

# A Greenhouse Gas Footprint Study for Exported New Zealand Lamb

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SCIENCE



# **A Greenhouse Gas Footprint Study for Exported New Zealand Lamb**

**Report prepared for the Meat Industry Association,  
Ballance Agri-Nutrients, Landcorp and MAF.**

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# Executive Summary

## 1. Background

This report describes the first study to examine the full life cycle carbon footprint of New Zealand lamb exported to and consumed in the main export market.

The New Zealand meat industry has a strong interest in minimising the impact that production and consumption of meat products have on the environment, both in terms of greenhouse gases (GHGs) and other important, sustainability measures.

## 2. Objectives of the Study

- a. To provide a unique, unprecedented benchmark from which all in the industry can understand the carbon footprint for New Zealand lamb consumed in the European market, specifically the United Kingdom.
- b. To enable every participant in the New Zealand lamb industry supply chain to better understand and improve their emissions performance.
- c. To provide simple tools for members of the supply chain to understand the impact that different operational decisions (effort and investment) would have on the carbon footprint of lamb.

## 3. Methodology

This study is unprecedented in its breadth, detail and methodology and because of that, is not directly comparable with other footprinting studies for meat.

This study has used the Life Cycle Assessment (LCA) approach and is consistent with the PAS2050 published standard for greenhouse gas footprinting. Life cycle assessment seeks to examine the impacts of a product from production to consumption.

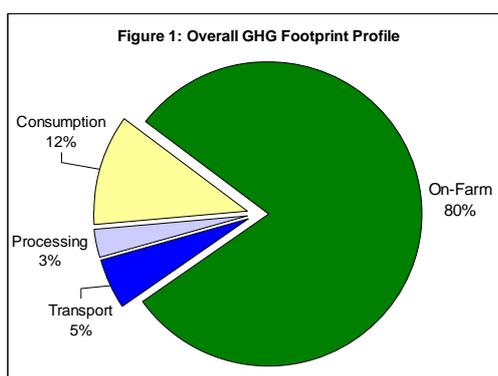
Emissions analysis undertaken for this study is consistent with New Zealand's GHG accounting methodology as submitted under the United Nations Framework Convention on Climate Change (UNFCCC).

## 4. Overall Findings

**The total carbon footprint was calculated at 1.9 kg CO<sub>2</sub>-equivalents for a 100 g portion of lamb meat. This can be segmented into 80% for the on-farm stage, 3% for meat processing, 5% for transportation and 12% for the consumer phase.**

This overall breakdown of the carbon footprint and the dominance of the on-farm component are broadly consistent with other international studies of products derived from farmed, ruminant livestock.

Key components of the lamb GHG footprint are as follows:



#### i. On Farm

On farm, the largest specific contributors to emissions are natural processes associated with sheep utilising pasture as a feed source. These natural processes include **methane from rumen digestion of pasture (via belching – 57% of total footprint) and nitrous oxide from animal excreta on soil (15% of total footprint).**

On-farm emissions are the most significant contributor to the footprint and also present the hardest challenges in terms of improvements. It is possible to improve the on-farm part of the footprint through management practices that increase the conversion of pasture to meat, thereby reducing the proportion of pasture consumed simply for maintaining the flock.

In this way, the sheep industry has already made significant progress in reducing its emissions. **Compared to 1990, New Zealand sheep farmers in 2009 produced slightly more lamb meat by weight, but from a 43% smaller national flock.** This productivity improvement is estimated to have reduced the GHG footprint by about 22%.

#### ii. Meat Processing

**Meat processing comprises only 3% of the lamb footprint but the study identifies opportunities for meat processors to reduce this contribution further, particularly in energy used for refrigeration, water-heating and operation of machinery, and wastewater management.** Meat processors are addressing these challenges through improved wastewater treatment systems, energy efficiency programmes and exploration of alternative fuels for boilers, including wood.

#### iii. Transportation

**Oceanic shipping of meat from New Zealand to Europe in refrigerated containers, at nearly 5% of total, is over 90% of the overall commercial transportation contribution to the total GHG footprint. These figures reinforce food**

**transportation as not being a key determinant of the overall footprint**, though meat exporters are working with shipping lines to identify ways to reduce this contribution.

#### **iv. Retail & Consumer**

**The consumer-related components of the footprint are estimated to account for 12% of the total GHG footprint** (increasing to 19% if travel to and from the supermarket is included). This highlights that the consumer can also play a role in reducing lamb's carbon footprint.

## **5. Next Steps**

Action being undertaken to address the issues highlighted in the study includes:

### **i. Continuous Improvement**

Across the lamb supply chain, farmers, processors and shippers should and will continue to focus on efficiency and improved environmental performance as a business priority.

### **ii. Strategic Emissions Reduction Initiatives**

The New Zealand meat industry and government are investing heavily to identify innovations that can deliver step-wise, rather than incremental, improvements in pastoral farming emissions. These strategic efforts are focused on research and development to create tools for emissions mitigation. This includes the minimisation of enteric fermentation methane through breeding or vaccines and the reduction of nitrous oxide emissions through soil additives and nitrogen management practices.

### **iii. Global Coordination of Emissions Measurement**

The New Zealand industry and government are actively seeking to coordinate global efforts to understand agricultural GHG emissions. One aspect of this is to share the methodology applied in this and other carbon footprinting studies, allowing agricultural producers around the world to compare and discuss emissions mitigation opportunities on a like-for-like basis.

Members of the New Zealand meat industry plan to continue to work together to facilitate efforts to mitigate emissions throughout the supply chain and to measure overall progress. Mitigation efforts will also be encouraged by the implementation of the New Zealand Emissions Trading Scheme (ETS), which applies a price to GHG emissions.

Industry members will continue to meet to discuss emissions reduction opportunities and the industry expects to repeat this study in the future in order to measure its progress in reducing the GHG footprint of exported New Zealand lamb.

# 1. Introduction

The New Zealand meat industry has a strong interest in minimising the impact that production and consumption of meat products has on the environment, both in terms of greenhouse gases (GHGs) and other important sustainability factors.

## 1.1. Basis of study

With the assistance of New Zealand's Ministry of Agriculture and Forestry (MAF), the New Zealand meat industry has commissioned this study to understand how and where production, processing, transportation and consumption of lamb meat in a key market contribute to the emission of greenhouse gases.

The partners that funded this study were the Meat Industry Association, Landcorp Farming, Ballance Agri-Nutrients and MAF, and key information support was provided by Meat & Wool NZ and individual meat companies. The study was undertaken by AgResearch, which is a New Zealand Crown Research Institute.

This study is a comprehensive, full life cycle study, taking it beyond the scope of previously published, partial life cycle studies. It has used the Life Cycle Assessment (LCA) approach and is consistent with the PAS2050<sup>1</sup> published standard for greenhouse gas footprinting. Life cycle assessment seeks to examine the impacts of a product over its full production and consumption life cycle, including waste.

On-farm emissions analysis undertaken for this study is consistent with New Zealand's GHG accounting methodology as submitted under the United Nations Framework Convention on Climate Change (UNFCCC). It should be noted this methodology does not include the accounting of carbon sequestration in agricultural soils and does not include any consideration of carbon sequestration in trees used in a normal farming context – such as shelter belts or planting for erosion control or conservation.

## 1.2. Aims of study

The purpose of this study was to identify the most significant sources of GHG emissions in the lamb meat life cycle and those that can be most readily addressed in order to reduce emissions.

It was anticipated the study would:

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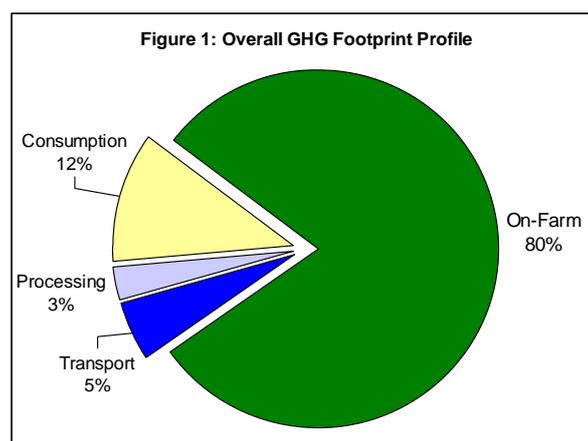
<sup>1</sup> Publicly Available Specification 2050 – British Standards Institute 2008

- Highlight the ‘hotspots’ for emissions in the lamb meat production and consumption life cycle. (Hotspots are those points or stages in the life cycle that make the most significant contributions to the overall footprint.)
- Analyse the potential to reduce emissions at various stages of the life cycle through the application of known techniques and technologies.
- Create a single, detailed and standardised methodology that can be used consistently by the New Zealand lamb industry (and others) to undertake future footprinting studies.
- Provide simple tools for industry members to understand the impact different operational decisions would have on the carbon footprint of their product.
- Direct the industry to those areas where effort and investment to reduce emissions are likely to yield the greatest benefits.

## 2. Emissions sources and emissions reduction opportunities

This section summarises the high level findings of the New Zealand lamb carbon footprint study including the significant sources of emissions and opportunities for emissions reductions.

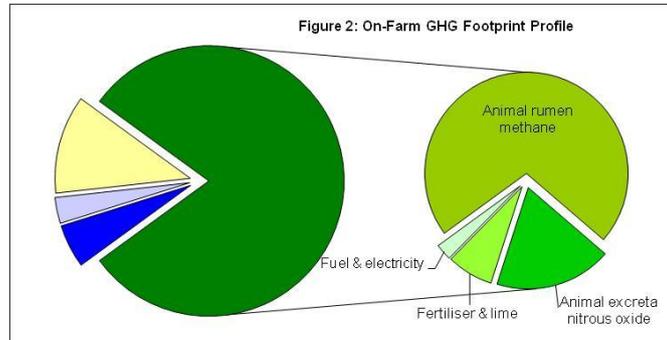
### 2.1 Overall findings



The total carbon footprint was calculated at 1.9 kg CO<sub>2</sub>-equivalents for a 100 g serving of lamb meat. This can be broken down into 80 percent for the on-farm stage, 3 percent for meat processing, 5 percent for the entire transportation phase and 12 percent for the consumer & retail phase. This overall breakdown of the carbon footprint and the

dominance of the on-farm component are broadly consistent with other studies of products derived from pastoral farmed ruminant livestock.

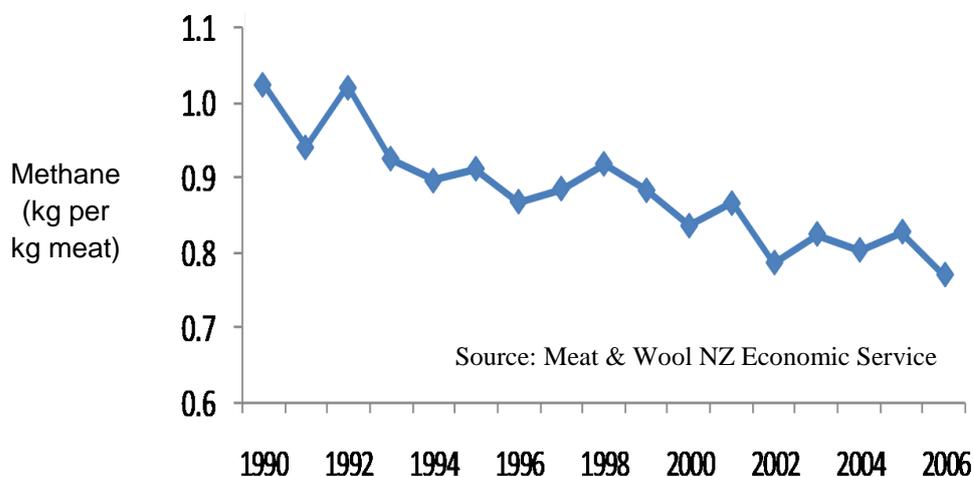
## 2.2 On-Farm



On farm, the largest contributors to the carbon footprint are natural processes associated with sheep utilising pasture as a feed source. These processes produce methane from rumen digestion of pasture (via belching, 57 percent of total footprint) and nitrous oxide from animal excreta deposited on soil (15 percent of total footprint).

It is possible to reduce the on-farm component of the lamb meat carbon footprint through management practices that increase the conversion of pasture to meat and thereby reduce the proportion of pasture consumed to simply maintain the flock. In this way, the sheep industry has already made dramatic progress in reducing its footprint – as shown in Figure 3, below.

**Figure 3:** Total sheep farming methane emissions per kg lamb meat processed



Compared to 1990, New Zealand sheep farms in 2009 produced slightly more lamb meat by weight, but from a 43 percent smaller national flock<sup>2</sup>. The authors estimate that this productivity improvement has had the effect of reducing the GHG footprint of New Zealand lamb by about 22 percent.

Productivity improvements have been achieved through new farm management techniques and genetics that allow more ewes to have twin or triplet lambs and by increasing the average weight of those lambs. Such productivity-focussed improvements are likely to remain a feature of New Zealand sheep farms.

*On-farm case studies:*

The study examined a small range of possible GHG footprint reduction initiatives in the context of actual farm models provided by Landcorp Farming. These initiatives included:

- The benefits of improved productivity, through one or a combination of:
  - Faster live weight gain
  - Higher ewe fecundity
  - Lambing of ewe hoggets
  - Reducing the required rate of ewe replacements
- Ceasing nitrogen fertiliser use (from a low level currently used).

Of these possibilities, the biggest reduction potential results from increasing the efficiency of sheep production. In the best case studies, achievement of challenging productivity improvements, such as the increase of lambing percentages by about 30%, or lamb growth rate by about 100g per day, would reduce the total lamb meat GHG footprint by up to 12 percent. Combinations of smaller improvements in several productivity measures would also produce similar reductions in the footprint.

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<sup>2</sup> Meat & Wool NZ Economic Service.

Emissions from external inputs to farms, such as fertiliser, fuel and electricity, are small due to the low-intensity and low-input nature of sheep farming in New Zealand.

Unlike other more intensive overseas farming systems, the use of high-energy demanding nitrogen fertilisers on New Zealand sheep farms is very low. Instead, New Zealand sheep farmers rely heavily on clovers in pastures, which use sunlight as energy to fix atmospheric nitrogen, which produces no direct GHG emissions.

*Fertilisers case study*

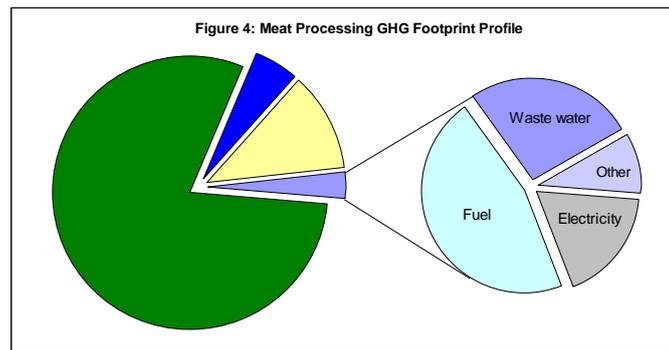
Fertilisers influence the lamb carbon footprint through the energy required to source raw materials, produce and apply them and also through the formation of nitrous oxide, which is released when nitrogen-based fertilisers are applied to soils.

The study examined the effect on the carbon footprint of different fertiliser regimes, including eliminating all fertiliser application. The results of this work showed that by eliminating or reducing fertiliser from current average application rates, the footprint may actually be increased because any benefits of reduced emissions caused by the fertiliser were offset by lower general productivity of the farm operation – i.e. because the farm produced less pasture and less meat, the average total emissions per kilogram of meat produced were actually higher when no fertiliser was applied.

Similarly, the use of fuel on New Zealand sheep farms is low and only contributes about 1 percent of the total carbon footprint.

Electricity use on farm made a very small contribution to the footprint at less than 0.1 percent of total. This is partly due to low electricity usage, but also because New Zealand's electricity generation mix is high in renewable sources. Nonetheless, further reductions in emissions from electricity are being created on some farms through deployment of technology such as micro-hydro generation.

## 2.3 Meat processing



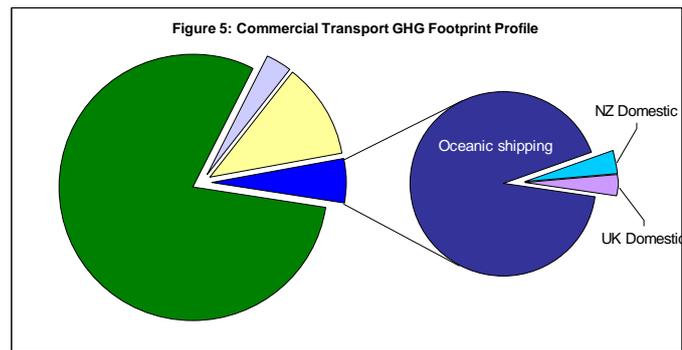
Meat processing made up only 3 percent of the total lamb carbon footprint. This was mainly from energy use and wastewater processing. A range of fossil fuels is used across different plants, largely for hot water and steam production. The main use of electricity is for chilling or freezing meat. Electricity is also used to operate machinery, for lighting and wastewater treatment. Methane and nitrous oxide are emitted during some wastewater processes.

The meat processing stage is only a small part of the carbon footprint but one over which industry has direct control and where some tools are available to reduce emissions. Progress is being made on reducing energy use. However, product will always need to be refrigerated and there will always be a need for hot water and steam for hygiene reasons, so there will be natural limits to how far energy efficiency can reduce the footprint.

The meat processing carbon footprint can also be reduced through the use of lower-emission energy sources. Since 1990, the meat industry has reduced its use of coal through improved efficiency and also through the deployment of lower-emitting energy sources, including natural gas, and also wood chip and other biomass fired boilers.

Wastewater processing is also becoming progressively more emissions efficient, with less use of anaerobic pond systems that produce methane, and more use of land application of wastewater. The latter not only reduces emissions, but has the added benefit of capturing nutrients for pasture or crop production rather than allowing those nutrients to escape and potentially degrade natural waterways.

## 2.4 Transportation

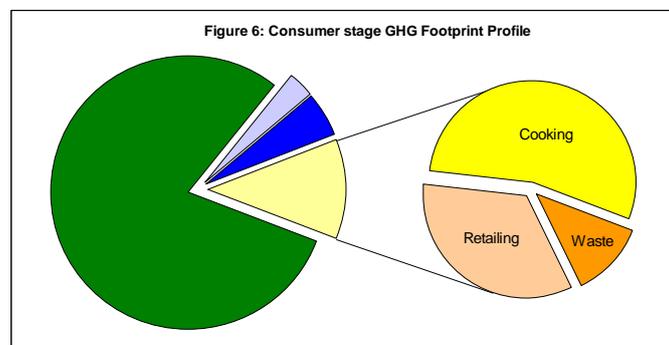


Oceanic shipping of product from New Zealand to the United Kingdom in refrigerated containers constituted about 5 percent of the total footprint and this is the main contributor (over 90 percent) to the transportation component of the overall footprint. While this is an important source of emissions, the relative size of this figure highlights that transportation distance influences only a small fraction of the total footprint. Focussing solely on this small fraction is an inappropriate and potentially misleading means of assessing the overall impact of emissions from a product.

The consumer transportation phase – to and from the supermarket or butcher – was excluded from this study as required by the PAS2050 method. To provide some context however, had the consumer transport phase been included in the study, this would have added another 7 percent to the total footprint – more than the total emissions for oceanic shipping and more than twice the emissions from the entire processing stage.

Other transportation components included road transport of animals from farm to processing, processing to wharf, wharf to Regional Distribution Centre (RDC) and finally, to retailers.

## 2.5 Consumer stage



The consumer components of the GHG footprint were not insignificant at 12 percent (increasing to 19 percent if consumer transport is included).

Cooking made up over half the emissions from this stage as the energy used in cooking in the UK has a relatively high emissions impact due to a predominance of fossil-fuel based thermal electricity generation.

Repacking and processing of meat in the Regional Distribution Centre made up about one-quarter of GHG emissions in this stage, which is influenced greatly by the materials used and the time meat spends in storage.

Consumer behaviour presents a significant opportunity to reduce the total life cycle GHG footprint at relatively low cost. Some examples of this include:

- Choice of chilled products rather than frozen.
- Not freezing chilled product.
- Avoiding microwave defrosting of frozen product

### **3. The developing science of GHG footprinting**

GHG footprinting is not an exact science, rather a complex form of non-financial accounting that does not yet have a globally applied or agreed set of detailed methods and rules.

While the PAS2050 and the ISO Life Cycle Assessment standards<sup>3</sup> set out broad principles that should be observed in carbon footprinting, they do not provide detailed methodology on how to treat the very complex accounting decisions that arise when assessing the footprint of specific products such as meat and multi-product enterprises such as pastoral sheep and beef farming. Much of the detailed methodology used in this study has been developed in the process of undertaking this research.

#### **3.1 Comparisons with other studies not appropriate**

This study is unique and unprecedented in its breadth and is helping New Zealand farmers, processors and exporters to understand the lamb carbon footprint and to focus on the most effective ways to improve that footprint throughout the life cycle. This work does not, however, provide a basis for comparison against others, nor for customers to compare competing products because, at this stage, there are inconsistencies in the carbon footprinting methodologies used in different studies. This lack of a standardised and consistently applied methodology highlights a major challenge for those retailers and regulators around the world that have a stated interest in applying carbon footprint labels to retailed food products. Such labelling will not provide credible or valid information to direct consumer purchasing decisions until such time as there are tightly

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<sup>3</sup> International Standards Organisation, ISO14040 and 14044 (2006)

defined and globally agreed methodologies for undertaking carbon footprint studies of certain product categories. (Such 'product category rules' are under development.)

There are, however, published studies that make a narrow comparison between two competing products using a like-for-like methodology<sup>4</sup>. Such comparative studies have shown that New Zealand lamb performs relatively well.

### **3.2 Key methodology decisions**

There are a range of 'accounting treatment' type decisions required throughout any GHG footprint study where the exact methodological approach is not specified within the PAS2050 standard or within ISO standards. The choice of methodology can, in many cases, have a significant impact on the final carbon footprint 'number' produced by a study.

Other published studies tend not to describe in detail the methodology adopted<sup>5</sup>. In this study, researchers have used their judgement to apply methodologies best suited to the requirements and intent of the PAS2050 and relevant ISO standards for life cycle assessment. Nonetheless, choosing the most appropriate 'accounting treatment' for certain emissions has still proved difficult in a number of areas.

This study is the first published meat GHG footprint study to cover the entire life cycle from farm, through to cooking and eating the meat, and the disposal of waste and sewage. Researchers have sought to apply the most comprehensive approach possible, and this determines that there will be certain methodological differences – particularly in terms of scope – between this and other published studies examining the GHG footprint of meat products.

Some of the key accounting treatment decisions are further discussed below. Appendix 1 also describes, indicatively, what alternative methodology decisions seem to have been taken in other studies and what quantitative impact those alternatives would have had if applied in this study.

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<sup>4</sup> For example; Williams et al. 2008.

<sup>5</sup> For example see Saunders et al. 2006; Williams et al. 2008; Peters et al. 2010; EBLEX 2009

### **3.2.1 System boundaries**

This study covered the emissions across the full life cycle of meat, from farm to consumption and consumer waste stages (though excluding consumer transport as prescribed in PAS 2050). Other published meat carbon footprint studies have covered only a part of the life cycle – typically the farm only or farm to retail distribution centre.

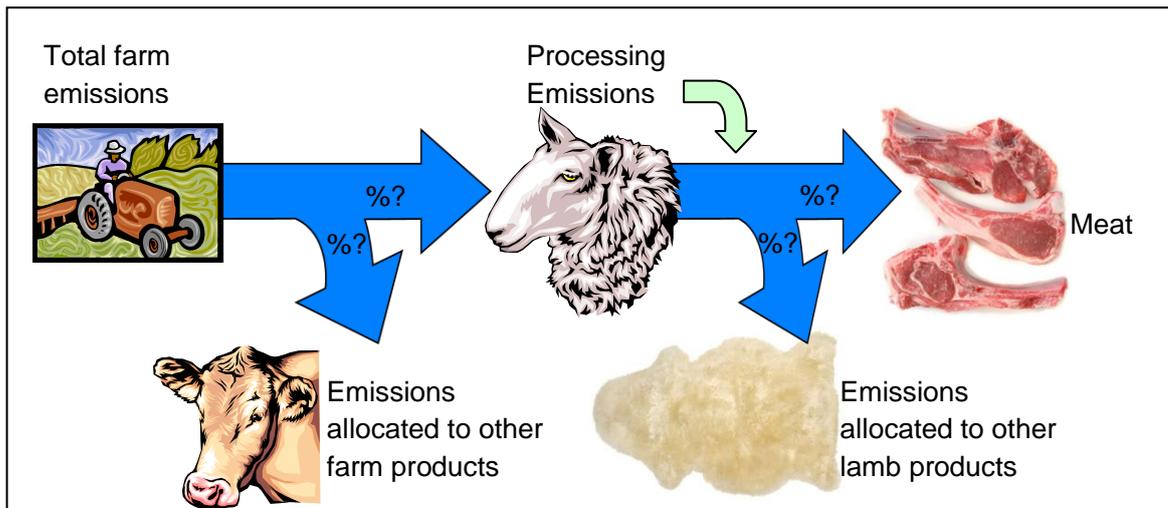
### **3.2.2 Functional unit**

To illustrate the results in consumer terms, this report considers a 100 gram portion of raw, purchased meat as the functional unit under consideration. This unit represents a recommended portion size in the United Kingdom. Other studies have calculated a footprint per kilo of animal live-weight or per kilo of carcass weight or even per unit of land area.

### **3.2.3 Allocation decisions between different product streams**

For carbon footprint studies of biologically produced products – particularly animal products – allocation decisions are hugely influential on the footprint calculation. In reality, a New Zealand sheep and beef farm produces a certain amount of emissions in any given year and also a range of saleable products. These products might include ‘finished’ cattle and lambs for processing, breeding or unfinished stock for sale to other farmers, culled animals, wool, and in some cases crops such as grain or stored feed such as hay or silage. In calculating the lamb meat carbon footprint, researchers must decide what portion of the farm’s total emissions should be allocated to a given lamb. They must then also decide what portion of a processor’s total emissions should be allocated to lamb meat (as opposed to other outputs such as wool, skins, offal, tallow, etc), and so on throughout the life cycle. Figure 7, below, illustrates some of the key allocation decision points. There are several options for the various allocation decisions at different points in the life cycle. In this study we have used biophysical allocation between different animal types on farm, based on the amount of feed they consumed. Economic allocation was used between lamb meat, mutton and wool and also at the meat processing stage between meat and non-meat products. Other studies have used nil (no allocation of emissions to non-meat products), economic or mass-based allocation.

**Figure 7 – Key allocation decisions in lamb carbon footprint**



### 3.2.4 Emissions factors for oceanic shipping

Estimating the emissions associated with oceanic shipping is complex given that product may be carried by more than one type of ship, on different routes at varying speeds.

This study uses a relatively high emissions factor for shipping, which was at the upper end of the published range, and so this estimate might be considered a worst case scenario.

### 3.2.5 Global Warming Potential factors

Only a relatively small portion of the lamb GHG footprint is actually made up of emissions of carbon dioxide. The convention for a single 'carbon dioxide equivalents' figure to express the carbon footprint requires that emissions of methane and nitrous oxide are converted into CO<sub>2</sub> equivalents using fixed conversion rates, known as Global Warming Potential (GWP) factors.

Because methane survives in the atmosphere for a limited period before breaking down, assessment of its global warming potential relative to carbon dioxide (which endures in the atmosphere until removed) is not straightforward and requires adoption of a specific period over which to assess the relative greenhouse impact of the two gasses. The period adopted under the UNFCCC is 100 years and the greenhouse impacts of gases over this period are the subject of ongoing study. The Intergovernmental Panel on Climate Change (IPCC)'s prescribed 100 year Global Warming Potentials (GWP100) for methane and nitrous oxide have changed several times in the last 10 years.

This study used the latest IPCC (2006) GWP100 figures of 25 for methane and 298 for nitrous oxide. Other published studies have used earlier (generally lower) GWP100 factors for methane and nitrous oxide.

Other authors have discussed the validity of using longer or shorter periods over which to assess the greenhouse impact of gases. When considered over a 500 year time horizon, for instance, methane has a relatively low GWP of 7.6.

### **3.2.6 Carbon sequestration on farm**

There are undoubtedly instances in New Zealand sheep and beef farming where carbon stores are being accumulated. This may be in the growing of shelter belts, the reversion of marginal land into native bush or the planting of steeper land with trees for erosion prevention. There is also a significant amount of research underway aimed at understanding the performance and potential of pastoral soils in accumulating soil carbon. Soil carbon sequestration is not thoroughly understood by scientists at this time.

A recent study<sup>6</sup>, undertaken for the State Government of Queensland, Australia, concluded the cattle farming industry in that state was nearly carbon neutral because carbon sequestration, via growth of vegetation and accumulation of soil carbon, largely offsets the emissions of GHGs from farming operations. Similarly, French researchers<sup>7</sup> have produced an estimate of the rate of soil carbon sequestration in sheep grazing pasture – which could offset some of the emissions from the farming operation. In the present study, the net emissions from sheep and beef farms were estimated in a manner consistent with the New Zealand GHG Inventory as reported to the UNFCCC. This approach does not consider sequestration, either through growth of trees on farms or accumulation of carbon in soils.

## **3.3 Data availability**

Comprehensive data sets are critical to achieving accurate estimates of the average carbon footprint. At the farm stage we used a detailed Meat & Wool New Zealand data set covering nearly 500 farms throughout New Zealand sampled to be statistically representative of the sheep and beef farming sector and stratified to cover the wide range of different farm types (from extensive high country through to more intensive rolling land). At the meat processing stage we obtained detailed data from a survey of

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<sup>6</sup> Bray & Willcocks, 2009

<sup>7</sup> Sousanna et al, 2004

11 lamb processing plants covering over 40 percent of the total lambs processed in New Zealand each year.

The authors are confident the quantity and quality of data utilised in this study is sufficiently robust to produce a representative picture of New Zealand lamb meat production as a whole. Other, smaller studies, based on a limited number of case study farms, for instance, do not deliver such a representative result.

## **4. Next steps**

This section outlines the future actions expected or recommended following this lamb carbon footprint study.

### **4.1 Reducing the footprint**

This study has confirmed a number of areas where the New Zealand red meat sector can continue to make incremental improvements in its emissions performance. We are also aware of a number of longer-term strategic research initiatives underway, which are intended to produce more significant, step-wise improvements in emissions performance.

The authors note that with the recent introduction and progressive implementation of the New Zealand Emissions Trading Scheme (ETS), New Zealand meat industry participants will have increasing economic incentive to invest in emissions reductions initiatives, thereby avoiding the newly created liability associated with emissions.

#### **4.1.1 Continuing incremental emissions improvements**

There are immediate opportunities for small, but significant improvements in the lamb carbon footprint, across the supply chain.

##### On-farm

At present, farmers have only a limited number of tools available to improve their emissions performance.

As a constant economic objective, sheep farmers will very likely continue the steady productivity gains they have delivered over the last two decades through the use of improved animal and forage genetics and through new and improved management practices and technology. Such productivity gains will result in reductions in the lamb carbon footprint as fixed emissions sources are divided over greater product output.

Some sheep farmers are also employing measures specifically targeted to enhance environmental sustainability, including GHG emissions, and these measures should be continued and encouraged widely. Such measures include:

- Creation of riparian zones around waterways – which minimise the loss of nutrients by runoff into waterways, including nitrogen losses, which result in nitrous oxide emissions.
- Tree planting on farms to reduce soil erosion through wind or water action. Such tree planting also acts as a carbon sink – removing carbon dioxide from the atmosphere and sequestering it as biomass<sup>8</sup>.
- Retention and management of long-term perennial grass and clover pastures thereby reducing inputs and emissions associated with pasture renewal.
- Minimum intervention practices, such as no-till and direct seed drilling, on farms where seasonal crops are cultivated, to reduce soil carbon losses<sup>9</sup>.
- Nutrient budgeting, often using the Overseer<sup>®</sup> nutrient budgeting tool, ensuring only the required levels of nutrients and lime are applied to pastures, thereby avoiding emissions from over-use.
- The use of carbon calculator tools that allow farm emissions to be measured and managed.

Meat & Wool New Zealand have a range of on-farm initiatives aimed at improving environmental outcomes through the efficient use of resources. This includes:

- A toolkit for the development and use of Land and Environment Plans for farmers, which is a step-by-step process to document the land and environmental issues on individual farms and identify ways the farmer can address them.
- A programme to encourage the use of a nutrient budgeting model (Overseer<sup>®</sup>) to ensure optimal use of fertiliser nutrients and lime and to minimise environmental emissions. (It should be noted, however, that losses of nutrients to waterways from sheep and beef farms are already several orders of magnitude less than those from intensive farming systems.)

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<sup>8</sup> It should be noted that UNFCCC rules for accounting GHG inventories do not allow the consideration of small-scale tree planting on farms as a source of carbon removals and such plantings have therefore not been included as a removal in this footprint study.

<sup>9</sup> Soil carbon accumulation in pasture systems is not a component of New Zealand's official GHG inventory and therefore benefits of increased soil carbon retention have not been incorporated in the on-farm component of this lamb footprint study.

At least one meat exporter – Alliance Group Ltd, a large farmer-owned processor – is working with its suppliers to improve animal genetics through a progeny testing programme and is developing a carbon footprint calculator to assist suppliers in on-farm decision making.

### Meat Processing

Historical data and anecdotal evidence suggest New Zealand meat processors have made significant progress in improving their contribution to the lamb carbon footprint, primarily through improvements in energy efficiency and through improved methods for wastewater management. This study suggests, however, that opportunities to continue this work remain.

#### *Meat processing case study I*

The Alliance Group Ltd, has implemented a strict programme of resource use monitoring and has observed a total reduction of emissions from processing energy use of almost 25 percent per unit of production between 2000 and 2009.

These reductions have been achieved through a combination of:

- Use of EECA<sup>10</sup> energy efficiency audits and implementation of their recommendations
- Upgrading of plant and equipment and building new, efficient facilities
- Introduction of more shift work that allows improved plant utilisation
- Growth in the proportion of chilled product shipped compared to frozen

New Zealand meat processors have used readily-available tools, including EECA energy audits to identify those areas of their business where energy can be saved. Such savings may be realised through better management practices, such as scheduling and coordination of energy intensive activities, targeted repairs and maintenance. These include fixing leaks and investing in new technology such as automated high-speed chiller doors, LED lighting or biomass boilers.

#### *Meat processing case study II*

Silver Fern Farms has pioneered the use of a Bubbling Fluidised Bed boiler, which is able to utilise sludge from wastewater treatment and woodchips as fuel sources. This system – the only one installed in New Zealand – reduces emissions from coal burning and from wastewater treatment and also eliminates a major waste disposal issue.

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<sup>10</sup> New Zealand Energy Efficiency and Conservation Authority

Over the last 10 years, improved processing practices and technologies have allowed an increasing proportion of New Zealand's lamb exports to be shipped chilled, rather than frozen. Chilled product is generally favoured by consumers but also carries a lower overall carbon footprint than frozen. The proportion of chilled shipments is expected to continue to increase.

### Transport

Oceanic shipping is already by far the most emissions-efficient method of transportation but further gains in efficiency are being actively pursued by shipping lines and shippers globally. Meat exporters work alongside shipping lines to identify ways of reducing shipping fuel usage while still delivering product to market without compromising quality or food safety.

Initiatives that improve efficiency and reduce emissions currently being rolled-out by shipping lines include:

- Upgrading to vessels that are larger and more efficient.
- Reducing the speed of vessels (slow steaming).
- Optimising shipping routes and shipping hubs and ship-to-shore communication to reduce the total overall distances and speeds travelled.

#### *Transportation case study – Maersk Line*

Maersk Line technical division are working closely with the New Zealand meat industry to develop new software technology that controls the motors of refrigerated shipping containers carrying chilled lamb more precisely. This technology is expected to reduce the total power usage of these containers by as much as 20 percent.

Maersk Line has also almost entirely phased-out use of R404A refrigerant (the traditional container refrigerant and the refrigerant assumed to be used in this study) in favour of the lower global warming potential R134A.

#### **4.1.2 Strategic emissions reduction opportunities**

There are a number of longer-term strategic actions underway that may, in due course, create the opportunity for large, step-wise reductions in the lamb carbon footprint. These strategic opportunities are discussed below.

##### Research

For several years, a group of New Zealand's pastoral sector groups, along with the New Zealand Government have invested significantly in the Pastoral Greenhouse Gas Research Consortium<sup>11</sup>, which has a key focus on developing methods to reduce methane and nitrous oxide emissions on-farm. Potential strategies for reducing methane include vaccines, feed additives, and selective breeding for 'low-methane' plant and animal traits. Emerging options for nitrous oxide reduction include nitrification inhibitors and soil and feed management practices.

The New Zealand government has also recently approved a further \$5 million annual investment to the New Zealand Agricultural Greenhouse Gas Research Centre, targeting mitigation strategies for reducing on-farm emissions. This is currently being extended by encouraging internationally linked research through a global alliance on mitigation research.

##### Transport

Shipping innovations under investigation include the development by naval architects of new vessels designs, with hulls that require less energy and are most efficient when travelling at slower speeds, as well as new refrigerants appropriate for use in containers with much lower global warming potential than traditional chemicals.

##### Retail & Consumer use

This study indicates there can be reductions made in the carbon footprint by encouraging the consumer to be efficient in their purchasing, cooking of lamb and in waste reduction. In particular, efficient cooking methods offer the largest gains considered within this study. Reducing the amount of travel by car to purchase grocery items (including lamb) would also lead to large reductions in consumption-stage emissions, though this is not included in the PAS2050 methodology used in this study.

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<sup>11</sup> (PGgRc) – A joint venture established in 2002 between Fonterra Ltd, Meat & Wool New Zealand, DEEResearch Ltd, AgResearch, PGGWrightson Ltd, FertResearch (FMRA), DairyNZ, Landcorp.

## 4.2 Progressing carbon footprinting

This study has highlighted the complexity of calculating a carbon footprint for a product like meat and the many decisions that need to be made on how various accounting elements can be treated. The authors consider a common, harmonised and comprehensive footprinting methodology is essential if purchasers and producers are to make valid comparisons of the GHG impact of lamb meat products. We believe it is important to seek an internationally standardised approach so studies can be compared internationally.

The authors have made available a detailed account of the methodology applied in this study<sup>12</sup>, and hope it may contribute in some way to a standardised and globally agreed carbon footprinting methodology for meat products.

The sponsors of this study, including the Meat Industry Association and Meat & Wool New Zealand, plan to share this study's methodological approach with other meat producers via the International Meat Secretariat and other international fora.

The sponsors of this study expect they will continue to work together to facilitate and encourage emissions reductions to improve the lamb GHG footprint, and that this study will be repeated in the future in order to measure the progress of improvements.

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<sup>12</sup> Ledgard et al., 2010 – Available by enquiry to author.

## Appendix 1

Table 1, below, summarises key areas where accounting treatment decisions are required and where those decisions are highly influential on the final footprint number. It also provides an indication of the potential impact of alternative methodologies on the overall GHG footprint number derived in this study.

**Table 1:** Key ‘accounting treatment’ decisions that impact carbon footprint calculation

<u>Key variable</u>	<u>Used in this study</u>	<u>Alternatives from other studies</u>	<u>Approximate effect on footprint</u>
System boundary	<ul style="list-style-type: none"> <li>Full LCA to consumption and waste</li> </ul>	<ul style="list-style-type: none"> <li>Farm only</li> <li>To RDC/port</li> </ul>	<ul style="list-style-type: none"> <li>-20%</li> <li>-12%</li> </ul>
Inclusion of consumer transport	<ul style="list-style-type: none"> <li>Not included</li> </ul>	<ul style="list-style-type: none"> <li>include</li> </ul>	<ul style="list-style-type: none"> <li>+7%</li> </ul>
Oceanic Shipping emissions	<ul style="list-style-type: none"> <li>0.05 kg CO<sub>2</sub>-equiv/tkm</li> </ul>	<ul style="list-style-type: none"> <li>0.01-0.05 kg CO<sub>2</sub>-equiv/tkm</li> </ul>	<ul style="list-style-type: none"> <li>Up to -4%</li> </ul>
Functional unit	<ul style="list-style-type: none"> <li>Lamb meat</li> </ul>	<ul style="list-style-type: none"> <li>Live-weight</li> </ul>	<ul style="list-style-type: none"> <li>Up to -60%</li> </ul>
Allocation method	<ul style="list-style-type: none"> <li>Biophysical &amp; economic</li> </ul>	<ul style="list-style-type: none"> <li>Nil</li> <li>Mass based</li> </ul>	<ul style="list-style-type: none"> <li>+46%</li> <li>-34%</li> </ul>
Animal methane emission	<ul style="list-style-type: none"> <li>Product of energy intake</li> </ul>	<ul style="list-style-type: none"> <li>Constant per animal</li> </ul>	<ul style="list-style-type: none"> <li>Up to -50%</li> </ul>
Global Warming Potential of methane	<ul style="list-style-type: none"> <li>GWP<sub>100</sub> 25</li> </ul>	<ul style="list-style-type: none"> <li>GWP<sub>100</sub> 21</li> <li>GWP<sub>500</sub> 7.6</li> <li>GWP<sub>20</sub> 72</li> </ul>	<ul style="list-style-type: none"> <li>-9%</li> <li>-39%</li> <li>+84%</li> </ul>
Greenhouse gases included	<ul style="list-style-type: none"> <li>Methane, N<sub>2</sub>O, CO<sub>2</sub>, refrigerant</li> </ul>	<ul style="list-style-type: none"> <li>CO<sub>2</sub> only</li> </ul>	<ul style="list-style-type: none"> <li>-75%</li> </ul>
Carbon accounting rules	<ul style="list-style-type: none"> <li>As per NZ’s inventory for IPCC</li> </ul>	<ul style="list-style-type: none"> <li>Include soil C sequestration</li> <li>Include trees sequestration</li> </ul>	<ul style="list-style-type: none"> <li>Unknown (-)</li> <li>Unknown (-)</li> </ul>

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