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Integrating food production, environmental sustainability and nutrition

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An integrated approach

There is growing interest in where our food comes from and how it is produced. This issue of *Vital* considers the broader implications of food production practices. Its genesis goes back to a series of meetings held in 2009 in which representatives of the primary food industry and public health sector shared their separate expertise.

The aim of the meetings was to develop an understanding from a public health perspective of the environmental sustainability of food production.

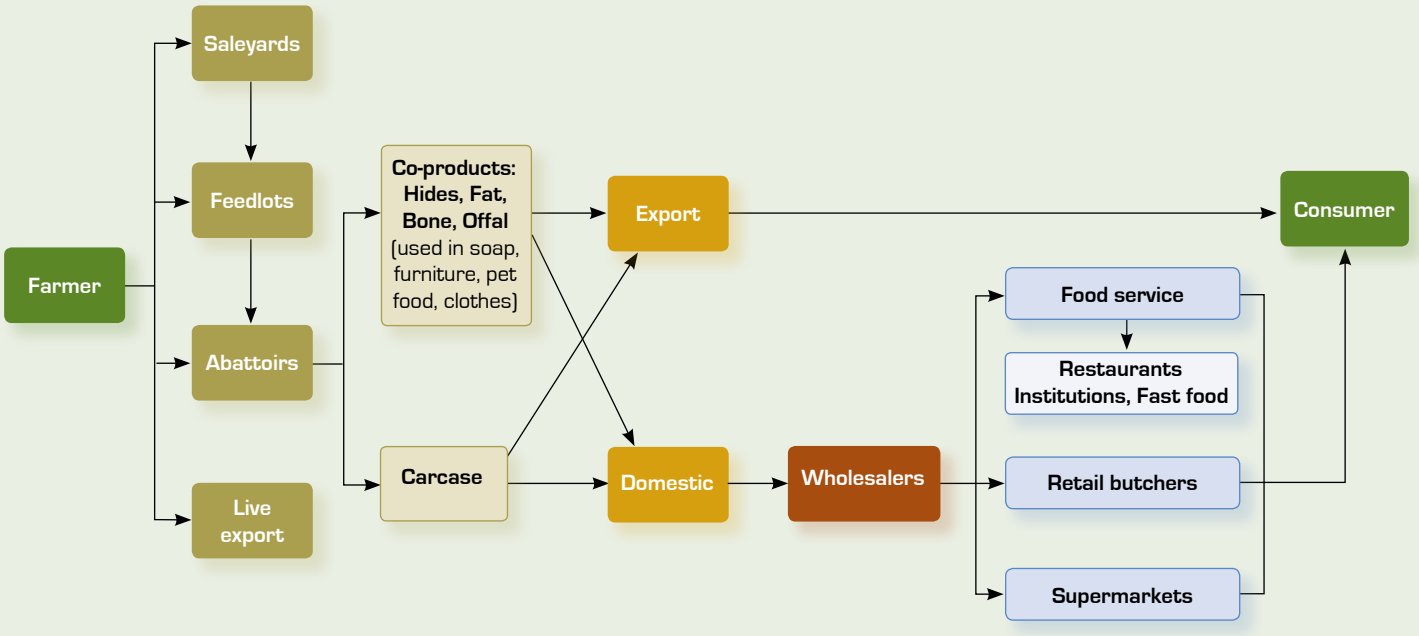
This collaborative activity between different primary food industries (including Australian Egg Corporation, Dairy Australia, Horticulture Australia, Meat & Livestock Australia) and public health representatives highlighted that environmental sustainability could not be considered in isolation but needed to be addressed within a context of the social, economic, nutritional and cultural aspects of food production. The food supply chain is long and complex, where many factors are interrelated. No single issue can be addressed in isolation. An integrated approach that considers all aspects of the food system is required to develop a coherent view. Key insights from these meetings are summarised in a report that can be accessed from www.redmeatandnutrition.com.au

The meetings also highlighted the different issues that exist for primary food production as compared to the production of manufactured food. To elaborate on some of these key issues, presentations on primary food production in Australia were held at the recent Public Health Association of Australia and Dietitians Association of Australia conferences.

Drawing from these insights and presentations, this issue of *Vital* seeks to build an integrated picture of Australian red meat production, looking at where it is produced, why different production methods are used and how those differences influence the environmental impact, nutrient composition and eating quality of red meat.

Access from www.redmeatandnutrition.com.au

Beef supply chain in Australia



Food systems, such as the red meat supply, are complex and interrelated – no one aspect can be considered in isolation.

Understanding differences
in red meat production

Beef is often described as grassfed or grainfed and the shorthand implies a clear division between two separate feeding regimes. In reality, beef production is diverse, determined by the landscape, seasonal conditions and market requirements. *Vital* spoke to Dr Ian Johnsson, General Manager of Livestock Production and Innovation at Meat & Livestock Australia to understand the influence of regional differences.

The digestive system of ruminants, including cattle, sheep and goats, is highly evolved and means that they can thrive on grains as well as low quality grass and other herbage which humans and other livestock species are unable to digest.

What is grassfeeding?

Grassfeeding can be likened to an 'ad libitum' style of diet, in which animals forage for their food. Depending on location, climate and geography these diets might include native grasses and shrubs, irrigated and fertilised pastures, legume-based pastures, grain stubble left after harvesting, or conserved hay or silage (fermented grass). Meat described as 'grassfed' comes from animals fed entirely in this way.

What is grainfeeding?

Grainfeeding is like a special diet constructed to deliver a nutritional profile specific to the needs of ruminants being finished for market. The feed is made from different ingredients that are combined to deliver, at a superior level, the necessary protein, carbohydrates, minerals, roughage and fat required to keep the rumen healthy and meet the nutrient requirements of livestock.

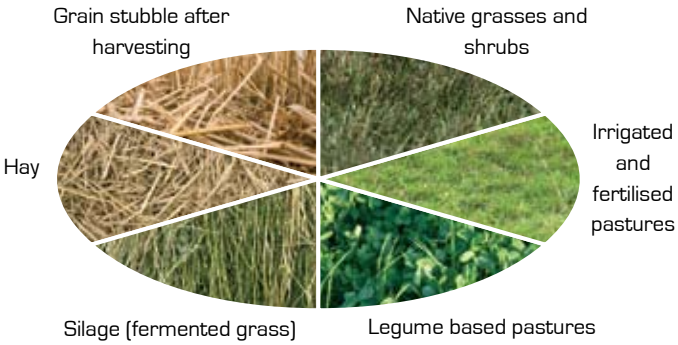
In Australia, ingredients include feed-grade wheat, barley, sorghum or triticale; protein from lupins and field peas; by-products of cottonseed and canola; and silage or hay. The grains fed to livestock are generally those that are not palatable to humans or that don't meet the strict product specifications of grains used in processed food products.

Meat described as 'grainfed' in Australia predominantly comes from animals who spend most of their lives eating grass, before being sent to feedlots where they are fed grain-based rations for a certain number of days. The number of days spent on grain is largely determined by market requirements in relation to eating quality and supply. In Australia cattle sent to feedlots for the domestic market typically spend 60 days on grain for consistency in supply and eating quality outcomes. A small proportion spends longer, in order to produce more marbled meat for niche markets.

Key differences in cattle feeding regimes

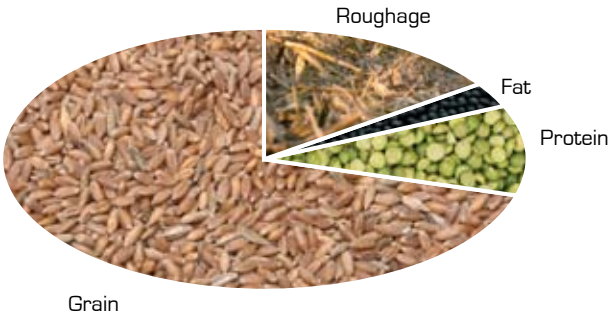
Feed sources

Grass feed

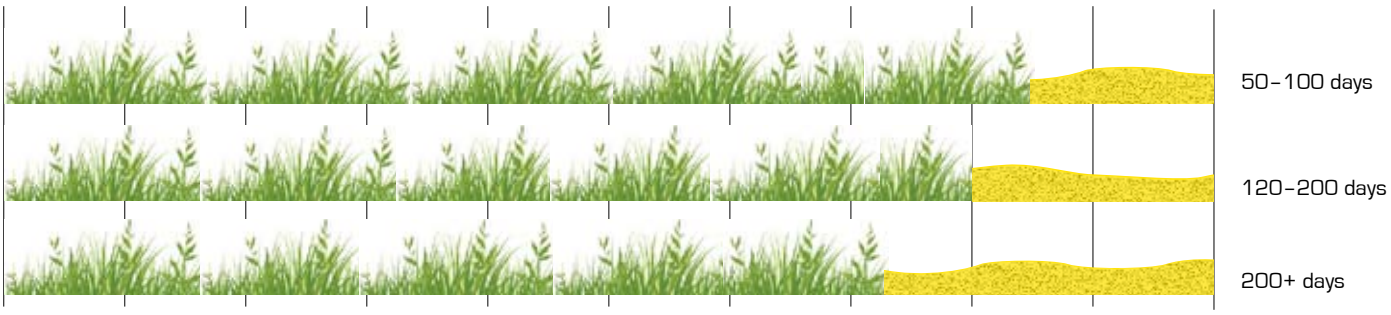


Combination of ingredients to meet nutrient requirements

Grain feed



Proportion of time spent on grain feed



About 30% of total animals slaughtered each year are grain-finished in Australia. However, because these animals are reared on grass for most of their lives, grain finishing only contributes about 12% of the total weight of beef produced (2.2 million tonnes) each year with grassfeeding making up the remaining 88%.

Production systems around the world

The main determinants of the feeding regime involved in beef production are the location, climate and market requirements existing in different regions. Production systems in Europe and the USA are quite different to those in Australia. Australian beef is predominantly grassfed, and grainfeeding is of short duration. The type of both grass and grain available as feed also differs in different regions.

In the northern hemisphere, for instance, colder climates mean that cattle require housing and intensive feeding. Consequently, the duration of grain-feeding tends to be longer than in Australia. In Europe, much of the European beef is sourced from the dairy herd. Cattle more commonly graze heavily fertilised and improved pasture and then move to feedlots where they are typically fed concentrated pellets derived from sugar beet, barley, food by-products such as brewers' grain and silage or hay, which are commonly available in Europe.

In the USA almost all market cattle are sent to feedlots for longer periods of time, typically 150 days. Whilst there, they eat a diet based on soy and corn, grains commonly grown in the USA. USA feedlots are much larger than those in Australia, typically housing between 70,000 and 200,000 head of cattle at a time, compared to the average of 1,600 in Australian feedlots.

As can be seen, both feeding regimes and types of feed differ around the world, based on local geographic and market conditions.

Production systems in Australia

In Australia, there are two distinct climatic and regional areas where red meat is produced. The following examples illustrate how climate and landscape influence the feeding regimes and production systems.

Extensive grazing in northern Australia

A large proportion of beef production in Australia occurs in northern Australia. These regions are characterised by arid and semi-arid woodlands, savannahs and grasslands. This land is generally unsuitable for other forms of agriculture, such as cropping, and so cattle-farming is the main agricultural activity. Cattle, primarily Brahman breeds suited to the conditions, graze large areas of native pasture, drinking from natural water holes, dams and bores. Farms are generally large (around one million hectares) in these regions and stocking rates are low, 1 – 10 cattle per square kilometre.

Extensive grazing in northern Australia

Mixed farming in southern Australia

Temperate climatic zones with higher rainfall and more arable land in the southern regions of Australia are suitable for cropping. In these 'food bowl' regions wheat and other grain farming predominates. In these areas mixed farming (cropping and grazing) is popular as livestock provide farmers with a source of income when crops fail. In addition, livestock can utilise paddocks unsuitable for cropping or in pasture rotation, allow soils to recover after cropping cycles. Farms are smaller than they are in the north, and consequently the beef and sheep which graze them are more intensively managed. They may graze the unimproved pasture on parts of the farm unsuitable for cropping, either because they are too steep, or because the soil is not fertile enough. They may also rotate through paddocks of legume-based pasture grown as a fallow crop to replenish the soil between crops of grain; and on paddocks of stubble left after harvest of the grain crop.

Mixed farming in South Australia

The impact of production practices on meat fat composition

The impact of production practices on the amount and type of fat in red meat is complex. To disentangle this complexity, it is necessary to consider both feeding regime and age and to a lesser extent, breed.

UNDERSTANDING THE TERMINOLOGY

Types of meat fat

Intramuscular fat, which is one measure of marbling, is the fat inside the muscle. This is different to selvedge fat, which is the separable fat on the outside of meat and intermuscular fat which is the separable fat between muscles.

Percentage of fatty acids

Meat contains saturated, monounsaturated and polyunsaturated fatty acids. The percentage of each fatty acid is based on total fatty acids. It indicates the proportion each fatty acid contributes to the total fatty acids.

Amount of fatty acids

The saturated, monounsaturated and polyunsaturated fatty acid content of meat depends on its total fat content. The higher the fat content, the higher the amount of saturated, monounsaturated and polyunsaturated fats.

Factors that affect total fat content

The amount of intramuscular fat in meat increases with carcase weight. The type of feed doesn't appear to matter – the same carcase weight and hence similar amounts of intramuscular fat can be achieved with grass or with grainfeeding.

The key difference is the time it takes to achieve the desired carcase weight, and consequent level of marbling. With grainfeeding, food is readily available at a high quality and so growth tends to be faster than with grassfeeding. There are some differences in breeds which affect growth rate and carcase weight, but these are small in comparison with time on feed. The key is that animals grow bigger faster on grain, and bigger animals are fatter[1].

With grainfeeding, the most substantial increase in intramuscular fat occurs between 84 and 112 days while selvedge fat (measured as fat thickness) increases significantly after 112 days[2]. These findings explain the lower levels of intramuscular fat in Australian beef, where grainfeeding tends to be of shorter duration. In addition, carcase weights tend to be lighter in Australia, compared to those in the USA, Europe and Japan, contributing to lower levels of selvedge fat. Further trimming of visible fat occurs at retail or prior to consumption contributing to levels of less than 4% saturated fat.

Factors that affect type of fat

There is little variation in the proportion of fatty acids in meat. Proportions of fatty acids are generally around 40–45% of saturated fatty acids; 40–46% of monounsaturated fatty acids; and 7–17% of polyunsaturated fatty acids, irrespective of feeding regime or breed[1]. There is little difference in the fatty acid profile of selvedge, intermuscular fat or intramuscular fat. As carcase weight, and hence total fatty acids increases, there is a slight increase in the proportion of monounsaturated fatty acids and a decrease in polyunsaturated fatty acids.

The type of feed does influence the type of polyunsaturated fatty acids. Unlike grains, grasses contain alpha-linolenic acid (ALA) which is converted into long chain polyunsaturated fatty acids such as eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA) and docosahexaenoic acid (DHA).

A study comparing types of polyunsaturated fatty acids in Australian beef shows that levels of EPA and DHA decrease with grainfeeding[3] (see Table 1). Interestingly, levels of omega-3 remained relatively high, even at 150–200 days of grainfeeding. When compared to the limited number of studies in the literature reporting EPA and DHA content (mg/100g of meat), these levels are 3 to 10 times higher than those reported from meat produced in other countries from either grassfeeding or a combination of grass and grainfeeding[4].

Table 1. Omega-3 content of Australian beef

Rump steak, trimmed	EPA+DHA (mg/100g meat
Grassfed 540 days	47.5
Grassfed 460 days + grainfed 80 days	31.2
Grassfed 340–390 days + grainfed 150–200 days	27.7

Ponnampalam 2006

Differences could be explained by differences in analytical procedures or in the ALA content of grass. Levels of EPA and DHA may be dependent on the ALA content of the feed during the early period of growth since long chain polyunsaturated fatty acids are located in phospholipids. Substantial variations in the ALA content of grasses have been reported with differences resulting from use of different species, differences according to seasons and in management practices.

References:

1. Warren HE, et al. *Meat Science* 2008; 78: 256–269.
2. Duckett SK, et al. *Journal of Animal Science* 1993; 71: 2079–2088.
3. Ponnampalam EN, et al. *Asia Pacific Journal of Clinical Nutrition* 2006;15(1): 21–29.
4. De la Fuente J, et al. *Meat Science* 2009; 82: 331–337.

The environmental impact
of different production practices

There is a web of environmental impacts associated with agricultural activity. To understand the extent of its impact, it is necessary to consider all aspects of production as well as regional differences. *Vital* asked Dr Beverley Henry, Manager for Environment, Sustainability and Climate Change at Meat & Livestock Australia, to explain how these factors influence greenhouse gas emissions, one of a number of environmental factors which are considered in sustainable agricultural production systems.

There are three key areas of beef production which differ in their contribution to greenhouse gas emissions – methane from enteric fermentation; feed production; and waste management.

Enteric fermentation

Methane, a greenhouse gas (GHG), is a by-product of ruminant digestion. Enteric fermentation as part of ruminant digestion produces hydrogen. Types of bacteria, called methanogens, help bind the hydrogen with carbon dioxide which produces methane. The animal burps out most of the methane. The level of methane production is determined by the amount, type and quality of feed (which affects the amount of hydrogen produced and the type and activity of microbes in the rumen).

The low roughage levels and higher digestibility of grain make it more digestible than the higher roughage levels of grass for the same amount of intake. Consequently, grainfeeding produces less methane than grassfeeding. In addition, the increased rate of growth that results from the higher quality grain diet means that the animal is younger and/or heavier when slaughtered and the total emissions per kg are lower in animals that are finished on grain, than those which are grassfed.

Production of feed

The following factors need to be considered:

Deforestation – land clearing is usually required to grow crops and may also be required to grow pastures. Deforestation is a significant contributor to greenhouse gas emissions and also tends to result in loss of biodiversity. Australian State governments has enforced legislation limiting tree clearing and more producers are now recognising the value of preserving bushland for biodiversity.

Fertiliser – nitrogen fertilisers, which produce the greenhouse gas nitrous oxide, are usually required to grow grain. They may also be used to grow pasture in Europe, but are used only rarely in Australia to improve productivity with legumes more commonly providing nitrogen at a lower cost. The use of nitrogen fertiliser is small or non-existent on feeds such as native grasses and legume-based pastures.

Energy – the power required to grow and deliver water for crops or pastures under irrigation, and to produce and transport feed to feedlots also needs to be taken into consideration.

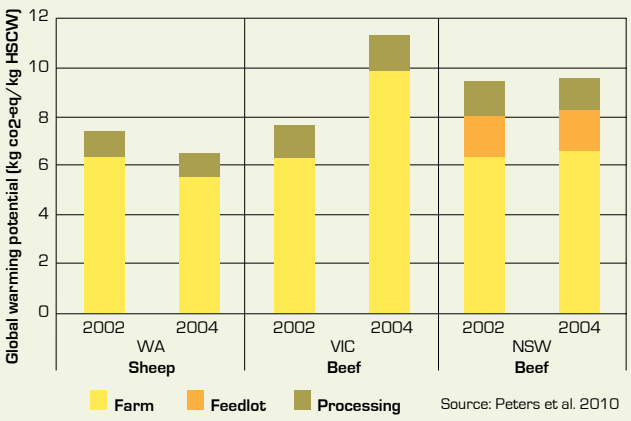
Waste management

When animals are grazing on pasture, waste is naturally recycled into the soil on-farm and greenhouse gas emissions tend to be low. In the intensive situation of feedlots, programs have been initiated to capture and re-use waste. All major feedlots in Australia require EPA licensing which require all effluent to be contained and recycled. Some processing plants and feedlots use anaerobic lagoons to digest organic wastes. This produces biogas, a methane-rich gas which substitutes for fossil fuel power generation.

Overall impact in Australia

It is the combination of management practices, feed quality, digestibility and how the feed is produced that determines overall environmental impact. In general, grainfed livestock are likely to produce more GHG emissions per head but less emissions per kilogram of product compared with fully grassfed animals. As illustrated in fig 1, the greatest contribution to emissions is methane from digestion in the rumen while the animal is on farm and the contribution from feed production and energy use is small. A small contribution to total emissions comes from processing and feedlotting. Australian red meat production is predominantly based on extensive grazing systems where animals mainly graze on native grasses. Grainfeeding is of short duration and low input feeds are largely used. In these systems, GHG emissions associated with beef production tend to be lower compared with more intensive production systems, such as those in the USA and Europe. In addition, feeds are animal 'feed grade' and hence don't tend to compete with production of grains for human consumption.

Fig 1. Global warming potential for three examples of red meat production systems in Southern Australia



Source: Peters et al. 2010

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