
</thead>
</table>
| Canals, M.L. et. al (2006) - apples | Establishing the greatest environmental impacts within on-farm activities | Full LCA of production to gate (excluding cold storage, distribution and disposal). Survey over 5 different farms. | Direct energy: Field operations (mechanisation) = 64-71% of total footprint  
Indirect energy: Pesticide production = 10-20% of total footprint, fertilizer production = 5-11% of total, machinery production = 7-12% of total. Direct GHG emissions were mostly energy related (fuel = 34-50%) and fertilizer application (25-51%). |
| Canals, M.L. et. al (2007) – apples | Evaluating the role of distribution in the environmental impact of a product. | Full LCA of production (New Zealand) to retail shelf (UK) | Production: New Zealand = 0.4-0.7MJ/kg apples  
Europe/South American countries = 0.4-3.8MJ/kg apples  
Storage energy requirements (European fruit) was up to 15% of total energy footprint. Energy source made positive impact on New Zealand fruit footprint (60% renewable energy) and hampered European apple's energy footprint.  
Influence of yield quantities and different producer management practices was significant.  
Storage loss and seasonality impacted results. |
| Blanke et. al (2008) - apples | LCA and influence of transport on total energy input | Production (South African and New Zealand) to retail shelf (Germany) | Locally grown fruit = 4.1MJ/kg fruit  
South African fruit = 6.4 MJ/kg fruit  
New Zealand fruit = 6.8 MJ/kg fruit  
Southern Hemisphere fruit production = 11% of total energy footprint. Distribution = 40-45% of total energy footprint  
Locally grown fruit: CA storage = 35% of total  
Study found that CA storage offset distribution emissions, however wastage and fruit quality must be considered |
| Brenton et al. (2007) – general fresh produce | Transport of products – Food Miles and the impact of carbon labelling | | Efficiencies throughout the supply chain can more than offset emissions that results from distribution (distance to market) |
| PepsiCo. Tropicana orange juice | Full LCA to establish greatest contributor to GHG emissions | Production, processing, use and disposal | Total footprint = 1.6kgCO2e/ half gallon carton.  
On farm activities (production of oranges) = 60% of total emissions, of which fertilizer production & application was greatest contributor (58%).  
Distribution = 22%  
Packaging = 15%  
Use/disposal = 3% |
| Barber and Scarrow (2001) - Kiwifruit | An energy audit of a specific kiwi fruit farm (i.e. results in GJ not tCO2e) | On farm processes, including embodied energy inputs (process emissions from fertilizer and infrastructure). 41 hectare farm. | Total energy footprint = 2013 GJ/yr or 49GI/ha  
Direct energy = 27% of total, of that diesel usage was 85% and electricity 15%.  
Indirect energy - embodied energy of fertilizers & agrochemicals = 51%, Indirect energy – capital energy use for production of irrigation, buildings and support structures = 22% |
3.3 The South African Fruit and Wine Industry Assessment

As outlined in the Confronting Climate Change project proposal, one of the main aims of the project was to:

“**develop a global standard-based protocol that outlines the methods and process involved in calculating the footprint of a product within the South African fruit and wine export sector; and a tool that can be used to establish a detailed (per farm) carbon footprint, within and across the industry. The resulting quantified emission factors per product or process can then be used to establish emission-reduction targets, which can feed in to management planning and reporting, as well as feeding in to an industry comparison for the sector.**

*In addition to the development of the Protocol and Tool, a broad-stroke industry-wide benchmarking exercise will be completed within the local market, in order to establish current emission averages for the industry. “*

Following one year of active training and encouraged participation within the industry, the first round of the industry “benchmarking exercise” was initiated in 2010. The data for the analysis was drawn from the backend data base of the online tool, where data is stored in generic format to be used for high level industry assessments. Following the first level analysis, however, it soon became clear that the data was neither of adequate quality nor quantity to reflect the industry accurately. A decision was made by the project team and Steering Committee to allow an additional year of online activity and more strategic engagement with specific industry representatives in order to improve the data sample set. Five industry data sample workshops were held during the first half of 2011, to account for the different harvesting periods and thus the availability of time for the industry members to take part in the process. In total 43 industry members attended the workshops, representing roughly 44 farms, 26 packhouses and 25 cellars from around the country. However, due to various capacity, harvesting and technical constraints, only 26 data sets were completed in time to use for the industry data analysis. The Colors Fruit and Vinpro data was used to supplement the database and improve representivity within the fruit and wine industries respectively.

**Method**

The greenhouse gas (GHG) emissions (measured in the unit tCO₂e/unit fruit or wine) were calculated using the set of conversion ratios adopted by the Confronting Climate Change carbon calculator protocol. The conversion ratios are predominantly based on the DEFRA 2011 values with more ratios more specific to a South African context adopted where possible (for example, GHG emissions from the use of Eskom supplied electricity). The dataset was then checked for incorrect or outlier data. Where an outlier was found (an observation that deviates markedly from other data within the same sample group), additional communication was made with the provider to assess if the data is true or incorrect.

On initial inspection, considerable variation was found in reported GHG emission data due to the variability in the type of entity audited (packhouse, logistics, farm or winery), the size of the entity, the regional position and related distance to suppliers, ports and markets. Therefore, single commodity farms were used to calculate an “average” GHG emission value for the commodity group on a regional basis where possible. The four fruit commodities included in the study were table grapes, citrus, stone fruit, and top fruit (also known as pome fruit). The wine industry data was analysed separately from the fruit commodity groups due to the different cultivation and processing activities involved.

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107 Available for download on the project’s website: [http://www.climatechangefruitandwine.co.za](http://www.climatechangefruitandwine.co.za)
Results

On farm production

The GHG emissions generated through the production of fruit on farm range from 0.2 to 0.7 tCO₂e per ton of fruit. On lower end, emissions from citrus farms tend to be less than 0.2 tCO₂e per ton of fruit, whereas on the upper end of the range, emissions from the production of table grapes are generally greater than 0.7 tCO₂e/ton of fruit (Figure 2).

![Farm GHG emissions: generated mainly through electricity, diesel and agrochemical consumption](image)

**Figure 2:** On farm emission comparison of the four fruit commodity groups

At a farm scale, electricity usage is the largest source of GHG emissions, accounting for over 70% of emissions on average (Figure 3). The percentage contribution may vary between commodities (Figure 4) but electricity usage generally contributes over 60% of the GHG emissions generated through the production of fruit on farm. It is assumed that the majority of electricity usage is for irrigation pumping. While the average contribution of agrochemicals and liquid fuels (diesel) is each approximately 13%, there can be significant variation in the relative contribution depending on the commodity under concern.

![The average GHG emission profile at farm level across the four fruit commodities](image)

**Figure 3:** The average GHG emission profile at farm level across the four fruit commodities
Figure 4: The GHG emission profile at farm level for the four fruit commodity groups

GHG emissions generated through the packing and distribution of fruit

In a similar manner, the emissions per unit fruit from the transport of produce to market vary considerably depending on the commodity (Figure 5). The variation observed, from less than 0.4 tCO$_2$e/ton for citrus and topfruit, to more than 1.0 tCO$_2$e/ton for stone fruit, is mainly due to the proportion of produce transported to market by air freight relative to sea freight (Figure 6). Whereas less than 2% of citrus and topfruit within the sample group is exported by air, up to 14% of stone fruit is transported to market by airfreight. On initial reflection, 14% may appear as a small insignificant component of the total mass transported, but the relative contribution is disproportional due to the considerable difference in the GHG emissions generated by air compared to sea freight - the GHG emissions generated through sea freight per ton transported are 25 times less or 4% of that of airfreight (0.025 vs 0.6193 kgCO$_2$e/ton.km).

Figure 5: GHG emissions generated in post-production (packhouse, coldstore & distribution)
Figure 6: A comparison of air freight versus sea freight per commodity group

GHG emissions from the packaging, pack-house and cold store processes

Although the total GHG emissions generated through the process of washing, packing and cold store of fruit prior to distribution are generally similar for citrus, stone fruit and table grapes (ranging from 0.29 – 0.34 tCO₂e/ton fruit), there is considerable variation in the relative contribution of each source of emissions for each commodity, be it from the different types of packaging or electricity usage at the pack-house and cold store stages (see Figure 7 & 8 below).

Electricity usage through the pack-house and cold-store process generates the majority of emissions followed by the embodied emissions of corrugated cardboard used packing fruit. The embodied emissions of plastic packaging can also make a significant fraction of the total emissions of particular commodities such as stone fruit and table grapes.

Topfruit however, has a significantly different GHG emissions profile due the use of controlled atmosphere (CA) storage. The use of CA storage, in which the concentration of oxygen, carbon dioxide and nitrogen in the air is regulated in addition to temperature, results in considerable GHG emissions per unit fruit. Compared to the 0.29-0.34 tCO₂e/ton⁻¹ range for other fruit commodities, the packhouse, CA- and cold storage component of the topfruit supply chain results in approximately 0.77 tCO₂e/ton fruit⁻¹ being emitted. CA storage alone contributes 30% of the total GHG emission generated through the production, packing, storing and distribution of topfruit. In terms of reducing the embodied emissions of topfruit, ensuring efficient use of CA storage is an obvious a key area of focus.

The relative contribution of each source of emissions through the production and supply of fruit

The distribution of fruit produce via sea and air generally makes up the majority of embodied GHG emissions (Figure 6). As discussed, the contribution of emissions generated through distribution relative to the overall embodied emissions of the commodity, is strongly dependent on the proportion of produce transported by air relative to sea. Especially for producers and exporters of stone fruit, reducing the percentage of produce transported by air to market, may be one of the more effective ways of reducing the net embodied emissions of produce.

Reducing electricity usage at a farm, pack-houses and cold store level is the next key area where significant emission reductions can be made. Particularly a shift to renewable sources of electricity could reduce the embodied emissions at a farm scale by up to 70%. Thereafter, as explored in the section below, GHG emissions generated through the use of
packaging, particularly cardboard and paper, are not insignificant. Again, a considerable reduction in emissions could be made if the amount of packaging was reduced or alternatives with lower embodied GHG emissions were used.

**Figure 7:** Relative contribution of post-production activities on GHG emission profile for the four fruit commodity groups

**Figure 8:** The overall GHG emission profile for the four fruit commodity groups
The impact of scale: comparing emissions from wineries

The GHG emissions produced per ton wine grapes or kilolitre of wine produced are often strongly related to the scale of production, albeit in a non-linear manner. As example, the charts below illustrate the relationship between annual production and GHG emissions produced per litre of wine during the winery process. The volume of wine produced annually is represented by the horizontal x-axis. As the annual production of farm increases, the GHG emissions per unit wine decreases considerably. GHG emissions per litre of wine for smaller wineries that produce less than 2000-4000 Kl of wine per year tend to be an order of magnitude more than larger concerns that produce over 5000 Kl of wine annually.

Whereas scales of efficiency are found on most inputs, one of the more prominent is electricity usage. Electricity usage per unit of wine produced was found to be up to 20 times less in larger wineries compared to smaller estates. GHG emissions from packaging were also considerably less for larger wineries (up to 5 times smaller), although this observation may not only be influenced by the scale of production but the manner in which smaller estates market and package wines compared to bulk delivery.

Figure 9: GHG emissions from winery operations

Figure 10: GHG emissions from electricity usage in winery operations
Future data considerations

The data used in this industry analysis was from a limited sample set and therefore is not representative of the industry at large. It is however, a valuable indication of the average GHG emission profile of the industry members using the online carbon calculator tool. In order for the data set to become an accurate reflection of the South African fruit and wine industries, a much larger sample group should be incorporated on both a regional and commodity group level. Capacity and time constraints caused by the various harvest periods, unexpected commitments, and the internal project team deadlines reduced the overall level of participation and had a significant impact on the final sample size used in the analysis. It is recommended for future benchmarking exercises that adequate resources and time allocations be accommodated in the schedule of the analysis process. In addition, it is anticipated that through continued engagement with the industry, the numbers of individuals using the online tool will increase, as a result of the support and encouragement from the industry bodies and key industry members. Finally, it is understood that the undertaking of a carbon footprint is currently a voluntary process and as such, is not always a priority for South African producers and exporters, who have many other areas that required mandatory auditing. However, it is highly likely that carbon measurement and reporting will become a mandatory requirement in the next few years, especially for international export products. In light of this, it makes sense that the industry members begin using the online tool sooner rather than later, to better understand the process involved and incorporate smooth alignment with existing auditing systems.

Conclusions from the local study

The results show that electricity usage is a significant contributor throughout the supply chain of all commodity groups due to the quality of the energy source and the dependability of all processes on this dirty energy source. This represents both a risk and opportunity for the fruit industry – a risk in terms of the high dependency of electricity for various activities as was highlighted in this study, together with the escalating energy prices expected over the next few years; and an opportunity to improve efficiencies and reduce both GHG emissions and financial costs per year. Specific activities to focus efficiency measures on include irrigation (pumping) and coldstore energy use. Electricity usage and emissions related to CA storage is significant for the top fruit commodity group and is highlighted as a key area for improved efficiencies. Packaging was also highlighted as a significant contributor to the total emissions, and represents an area where small changes can have a great impact in reducing emissions, packaging waste and costs. Overall, the transport

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Figure 11: GHG emissions from packaging used in wineries

South Africa’s grid electricity is coal-based, a dirty and inefficient fuel source, which therefore generates large GHG emissions during usage.
mode to market was the most important factor in determining the total GHG footprint of the different commodity groups over full supply chain. Utilization of air freight, even if only for a small percentage of total export, will overshadow all other transport options and significantly impact the footprint of the product reaching the retail shelf. However, international studies\textsuperscript{109} show that carbon efficiencies elsewhere in the supply chain can more than offset the emissions associated with transportation.

The following summary provides suggested actions that could mitigate the carbon footprint of the average South African fruit/wine producer.

Mitigation options highlighted from the study:

- Implement energy efficient technologies, explore renewable and independent power sources (such as solar powered cooling, infrastructural changes and gravity fed irrigation pumps), specifically for on-farm and coldstore activities.
- Distance to market is a disadvantage for the South African fruit industry, but choosing a more efficient transport mode for international distribution can make a significant difference to the total footprint, often negating the additional energy requirements used for storage of locally produced products.
- Sea freight is substantially more efficient than air freight and should be utilized as much as possible.
- Within local transport routes, exploring rail options could reduce the transport related emissions and costs, although more research needs to be done to adequately quantify this (see Tonnage off Tar initiative run through the Post Harvest Innovation Fund\textsuperscript{110}).
- Improving efficiencies within transport, for example, the load of the truck and frequency of utilization, makes a significant difference in reducing the overall footprint of the product.
- Reduce agrochemical inputs and switch to more biological alternatives where possible
- Utilization of precision application will avoid excessive agrichemical use and reduce both emissions and costs.
- Packaging options contribute substantially to the overall footprint of a product and thus offer an area where changes in packaging products (for example, to more recycled- or bio-based products) can reduce energy and overall GHG emissions of the product.

These mitigation options have been highlighted through the local and industry case studies. It is, however, recognised that the production and management choices within each business are unique. It is the aim that the above mentioned high-level options provide a starting point for the industry to begin engaging and considering the mitigation opportunities that could enhance their current and future business practices. Complimenting the above mentioned trends and opportunities, the freely available carbon footprint tool\textsuperscript{111} allows industry members to assess their specific business practices and identify emission hotspot areas where implementing change would have the most impact. As the support of the tool grows, so too will the database for the industry analysis, providing a more representative and accurate profile of the industry to be established. Eventually, the industry database aims to providing a powerful monitoring and benchmarking tool for the South African fruit and wine industry to utilize in comparative reporting, identifying common research and development priorities, and in engaging with international market players.

\textsuperscript{109} Op. Cit. – see footnote 100
\textsuperscript{110} http://www.postharvestinnovation.co.za/index.php?option=com_content&view=article&id=45&Itemid=43
\textsuperscript{111} Available at www.climatefruitandwine.co.za
CONCLUSION

The South African government has committed to significant emission reduction targets - a 34% decrease in emissions relative to a ‘business as usual scenario’ by 2020, followed by a steeper 42% decrease by 2025. And the government is not going to be able meet this target without calling on industry and private sector to come to the party. Already, the National Climate Change Response White Paper released in October 2011 makes reference to the planned national government’s intention to introduce a mandatory reporting mechanism for companies that emit more than 100,000 tCO2e (Scope 1) annually or that consume electricity that equates to more than 100,000 tCO2e (Scope 3)112. This acknowledges that the government recognises the need to begin measuring, monitoring and reducing GHG emissions which, in South Africa, is largely linked to electricity usage. Neither the mechanism nor the regulatory environment in which to enforce the reporting and reduction are yet to be defined, but what is clear is that the obligation is not going away. Those businesses opting to take their initiative and begin addressing it now, will be in a more strategic position to respond later, when the mandatory requirements kick in. For export companies, particularly in the fresh produce industry, this pressure is compounded due to market access requests pushing back through the supply chain.

There is no doubt that the current environment is a challenging space to do business in. These pressures cause many South African producers to feel overwhelmed and unprepared. But through that pressure comes the reaction to change, to adapt, and to become better- better suited to meet the international regulatory requirements, better suited to meet the consumer demands, and better suited for the changing climatic conditions. The project team and industry bodies supporting the Confronting Climate Change project are helping to facilitate that change through continued knowledge sharing and discussion, skills transfer and training, data gathering and analysis, and prioritizing the research and development of effective change management strategies. As part of this support structure, this Strategic Framework Reference Document aims to provide a thorough review of the subject of climate change, placing the tangible issues in context of the South African fruit and wine industries, and the international environment in which their members do business. Below is a summary of the key risks and opportunities that exist for the industry, in the short, medium and long term, and from which management decisions and response strategies at both an individual and industry level can be initiated.

A SUMMARY OF KEY RISKS AND OPPORTUNITIES FOR THE INDUSTRY

**Electricity usage:** The dominant and most immediate risk for the fruit and wine industry is related to the strong reliance on fossil-based energy sources (Eskom and diesel) as the majority of processes within the supply chain utilize this form of energy. This risk exists both in terms of financial implications and possible regulatory mechanisms that are likely to be implemented in the near future (such as carbon tax and/or mandatory GHG emission measurement and reporting). The first step in better understanding the proportion of electricity usage in business activities and the resulting GHG emissions is to undertake a GHG assessment. This process will outline the most immediate and significant activities to prioritize energy efficiency and reduction implementation actions. Through this process, opportunities exist in terms of reducing reliance on carbon intensive and expensive energy sources which can reduce operational costs and improve the sustainability of business performance.

**Regulatory systems:** Upstream industries such as power generation and downstream industries such as transportation will likely be regulated on their carbon emissions in the near future. This regulation, typically through a cap-and-trade scheme such as the European Union’s Emissions Trading Scheme, imposes costs on less efficient companies as they must purchase additional emissions credits from more efficient companies. Since emissions trading schemes are aimed at the largest

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112 Considering the current emission factor for electricity is 1.03 kg CO2e/ kWh, the companies eligible for mandatory reporting would be those using more than 97,000 MWh of electricity a year.
emitters of greenhouse gases, such as power plants and refineries, the fruit and wine industry may escape direct carbon emissions regulation. More likely, however, is that it would be indirectly affected as upstream suppliers of electricity and agrochemicals and downstream suppliers such as transportation services become regulated, to the degree which they are dependent on fossil fuel energy. Doing business with the more efficient companies will result in a certain degree of insulation from price volatility and overall lower GHG emissions.

Another option for regulating carbon emission comes from government setting a price, rather than a volume. Carbon tax could be applied at the supplier (and major emitter) level, such as in emissions trading, or it could be applied at the consumer level whenever fossil fuel-based products are purchased, such as the case with the recently imposed tax on new vehicles. The impact on the fruit and wine industry would not differ much between the two different schemes, emissions or taxation. What is clear is that the additional cost at present is felt only by those companies that offset their emissions voluntarily and that future cost increases due to emissions reduction efforts will be proportional to the fossil fuel dependence of a supply chain. Since any additional emissions today increase the amount we must reduce our emissions at some future date, it is useful and to think of today’s emissions in terms of tomorrow’s mitigation costs.

**Market access:** Currently the main driver regulating and initiating “carbon-related” action within the industry, improved market access provides incentive for industry stakeholders to begin measuring and monitoring the GHG emissions within their business operations and supply chains. The freely available online tool offers a readily available *opportunity* to begin the process through an established standard and reporting mechanism. As sustainability issues continue to be a priority in the major international retail outlets, communication of the development and progress of addressing carbon related issues within one’s business may improve the marketability of one’s product.

In conclusion, there are “quick-fixes” or one-stop solutions that will suit every individual in effectively addressing such a complex issue as climate change. But it is not all doom and gloom either. Many opportunities exist where change can both mitigate climate change and improve business profits. An important first step in this process is to start measuring business activities in order to gain an understanding of the business profile and establish a baseline – or starting point – from where to begin the journey of change. Whether in a mandatory or voluntarily capacity, it makes business sense to start this process sooner rather than later, to better adapt and succeed in the carbon constrained future.

*It is the aim of the Confronting Climate Change project to facilitate effective collaboration, knowledge sharing and empowerment so the fruit and wine industries can better address the impacts of climate change together, and form a united industry-wide response and action plan that both mitigates and adapts to these impacts, while exploiting the opportunities that exist through improved development choices.*
Table 1a: Autonomous climate change adaptation options available for the fruit and wine industry (Midgley, S)\textsuperscript{18}

<table>
<thead>
<tr>
<th>ADAPTATION CATEGORY</th>
<th>ADAPTATION PRACTICE</th>
</tr>
</thead>
</table>
| Soil resources      | • Practices to reduce soil erosion  
|                     | • Conserve and improve soil carbon content, microbial activity, and water retention through integrated soil management  
| Water resources     | • Improve irrigation efficiency  
|                     | • Reduce production area and use existing water availability to produce high value produce in core areas  
|                     | • Secure additional reliable on-farm supply of fresh water for irrigation  
|                     | • Remove and control alien invasive to restore stream flow  
|                     | • Improve drainage to reduce negative impact of heavy summer rain  
|                     | • Introduce stricter measures and increase monitoring capacity to reduce pollution and salinisation of fresh water resources  
| Genetic resources   | • Develop suitable genotypes (drought-, heat- and pest-resistant cultivars) through local breeding  
|                     | • Develop suitable rootstocks for perennial horticultural crops which are hardy to the conditions, through local breeding  
|                     | • Import suitable cultivars and rootstocks and evaluate locally  
|                     | • Change to cultivars which use less water e.g. early-ripening  
|                     | • Change the crop to something more suited to the new conditions, this includes developing new infrastructure and developing markets e.g. Mediterranean-type fruit crops  
|                     | • Crop diversification and mixed farming, spread the risk  
| Pest, diseases, weeds | • Plant protection: identify, monitor and control pests, diseases and weeds (both existing and new)  
|                     | • Post-harvest maintenance of cold chain under warming conditions  
| Production practices and microclimate manipulation | • Adjust training system and canopy leaf management to create cooler conditions  
|                     | • Optimal use of natural windbreaks to reduce evapo-transpiration  
|                     | • Develop new effective and environmentally acceptable chemical products for use as dormancy-breaking agents for deciduous fruit  
|                     | • Use evaporative cooling technology to cool the crop and reduce sunburn  
|                     | • Use non-water technology to cool the crop and reduce sunburn (e.g. kaolin, shade netting)  
|                     | • Use hail netting to reduce losses due to changing occurrence of hail  
|                     | • Employ frost protection during early season  
| Weather services and information systems (collective) | • Extension of weather station network co-ordinated and managed by a central agency, with regular accurate information and forecasts to farmers; early-warning systems  
|                     | • Develop scientifically-based, suitably packaged information systems to help farmers with decision-making (Decision Support Systems, DSS), collate various sources of expert knowledge  
|                     | • Improve communication between role-players within and between the various industries  
| Disaster preparedness and response | • Maintain and strengthen fire-fighting capacity  
|                     | • Develop and improve early warning systems  
| Economic and labour | • Improve trade equity, access to new markets, benefit from new opportunities in global context  
|                     | • Adjust marketing strategies  
|                     | • Manage suitable insurance cover and other risk management approaches  
|                     | • Reduce farming to profitable units  
|                     | • Merge or form alliances with other farms (economies of scale and risk reduction through diversification)  
|                     | • Re-skilling and training of labour to support changing farming practices  

APPENDIX II

CLIMATE CHANGE REALTED INDUSTRY PROJECTS
# Climate Change related projects in the Fruit & Wine Industry as of end July 2011

Database compiled from Winetech, CRI & DFPT project lists

Last update: 30/09/2011

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<th>Project Title</th>
<th>Contact Point</th>
<th>Duration of project (years)</th>
<th>End date</th>
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