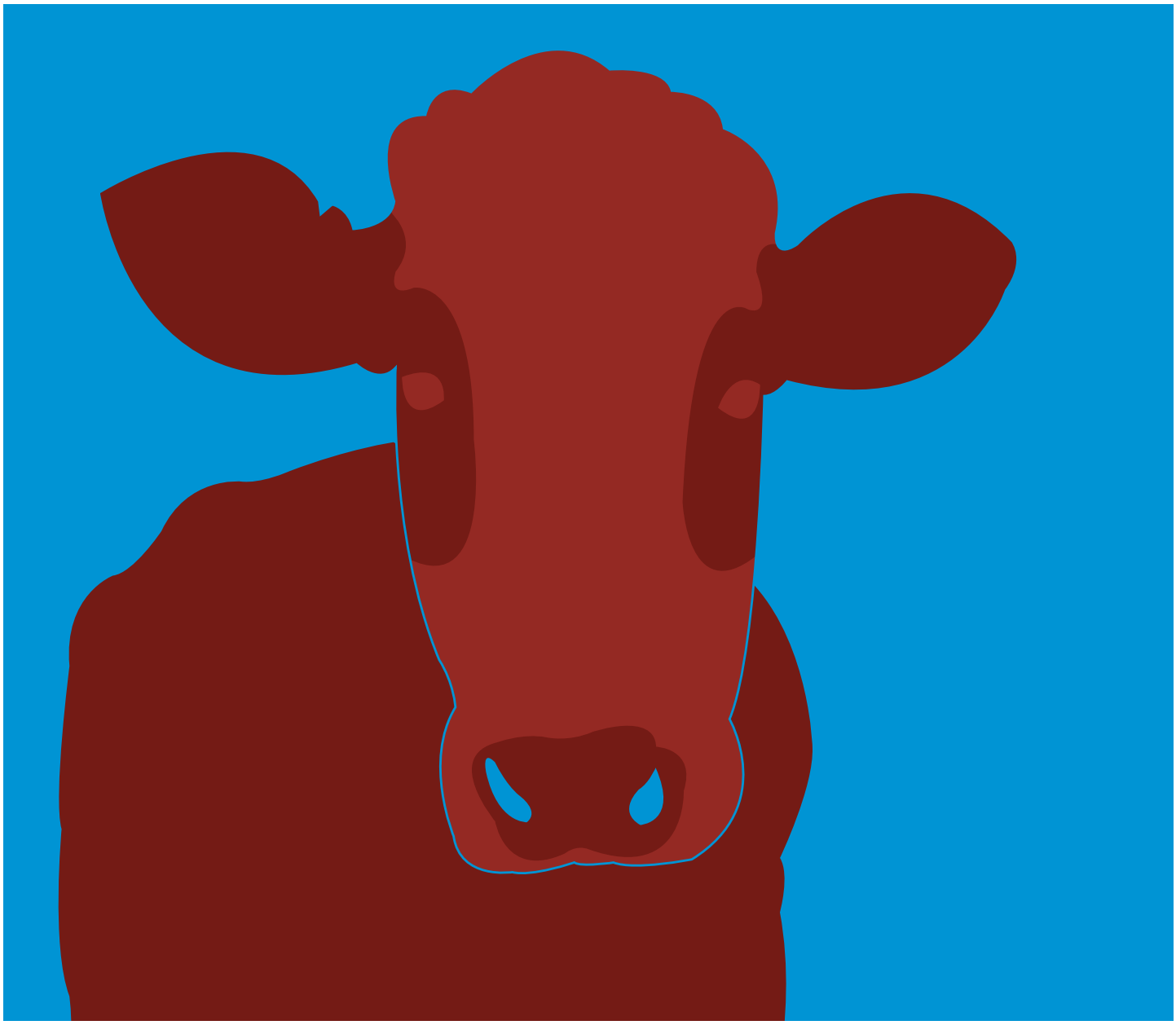
safefood

A Review of the Beef Food Chain



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Abbreviations

ADI	Acceptable daily intake
AMS	Animal movement system
APHIS	Animal and public health information system
AR	Average requirement
ATP	Adenosine triphosphate
BIP	Border inspection post
BQAS	Beef Quality Assurance Scheme
BSE	Bovine spongiform encephalopathy
CLA	Conjugated linoleic acid
CLP	Clean livestock policy
CJD	Creutzfeldt-Jakob disease
CMMS	Cattle movement monitoring system
CVD	Cardiovascular disease
CWE	Carcass weight equivalent
EFSA	European Food Safety Authority
EPIC	European Prospective Investigation into Cancer
FBO	Food business operator
FMD	Foot and mouth disease
FQAS	Farm Quality Assurance Scheme
FSA	Food Standards Agency
FSAI	Food Safety Authority of Ireland
FSTC	Food Safety Training Council
FVO	Food and Veterinary Office
GB	Great Britain

HACCP	Hazard Analysis and Critical Control Point
IOI	Island of Ireland
LRI	Lower reference intake
MBM	Meat-and-bone meal
MRM	Mechanically recovered meat
MRL	Maximum residue level
MUFA	Monounsaturated fatty acid
NDNS	National Diet and Nutrition Survey
NI	Northern Ireland
NSIFCS	North-South Ireland Food Consumption Survey
OTM	Over thirty months
OV	Official Veterinarian
PUFA	Polyunsaturated fatty acid
QUID	Quantitative ingredient declaration
RASFF	Rapid Alert System for Food and Feed
ROI	Republic of Ireland
SFA	Saturated fatty acid
SLAN	Survey of Lifestyle, Attitudes and Nutrition
SRM	Specified risk material
TSE	Transmissible Spongiform Encephalopathy
vCJD	Variant Creutzfeldt-Jakob disease
VI	Veterinary Inspector
VMP	Veterinary medicinal products
VTEC	Verocytotoxigenic *Escherichia coli*

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Executive Summary

In 2005 ***safe*food** initiated a programme which involves two comprehensive food chain screening exercises per year over a three year period. Each review profiles a specific food category, identifies and describes the relevant food safety and nutritional issues pertaining to it at various points along the food chain, and identifies opportunities to communicate the human health benefits to, and influence the behaviour of, the various stakeholders. The primary focus of these reviews is food safety and nutrition issues; however, other concerns identified by the consumer not directly related to food safety are discussed, for example, labelling, quality assurance schemes and training.

Beef is a highly nutritious food; a premier source of high quality protein and bioavailable iron in the diet and has traditionally been the mainstay of the main family meal. However, in the past twenty years consumer confidence in beef has been undermined by incidences such as the emergence of Bovine Spongiform Encephalopathy (BSE) in the mid 1980s; the various outbreaks of Verocytotoxigenic *Escherichia coli* (VTEC) associated with beef products in the mid 1990s; and latterly, while not a food safety issue, the outbreak in the United Kingdom (UK) and Northern Ireland (NI) of Foot and Mouth Disease in 2001.

In the wake of these incidences beef producing farmers, industry and food safety agencies across Europe have been required to make significant changes across the food chain to protect consumer health and help restore consumer confidence in what is a very valuable foodstuff, both from an economic and a health point of view.

Quantitative research conducted on behalf of ***safe*food** indicates that beef dishes remain popular with consumers, with more than three in four adults on the island of Ireland (IOI) responding that they consume beef, claiming taste and enjoyment as the main reason. Of the types of beef consumed, minced beef, burgers and steak were reported as being the most popular and consumed regularly on week days. Roast beef remains a popular Sunday meal option, indicating that the "Sunday Roast" is still a major event. There were no significant concerns with respect to food safety issues; however, quality assurance marks and place of purchase were considered important indicators of food safety.

In focus groups conducted on behalf of ***safe*food**, beef was generally perceived as being a healthy food, although the cuts of beef and cooking methods were seen to play a key role in this. There was a perception amongst parents that it was more important for men and young boys to have beef in their diet and there was no reference to the importance of beef as a source of iron in the prevention of anaemia in young women. There was awareness in the groups of putative links between red meat to conditions such as bowel cancer.

Consumers considered themselves well informed with respect to the varying quality of different cuts of meat. There was little concern regarding the safety of beef, although consumers considered minced beef to be a more risky commodity than whole cuts. Consumers regarded the establishment of enforcement agencies in the wake of the BSE outbreak, such as the Food Safety Authority of Ireland (FSAI) and the Food Standards Agency (FSA) in NI, as being paramount to restoring and ensuring consumer confidence in the beef food chain.

From an economic perspective beef is a very valuable commodity on IOI. According to the Bord Bia 2006 annual report, cattle and beef account for the largest share of General Agriculture Output in Republic of Ireland (ROI) at 29 percent (€1.5/£1.0 billion). In NI the beef and sheep sectors account for the largest share of gross turnover in the food processing sector at 23 percent (£580/€879 million).

ROI is 820 percent self-sufficient in terms of beef production, nevertheless, imports of beef are still significant with 33,000 tonnes being imported in 2006, representing five percent of total beef available in that year. The majority of beef imported into the ROI is from the UK, with approximately 18,645 tonnes being imported in 2006 (approximately 56.5 percent of total imports). Imports from other EU Member State countries in 2006 were approximately 10,923 tonnes. Beef imports from Brazil declined significantly in 2006, from 9,372 tonnes in 2005 to 6,138 tonnes. Import data from NI are not available separately from total UK data.

Beef is one of the most perishable of all foods since it contains an abundance of all of the nutrients required for the growth of bacteria, yeasts and moulds. Thus meat will rapidly spoil unless the contamination of microorganisms is minimised and the storage conditions inhibit the growth of the microflora present.

While bacteria such as *Salmonella* and *Clostridium perfringens* are associated with beef, the pathogen now most commonly associated by consumers with this food is VTEC and more specifically *Escherichia coli* O157. This is a significant pathogen and the result of infection can lead to long term health implications such as renal failure and, on occasion, death, particularly in vulnerable groups.

In the US a number of large outbreaks of VTEC have been attributed to undercooked minced beef. In the UK, two serious outbreaks, including the pivotal 1996 outbreak leading to 18 deaths, were associated with commercially cooked meats and improper handling of raw and cooked products leading to cross-contamination. These cases, and the severity of their outcomes, led to a radical overhaul of how the beef food chain operates particularly within the UK and ROI. New legislation, regulations and recommendations governing how animals are handled at the time of slaughter, through to the separation of raw and cooked meats in butchers' outlets, were introduced. While VTEC infections still occur, and in fact surveillance data indicates they are on the increase, the vector for these infections is now much less likely to be food-related.

Other microorgansims of relevance in relation to beef include *Salmonella* Typhimurium and *Campylobacter*; however, there have been no significant outbreaks of either organism on IOI in recent years. Of more concern is the increase in the rise of antibiotic resistant bacteria, namely *S.* Typhimurium DT104. This bacterium has been shown to be resistant to a number of commonly used antibiotics including ampicillin and tetracycline. Illnesses caused by multidrug-resistant *Salmonella* species are more difficult to treat as the effective medication choices are limited. Numbers of *S.* Typhimurium DT104 peaked in 2004 on IOI but there has been some decline since.

While there are inherent risks within the beef food chain with respect to microbiological contamination, changes in farming and slaughter practice, particularly in the wake of VTEC, have resulted in a strictly controlled, hygienic and well regulated industry. The main emphasis has been on the control and prevention of potential contamination of the meat by the bowel contents of the cattle, the main reservoir of VTEC, before and during slaughter. Before slaughter animals are visually checked for levels of cleanliness of their hides and only those which meet set criteria are considered. While immediately after slaughter, the bowel and its contents are removed carefully so as to avoid contamination of the carcass.

Decontamination of carcasses and fresh meat by physical or chemical methods or a combination of both has been investigated. Currently under EU legislation the use of potable water and 'approved substances' for carcass washing is permissible.

In 1986 a previously unknown condition emerged in cattle in the UK. This condition was subsequently identified as Bovine Spongiform Encephalopathy (BSE) or more commonly know as "Mad Cow Disease". While attempts were being put in place to try and control this disease in cattle, a new form or 'variant' of an already existing human condition, Creutzfeldt-Jakob Disease (CJD), was identified and linked to the consumption of beef contaminated with BSE. The emergence of BSE, and its link to variant CJD (vCJD), has been singularly responsible for the most profound changes to how food is produced and regulated in the modern farming era.

While the exact origins of BSE are still uncertain there is a general consensus that it was facilitated by the practice of including meat-and-bone meal (MBM) in cattle feed. Cases of BSE peaked in the UK in 1992 with 37,000 cattle being infected, with the number of human cases of variant CJD peaking in 2000 at 28 deaths.

To control BSE and reduce the risk of exposure to humans a number of regulations were put in place. These included the ban on the use of MBM in animal feed; the removal of specified risk material (SRM) from carcasses before entering the food chain (these are the organs and tissues most likely to harbour the infectious BSE agents, prions); the testing of all cattle over thirty months prior to slaughter for the presence of BSE, and in the UK the "Over Thirty Month" rule, whereby from 1996 on, only animals younger than 30 months were permitted to enter the food chain; and a ban on the use of mechanically recovered meat from cattle. Also, the establishment of national food safety bodies such as the FSAI, FSA and ***safe*food**, as well as enhanced monitoring and traceability systems, have also been the positive legacy of the BSE crisis.

While the BSE crisis mainly arose in Great Britain (GB), there was a significant number of cases on IOI. Following the combination of controls and regulations that were introduced the numbers of BSE infected cattle on the island dropped from its peak of approximately 500 cases in the mid 1990s to 37 in 2007.

In recent months restrictions such as the over thirty month rule have been rescinded (although the testing of all cattle over thirty months for BSE is still required before they enter the food chain) in the UK and ROI, thus restoring consumer confidence.

In the aftermath of the BSE crisis, traceability of cattle along the food chain is now the foremost tool ensuring the integrity of, and underpinning confidence in the beef food chain. While there are slight differences in the approaches taken, all cattle in NI and ROI are now traced from birth to slaughter and identification data recorded on central databases. Other innovations in the area of traceability have include commercial systems such as DNA Traceback™ which allows traceability of individual animals and is used by some of the large retail multiples.

A number of quality assurance schemes exist on IOI. In NI the Farm Quality Assurance Scheme is supported by the Livestock and Meat Commission and the Department of Agriculture and Rural Development. While in ROI there are two schemes, the National Beef Assurance Scheme run under the auspices of the Department of Agriculture and Food and the Bord Bia Quality Assurance Scheme. All schemes seek to provide assurances to buyers and consumers of the quality and safety of beef on IOI by establishing standards to which participating farmers must adhere.

The incidences of chemical contamination of beef are largely confined to the primary production level and include veterinary medicinal products and feed additives, as well as environmental contaminants. There is comprehensive monitoring of all potential chemical contaminants entering the beef chain by the respective competent authorities on IOI. With regard to veterinary medicinal products, levels found in beef in both ROI and NI from authorised medicines were below those considered to be of human health concern. With respect to growth hormones, both ROI and NI reported no evidence of the use of banned products in beef in respective monitoring programmes. Such results highlight the safety and integrity of the beef production systems on IOI.

While there are no specific dietary recommendations for beef and beef products, UK guidelines suggest that one eighth of the total foods should come from protein sources (including beef), while in ROI it is recommended that two servings of foods classed as rich in protein are consumed daily.

As well as being a recognised source of protein, beef is also rich in inorganic constituents such as iron, selenium, zinc and copper. In particular the type of iron available from beef is in the more readily bioavailable, haem iron. Beef is also a good source of B vitamins, particularly vitamin B_{12}.

Although there are many nutritional benefits from eating beef as part of a healthy balanced diet, it has often received negative attention as a source of fat and in particular saturated fat. The total fat of beef depends on

the anatomical position from which the cut originated on the animal, and in many cases much of the visible fat can be removed at the butchering or domestic stage. In more recent times there has been a consumer drive towards leaner cuts of meat and this has been demonstrated in a significant drop in the fat content of certain cuts over the past 30 years. As well as saturated fat, beef also contains conjugated linoleic acid (CLA) and mono and polyunsaturated fatty acids which are considered nutritionally beneficial.

Ninety nine percent of adults in ROI included in the North South Ireland Food Consumption Survey consumed beef with the most common types including steak, burgers, roast beef and as part of a composite food such as stews and casseroles. In general there are no public health nutrition concerns from eating too little beef when the nutrients it provides are sourced from other foods; in fact, there may be some health implications from the fact that beef tends to be consumed in larger portion sizes than other meats. Stews and casseroles remain popular and the added benefit of these dishes is that the addition of vegetables can boost the nutritional content of the meal. However, overall high consumers of beef are less likely to meet carbohydrate intake recommendations and have less fibre dense diets.

Data from NI and the rest of the UK follow similar patterns to ROI. In the rest of the EU there appears to be a north/south divide with consumers in southern European countries eating more fresh beef, while their northern counterparts are more likely to eat processed meat products.

Preliminary results from the National Children's Survey in ROI indicate that children consume most of their meat as processed meat. Since processed meats are higher in salt and fat and lower in other nutrients compared to lean meat this may lead to potential increased health risks such as increased blood pressure, cardiovascular disease (CVD) and obesity in later life.

Due to its relatively high fat and saturated fat content there have been a number of studies linking a high consumption of beef with conditions such as CVD and cancer. However, a feature of these studies is the lack of discrimination between processed and fresh cuts of meat or between fatty and leaner cuts. Also wider aspects of the diet were not considered including the consumption of fruit and vegetables. Upon further review of these studies two key factors emerge. Firstly, that there is no evidence that lean cuts of red meat increase the risk of CVD and secondly, that the balance of other food groups such as fruit and vegetables in association with red meat intake is important. Lean cuts of meat are naturally low in salt, a factor that is associated with the development of hypertension.

Adequate fruit and vegetable consumption is also associated with lower blood pressure. In relation to cardiovascular health, the consumption of lean red meat in association with fruit and vegetable and wholegrain intakes is important for a positive health outcome.

In recent years the most controversial topic with respect to beef has been the increased number of imports of beef from Third Countries, specifically Brazil. While this is an issue in both NI and ROI, in July 2006 new legislation was enacted in ROI which requires restaurant and catering establishments to provide information to consumers on the country of origin of the beef served on their premises. This legislation was introduced on the basis of trade issues and there are no food safety implications.

Further legislation was enacted in January 2008 which increased restrictions and controls on imports of beef from Brazil in all EU countries. From 31 January 2008, beef is only allowed to be imported from an approved and restricted list of holdings in Brazil which are fully in line with EU import requirements and which meet strict criteria.

This review has collated and considered the information available - in the public domain (both regulatory and scientific) - on the safety and health implications of beef. On the basis of the evidence the following conclusions are drawn, which may provide the basis for action by ***safe*food** and other agencies on the island, as well as for stakeholders, public health professionals and consumers.

Conclusions

Primary producers and processors
The legacy of BSE has led to positive developments such as the establishment of national food safety bodies such as the FSAI and FSA as well as enhanced monitoring and traceability systems. Apart from occasional individual cases this disease is now under control and restrictions such as the over thirty month rule rescinded, thus restoring consumer confidence in the food chain.

Similarly, outbreaks of VTEC O157 have resulted in a review of best practices and regulations governing the beef food chain, particularly at the farm and slaughter areas. While this and other VTEC organisms in the food chain still pose a threat, there is an increased recognition that other environmental factors, such as water, are significant sources of contamination.

Overall, the primary production and processing aspects of the food chain are well controlled and regulated. Nevertheless, it is essential that meat processors take appropriate measures to ensure that the contamination of raw meat with VTEC and other pathogens is minimised. This can be facilitated by:

- *Ensuring cattle are clean when presented for slaughter.*
- *By strictly controlling manufacturing systems; and*
- *By considering the potential additional safeguards offered by carcass bacterial decontamination procedures.*

Distributors

- *It is essential and indeed a legal requirement, that the chill chain is maintained throughout the food chain.*
- *Traceability is also an essential feature of the beef supply chain and food business operators have a legal responsibility in this area.*

Retailers and caterers

- *The retailer and caterer represent the front line of the food industry to consumers. Food business operators have a legal responsibility in ensuring food safety.*
- *Worker hygiene and hygienic practices are legal requirements and are central in the prevention of cross-contamination.*
- *HACCP and training are at the core of good food safety practice. The increasing numbers of non-English speaking employees in the food chain has put even more emphasis on the need for training in the medium of their native languages.*

- *Cross-contamination of raw and cooked foods should be avoided and separate utensils and chopping boards used.*
- *Minced meat, burgers, rolled meats and kebabs should always be cooked all the way through until well done. Customers should not be given the option.*
- *Adherence to food safety regulations can be promoted as a business asset.*
- *When cooking and serving beef, where possible visible fat should be removed and low fat cooking methods and sauces/accompaniments used.*

Consumers

- *Beef is a nutritious food and should not be overlooked as an excellent source of iron, particularly by young women and children.*
- *The consumption of lean red meat in association with fruit and vegetables and wholegrains, has been shown to have a positive effect on cardiovascular health. The addition of vegetables to a beef dish also has a positive effect on the mineral and vitamin content. It is important to promote and support a balanced diet encompassing all the food groups.*
- *When choosing cuts of beef, choose fresh unprocessed cuts and where possible lean cuts or trim the fat following purchase.*
- *Children consume most of their meat intake as processed meats, which tend to be higher in salt and fat and lower in nutrients compared to lean meat. Furthermore, inadequate intakes of fresh, unprocessed, lean meat negatively impacts on the iron status of young children. Healthy eating messages for children should promote the consumption of lean beef and composite dishes, as well as encouraging increased consumption of fruit and vegetables.*
- *The addition of ingredients such as creams and sauces can alter the nutritional profile of a dish in terms of increased fat, salt and calories.*
- *Cooking methods, such as grilling, dry frying and stir-frying should be chosen. When roasting, cuts should be placed on a rack to allow the juices to drip onto a tray below.*
- *Portion size control is important. Evidence suggests that beef is consumed in larger portion sizes than other meats. The recommended portion size for beef is approximately 57g (2oz). It is advised that people who eat red meat should consume less than 500g (approximately 17.5oz; cooked) a week, very little if any to be processed.*
- *Consumers should be advised with respect to the correct handling, storage and preparation of foods. This extends to steps taken to eliminate the potential risk of cross-contamination from raw to ready-to-eat foods. Consumer research suggested that consumers were confident about how beef and beef products should be cooked; however, consumers should be reminded that:*

    - All surfaces, including hands and utensils, should be cleaned to prevent cross-contamination.

    - Beef, both raw and cooked, should be stored in a refrigerator at less than 5°C.

- *Growth of pathogenic bacteria can occur if the cold chain is not maintained during transport to the home. Raw meat should be packed in separate bags or containers away from other foods, particularly ready-to-eat foods, to avoid potential cross-contamination. The use of insulated bags or freezer bags is recommended during transportation. Food should be refrigerated or frozen as soon as possible following purchase.*

- *Frozen meat must be fully defrosted before cooking. The safest way to do so is in the fridge. It should be placed on the bottom shelf on a plate or tray to prevent juices from dripping onto any other foods.*

- *Whole cuts of beef, such as roast beef and steaks can be cooked to preference (i.e. rare) as long as they are cooked on the outside; however, minced beef products such as beef burgers, rolled meats and kebabs, should be thoroughly cooked and never served rare or pink in the middle. Vulnerable people, including older people, babies and toddlers, pregnant women and people who are unwell, should avoid eating beef that is rare or pink.*

- *To check that minced or comminuted meats are cooked properly, cut into the middle with a clean knife and check that it is piping hot all the way through (steaming), there is no pink meat left and that the juices run clear.*

1. Introduction

1.1. Background

The purpose of this review is to provide consumers with the most relevant and pertinent information available to enable them to make informed choices with respect to the foods they eat. In doing so, the review sets out to help consumers understand how the food safety system works; the efforts being taken by the regulators, producers, and industry, to reduce the inherent risks; and the prudent and sensible steps that can be taken to address both perceived and potential risks. ***safe*food** will use the information gathered in the review to provide opportunities to promote good practice amongst all stakeholders along the food chain.

1.2. Terms of reference

To report on foods in light of their impact on human health and consumer concerns, and in particular to:

1. *Profile the food category, identify and describe the issues relevant to human health at various points along the food chain.*
2. *Report on how the food safety system works across the entire food chain.*
3. *Identify opportunities to communicate the human health benefits and potential risks of this food category to the consumer.*
4. *Examine the various communication needs of all stakeholders to influence the behaviour across the food chain.*
5. *Identify opportunities to highlight recommended best practices and develop communication programmes based on stakeholder needs.*

1.3. Scope

This document collates and considers the information available in the public domain (both regulatory and scientific) on the health and food safety implications of the beef food chain. On the basis of the evidence, the review draws a number of conclusions for stakeholders in the beef food chain, including producers, processors and distributors, as well as retailers, consumers and public health professionals.

While the primary purpose of these reviews is directly pertaining to food safety and nutrition issues, other issues are discussed, including labelling, organic production and animal welfare.

To support the technical information presented in this document, a summary document outlining the relevant pertinent points in a non-technical format has been made available.

1.4. Consumer focused review of beef

1.4.1 Introduction

Beef is a highly nutritious food; the premier source of high quality protein and bioavailable iron in the diet and has traditionally been a mainstay of the main family meal on the island. However, in the past ten years consumer confidence in beef has been shaken by incidences such as the emergence of Bovine Spongiform Encephalopathy (BSE); the various outbreaks of Verocytotoxigenic *Escherichia coli* (VTEC) associated with beef products; and latterly in 2001, while not a food safety issue, Foot and Mouth Disease.

In the wake of these incidences beef producing farmers, industry and food safety agencies across Europe have been forced to make significant changes to farm and food processing practices and legislation has been introduced to protect consumer health and help restore consumer confidence in a very valuable product, both from an economic and health point of view.

1.4.2 Food safety risks in beef from a consumer perspective

1.4.2.1 Quantitative research

***safe*food** conducts bi-annual market research during which, amongst other things, consumers' attitudes and behaviour to particular foods and food preparation habits are determined. In its July 2006 research, consumers were asked regarding any food safety concerns that they may have with respect to beef. Consumers were also questioned on their awareness of the benefits of beef consumption.

A total of 803 face-to-face interviews were conducted on the island of Ireland (IOI); 497 in the Republic of Ireland (ROI) and 306 in Northern Ireland (NI). The sample consisted of adults aged 15 to 74 and was nationally representative.

Three out of four people ate beef regularly, with the main reason for consuming based on enjoyment (Table 1.1).

Table 1.1 Rationale for eating beef (unprompted)

	IOI (%) n = 803	ROI (%) n = 497	NI (%) n = 306
It's a meat I really enjoy	45	47	43
It tastes really good	40	35	51
I think it is good for me	23	29	9
It is something I have eaten since I was a child	19	22	13
It is a very good source of iron	16	20	8
It is a very good source of protein	14	17	8
It is a very good source of B vitamins	6	8	1
It allows me variety in my diet	14	16	10
Other	4	5	1

Minced beef, burgers and steak were the most popular types of beef consumed. Minced beef was being used frequently during weekdays suggesting that "quick" meals such as pasta-based dishes or chilli con carne-type meals are the most popular on these days. Interestingly, of those that consumed beef, 65 percent reported consuming roast beef on a Sunday with few opting to eat during the week. Casseroles and stew-type dishes also remained popular.

Methods used during cooking were dependent on the types of beef cuts being cooked. Grilling and frying were the most popular methods for cooking steaks and beef burgers. Few respondents reported choosing butter or vegetable oil for cooking and where oil was used, it tended to be olive oil. Almost two in five respondents (n=611) reported cooking minced beef in its own juices.

Consumers were asked what their cooking preference for steaks and burgers was. For steaks the preference was for well done (56 percent of IOI respondents, n=611). This was also the case for burgers (73 percent of IOI respondents, n=611). However, a number of respondents (two percent) did state that they eat their burgers rare, indicating that there is still some lack of knowledge of the correct cooking of comminuted meats or indeed a lack of behaviour change following on from public information campaigns.

Consumers were asked what their concerns were with respect to beef. The main unprompted concerns (all IOI, n=803) were how beef is cooked (70%); risk of exposure to bacteria such as *E. coli* (63%); BSE (61%); country of origin (59%); use of hormones (59%); antibiotics (57%); labelling (59%) and packaging (57%). In most cases, responses from NI and ROI were similar except for country of origin where respondents in ROI were more concerned (62%) than in NI (53%). This has consistently been shown in all the reviews to date and also underlines the driving force behind the recently enacted legislation on country of origin labelling for beef in catering establishments in ROI.

Quality assurance marks were the indicator of choice in assuring consumers of the safety of their beef products (68%), whether or not in fact such vehicles actually conferred safety status. Other indicators included place of purchase (62%); country of origin (61%); traceability or knowing what farm it comes from (60%); and organic (48%). Again there were few inconsistencies between responses from NI and ROI, except in issues relating to country of origin (54% and 64%, respectively) and traceability (51% and 65%, respectively).

1.4.2.2 Qualitative research

In September 2006, ***safefood*** commissioned qualitative research to elicit consumers' perceptions of the beef supply chain driven by the findings of the above quantitative research.

The broad core objectives were to:

- *Explore general consumer attitudes, perceptions and behaviours towards beef.*
- *Determine attitudes towards beef consumption including motivations and barriers towards purchase/consumption.*
- *Assess knowledge of the nutritional value and health benefits of beef.*
- *Explore attitudes to associated contamination and microbiological risk of beef at particular stages in the food chain.*

Six discussion groups (eight participants per group) were held amongst beef consumers in ROI and NI. The groups were conducted across urban (Dublin and Belfast) and rural (Kilkenny and Portadown) locations to provide a mix and allow for regional variation, if applicable. Variation in target markets was taken into account when choosing the optimum group matrix, with particular emphasis on females as they were considered more dominant in the purchase and cooking of beef (Table 1.2). Mixed and single gender groups were also conducted as males especially might behave differently when alone. Additional recruitment criteria included: (a) all to consume beef regularly (at least once a week) or occasionally (once or twice a month); (b) at least half of each group to cook beef at home, and (c) group four – all mothers with children living at home.

Table 1.2 Focus group matrix

Group	Gender	Age	Social class	Consumption	Location
1	Mixed	25-35	C1C2	Regular	Dublin
2	Male	35-45	BC1	Regular	Kilkenny
3	Female	35-45	C1C2	Regular	Belfast
4	Female	45-55	C1C2	Regular	Dublin
5	Mixed	55-65	C1C2	Occasional	Portadown
6	Female	45-55	C2D	Occasional	Kilkenny

Health benefits

Beef was generally perceived as a healthy food by participants, although beef type and cooking methods were seen to play a key role in this.

In terms of beef consumption singles, couples and young professionals in the groups stated that they were limiting their beef consumption to once or twice a week. They were conscious of fat content and balancing energy intake with activity. People with younger children were eating beef frequently, often two or three times per week, while older people were trying to cut back on red meat consuming once or twice per week and having smaller portions. The latter was as a result of the perceptions around the fat and cholesterol content of beef and reported links between red meat and bowel cancer, which were evident among all of the groups. Table 1.3 summarises the reasons cited during the focus groups for the consumption of beef.

Table 1.3 Rationale for consuming beef

NUTRITION Protein, Iron, Vitamin B (low awareness)	**GREAT FOR KIDS** Assists growth, provides energy, filling
CONVENIENCE Suitable for freezing, doesn't require same day cooking, widely accessible, easy to handle, no skinning/scaling	**LOW RISK** Can be eaten very rare, best before dates more relaxed than other meat
TRADITION Cornerstone of Sunday roast, familiar - know what to do with it, comfort food	**VERSATILITY** Many different ways to cook it, fits with international cooking styles
TASTE Stands alone, well-liked, inoffensive	

The benefits of red meat were well recognised in terms of providing protein, iron and energy; however, there was low awareness of B vitamins and little or no awareness of zinc. This awareness around nutritional benefits was more prominent in ROI compared with NI in the quantitative research (Table 1.1).

Fat content was negatively associated with 'healthiness'. Pork and red meat were seen to be higher in fat, while chicken and fish were perceived to be lower. In general, participants claimed to be knowledgeable about fat, e.g. red meat (especially skin/crackling) was considered to contain 'less desirable' saturated fats. Participants also stated they were now conscious of using low fat cooking methods, including removing skin and fat from meat; using low-calorie cooking spray instead of butter and oil; and grilling instead of frying.

Parents were aware of the benefits of red meat for growing children, especially in terms of energy and iron. Young adults with no children were conscious of minimising the fat content of beef, choosing leaner cuts and healthy cooking methods. Women perceived beef primarily for the family while personally preferring the 'lightness' of meats such as fish and chicken.

Men traditionally saw beef as a necessary component of their weekly meals. They did express an increasing awareness of cutting down on fat and limiting portions to control cholesterol etc., while opting for low-fat cooking styles.

There was a strong reported belief of a link between beef and sport and physical activity, and parents reported a perceived importance of feeding beef to boys. There was no reference to beef in relation to it being an important source of iron in the diet and the prevention of anaemia in young women.

The main drawbacks to beef consumption included the suggested link with raised cholesterol; cheaper cuts of meat and higher fat content; and the salt and fat content of processed meats (Table 1.4).

Table 1.4 Rationale for disliking beef

LONG TERM HEALTH IMPACT Too much red meat can cause bowel cancer, High cholesterol bad for heart	**SCARES** BSE, *E. coli*
FAT CONTENT Cheaper cuts are calorific	**COOKING TIME** Some cuts require long cooking times
TIME TO PROCESS Heavier than other meat - hard for the body to break down and process	**PRICE** Have to pay a lot for desirable leaner cuts

Beef buying behaviour

Beef is now less relied on as a staple food due to a larger choice of meats available and more unusual meats becoming more accessible. Consumers reported moving towards better, more expensive cuts of beef since the BSE crisis and were confident in how beef is categorised with an idea of how different cuts are best used.

When asked about dining out, participants were more likely to order other meats, such as duck or venison than beef. Consumers rationalised this by wanting to order different foods to what was eaten at home. Also beef portion sizes at high-end restaurants were seen as small and poor value for the price paid. People were more comfortable ordering beef in takeaway/casual dining situations, for example steak and chips, or burgers.

In terms of the types of beef purchased, roast beef remains a weekly/fortnightly staple and is still seen as something of a treat for the family. Steak on the other hand has become a more popular everyday product.

When choosing mince, lean, but not ultra-premium mince was the choice (premium cuts were considered to be wasted on mince). Cheap, mince was avoided, but necessary if buying on a budget. Concerns regarding cheap mince included that it was the 'scrapings of meat'; high fat content; low quality expected; and low controls on safety. "Cheap" mince when used was disguised in dishes such as chilli, lasagne, and spaghetti bolognese.

Shin/stewing beef (for soups, casseroles) was also mentioned as being purchased less frequently, although purchased more commonly in rural areas. These cuts were considered inconvenient, taking too long to cook if busy and tough if not cooked properly.

The process from farm to fork: food safety and general concerns

Overall consumers reported that they did not think about the farm to fork process too much. Issues such as animal welfare and slaughter are pushed to the back of their minds and in the wake of the BSE crisis they expected food safety controls to be watertight.

In general there would appear to be more concern over the general nutrition/healthiness of beef than over any safety risks. Consumers were aware that beef could be eaten rare and thus it was not considered risky if 'not cooked properly'.

Expiry dates on beef were considered to be less critical than with other meats, people stating that they trusted their own judgement. However, mince was recognised as being a "riskier" form of beef and consumers cited that

mince was more prone to bacterial contamination due to exposure to air. However, the main risk from minced meat is the contamination of central pieces by bacteria from the meat's surface. Thus, minced meat and minced meat products must be cooked thoroughly.

Current concerns regarding BSE were minimal, although participants readily recounted stories from the BSE scare era. There was reported enhanced consumer confidence through the establishment of agencies such as the Food Safety Authority or Ireland (FSAI) and Food Standard Agency (FSA).

Escherichia coli (E. coli) fears were very low. It was seen to be an issue surrounding general food safety and restaurant cleanliness and was not a concern uniquely relating to beef.

Different risks perceived at different stages of the food chain
In general, different risks were perceived at different stages of the beef food chain.

- *Farm level*
  At farm level perceived risks centred on BSE and whether cows were being properly treated for diseases, and were being fed safe, clean food themselves.

  Only trace levels of additives and preservatives were expected to be present in beef. Higher levels of preservatives/ additives are expected to be found in pre-packaged beef strips etc. There was little concern over growth hormones/ growth promoters in beef.

  Organic beef was seen as a luxury and consumers considered good quality non-organic beef to be on a par. There was also a perception that beef can never be 100 percent organic. The source of the beef (country of origin, farm, and supermarket/butcher) was considered to be more important than whether the beef was organic or not.

- *Storage/transport*
  During the storage/transport stage, perceived risks included temperature control in areas where the meat is hung and aged.

- *Handling*
  Participants acknowledged the role of food handlers and were mindful of the risk of *E. coli*. Preventive measures cited included correct storage and freezing; correct cooking temperatures; defrosting properly; and restaurant cleanliness.

Place of purchase
In the groups there was a relatively even split of people buying from supermarkets and butchers; although butchers tended to be more dominant in rural areas. Neither supermarkets nor butchers were perceived as being ultimately superior over one another (Table 1.5). Additionally, price was not the main factor in choosing where to shop.

Table 1.5 Benefits and drawbacks of butcher shops and supermarkets

Butcher shops	Supermarket
Good	
A trustworthy, friendly relationship	A high turnover of meat causes people to think it is fresh
They give advice and tips on how to cook/use meat	Self explanatory labels, everything you might want to know is stated
You can get it cut to your liking	A huge variety of cuts to choose from
You can get other fresh fare there – eggs, vegetables, etc.	Conveniently packed, grab and go
Hot counters in butchers are becoming more common, increases convenience	
Bad	
An extra stop when shopping	Lacks the personal, friendly service
Not as traceable as supermarket beef - less detail given with dates and labels	No-one to give personalised cooking tips and advice
A 'less sterile' environment than supermarkets, meat exposed to open air	Price may reduced and you don't know why

Labelling

Consumers looked for the basics on labels. Price and description came foremost followed by weight and best before dates (term used by consumers - 'use by' is the correct term as applies to beef products). In spite of claiming that it was important, participants did not look immediately for the source of the beef. Quality assurance symbols were largely taken for granted and expected to be there.

Participants in the ROI groups were not familiar with the new labelling legislation in the catering sector (see Chapter Six). Their initial reaction was that this is for high end restaurants and that the onus to label would in fact increase the price. Consumers were also dubious about believing origin claims on menus, citing that restaurants would alter their beef sources according to supply anyway.

Country of origin

Participants thought of origin in terms of country, broadly categorising beef as 'Irish', 'British', or 'foreign', rather than individual cattle or farms. Beef on the island was seen to be world class. 'Local' beef in particular had great appeal as it was perceived to be healthy and fresh.

On the other hand, it was assumed that beef from abroad must have a solid quality reputation to overcome the barrier of the distances travelled. Perceptions of the quality and safety of beef from a number of different countries are outlined in Table 1.6.

Table 1.6 Concerns with worldwide supply

Country	Perceptions
Irish	Seen as safest, freshest
English	Shaken off BSE fears, some hesitation remains with cheaper cuts
Scottish	Aberdeen Angus – world leader in beef
German	Good quality
Eastern European	Concern over safety controls
Asian	More dangerous than local, people dubious about safety checks
USA	Good, but distance from Ireland raises questions about safety and freshness
Brazil	Good quality
Argentina	Perceived as a large provider, some hesitation remains post BSE scares

Preparation and cooking
Participants claimed to be knowledgeable about beef safety. It was reported that beef can stay in the fridge for two to three days, and in the freezer for up to three months. Basic meat safety rules are applied to beef: wash hands after handling beef; wash chopping boards and surfaces thoroughly; covering meat in the fridge and storing it on the bottom shelf.

Consumers perceived the taste of beef as being closely associated with freshness. Freshness for them, however, was not about from farm to fork in as quick a time as possible, it was more about beef being hung/aged for just the right amount of time. People were confident in assessing the look and smell of beef with deep red, juicy beef recognised to be fresher and tastier. There was a perception that 'if it smells ok...it is ok' unlike chicken or shellfish. Few participants admitted to tenderising beef, with the majority thinking it an unnecessary activity.

Older people used more traditional cooking styles such as the traditional Sunday roast beef, stews, and steak; while younger people and mums were more willing to experiment with beef by trying out international cooking styles such as stir fries and curries.

Consumer advice
In terms of advice, participants stated that they trusted food safety 'experts' such as the FSAI, FSA and ***safefood*** more than the media. While acknowledging that the media raises awareness, they thought the coverage is more likely to be subjective. Participants did express confusion over the various boards and authorities and who they should listen to.

2. The Supply Chain

2.1. Introduction

The beef industry makes a significant contribution to the economies of Nothern Ireland (NI) and and the Republic of Ireland (ROI)[1].

With increasing globalisation of markets, this chapter describes the beef market on the island of Ireland (IOI) and places it within a European and global context.

2.2. Island of Ireland

2.2.1 Introduction

The beef sector (in terms of live cattle trade and meat) accounts for the largest share of gross agricultural output in ROI at 29% with a value of €1.5 (£1.0) billion. The milk sector is next at 26%, followed by the pig meat (6%), sheep (4%), cereals (3%) and forage plants (15%) sectors (Bord Bia 2007a). ROI is 820 percent self-sufficient in terms of beef produce; however, imports are still significant (Department of Agriculture, Fisheries and Food 2007a).

In NI, the beef and sheep meat sector accounts for the largest share of gross turnover in the food processing sector at 23% and is valued at £580 (€879) million. This is a position shared by milk and milk products (also 23 percent). These sectors are followed by the poultrymeat (16%), drinks (11%), pig meat (8%), bakeries (8%) and fruit and vegetables (6%) sectors (Department of Agriculture and Rural Development 2007). NI is 808 percent self-sufficient in terms of beef production (Livestock and Meat Commission NI 2007).

Cattle on IOI are reared mainly on grass, which is grazed in the spring, summer and autumn. During winter months they are predominantly housed indoors and fed silage. Calves for beef come from both the dairy and suckler herds and are generally born in spring, with almost 85 percent born in the January to May period (Department of Agriculture, Fisheries and Food 2005).

Cattle produced on IOI have two main outlets. Animals are either exported live to EU or Third Country destinations, or finished for slaughter in abattoirs on the island. Beef is produced from two sectors - dairy beef produced as a 'sideline' from dairying operations and beef from specialist beef producers.

On IOI, and even within the EU, there has been a general trend towards a more concentrated slaughtering industry both in terms of ownership, and in terms of production plants. In recent years, small slaughterhouses have closed and large slaughterhouses have moved closer to the production areas. This has been due in part to the requirements of the large retail chains and EU hygiene requirements. The large retail chains use their buying power to demand products and services that meet their pre-specified standards, i.e. descriptions of the various products and services supplied by slaughtering companies (including weight of quarters, muscles, packaging, and production methods) and they demand these standardised products in large quantities on which they expect discounts and above all they require regularity in the supply.

Slaughtering companies vary in size and also in the variety of activities they perform. Some smaller companies are involved in slaughtering only, which includes killing the animal and removing the 'fifth quarter' (including skin, liver, kidneys and intestines). Carcasses are sold directly to retailers or through wholesalers, or to the meat industry. Larger companies generally perform additional cutting and boning operations to provide primal cuts ready to be cut by the retail trade. They now also incorporate portioning and packaging operations to provide finished product to the large retailers.

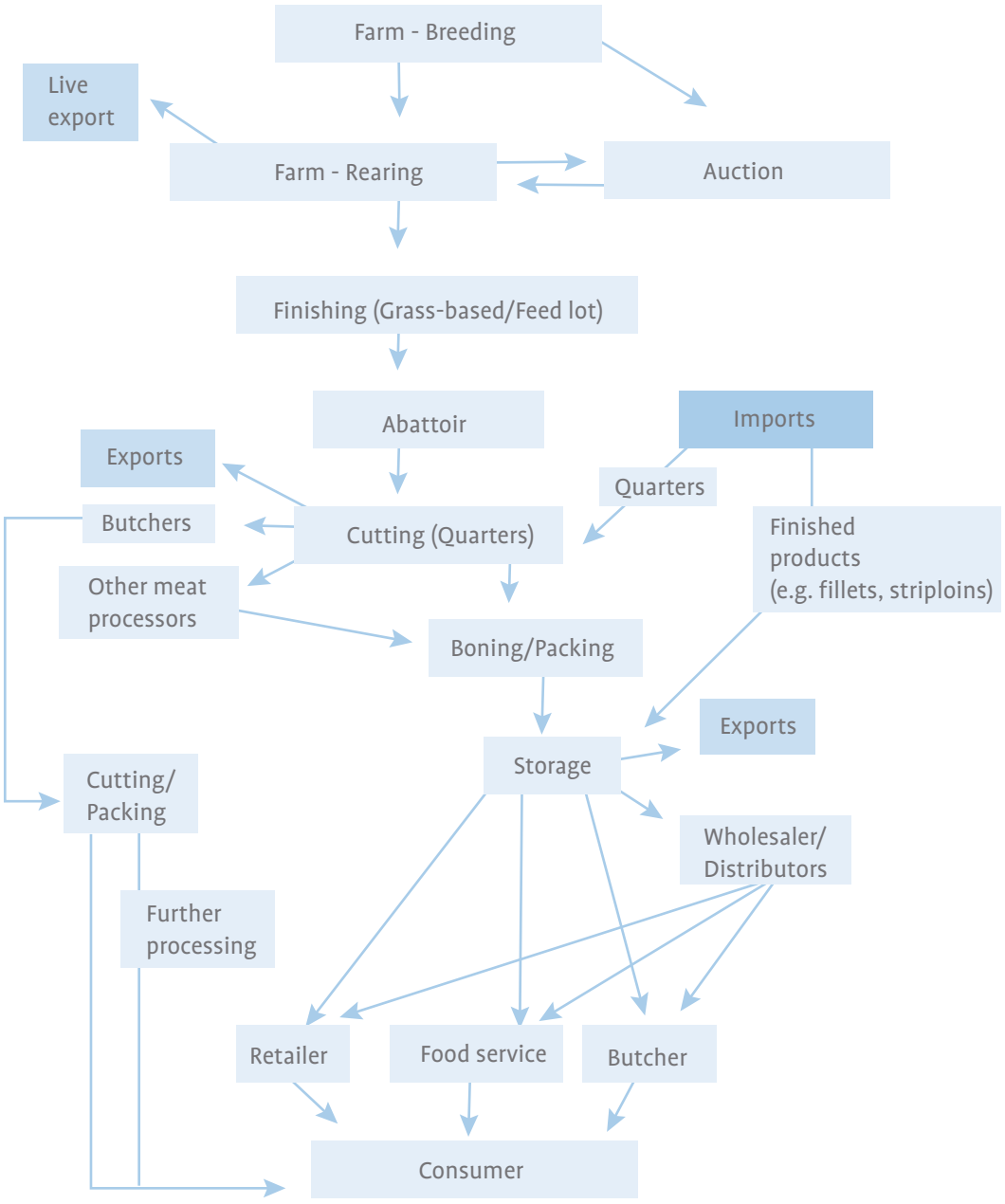
[1]The industry makes a significant contribution because of EU subsidisation (the 'single farm payment').

Slaughterhouses source their cattle from individuals, farmers, producer groups/cooperatives or cattle markets.

The role of independent wholesalers in the industry is declining as the wholesale and distribution functions are integrated into larger companies, which can be either slaughtering companies or large retail chains. The decreasing sales of beef through butchers, who are the principal customers of many wholesaling companies, put additional pressure on wholesalers.

The beef supply chain on IOI is outlined in Figure 2.1.

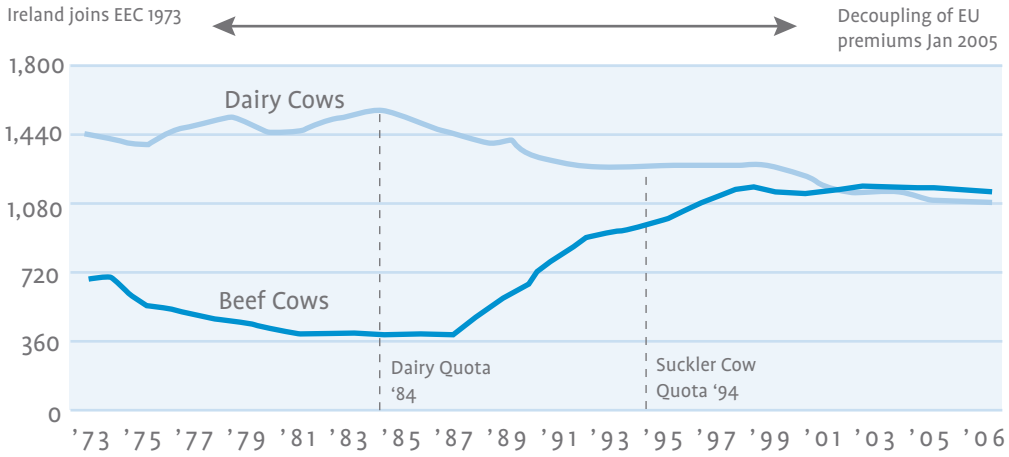
Figure 2.1 The beef supply chain on IOI



2.2.2 Beef herd on the island

There were 6.19 million cattle (both dairy and beef) in total in ROI in 2006 (Bord Bia 2007b). The beef breeding herd in ROI comprised 2.71 million head in 2006, while the beef (suckler) herd accounted for 1.22 million head (Bord Bia, Personal Communication, January 2008) (Figure 2.2).

Figure 2.2 Development of the cow herd on ROI, 1973 to 2006



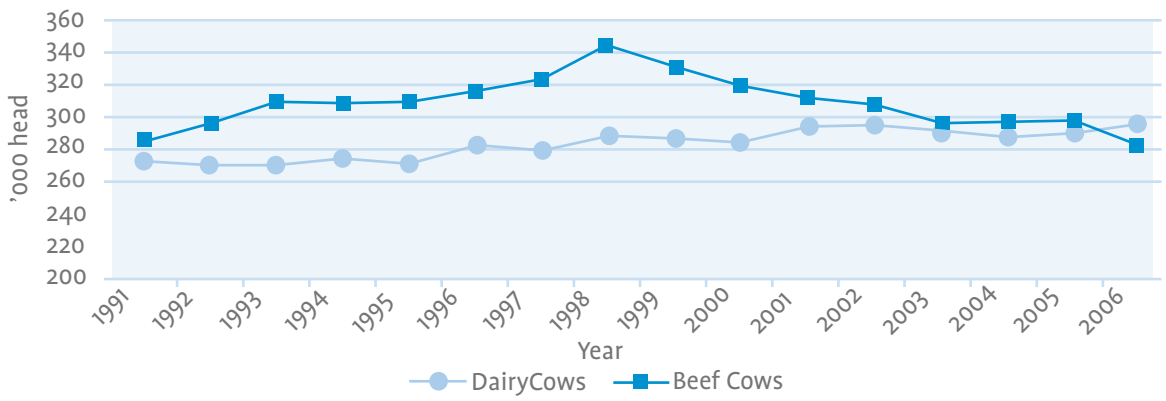
Source: Adapted from Central Statistics Office's December Livestock Survey Results in Bord Bia (2006) and Bord Bia, Personal Communication, January 2008.

The dairy herd on ROI is comprised almost totally of Friesian cows, but in the order of 50 percent of these are bred to beef bulls. It is estimated that over 60 percent of suckler cows are crosses of continental breeds such as Charlaois, Limousin, Simmental and Belgian Blue, with the remainder made up of Hereford and Angus types. Almost 90 percent of all suckler cows are bred to continental beef breed bulls (Department of Agriculture, Fisheries and Food 2005).

There were 283,000 beef cattle in NI in 2006 with a total herd of 1.636 million cattle (Department of Agriculture and Rural Development 2007).

The beef herd in NI is comprised of Limousin (33%), Simmental (18%), Aberdeen Angus (16%), Charlaois (12%), Hereford (6%), Shorthorn (2%), Friesian (1%) and other (11%) (Department of Agriculture and Rural Development 2006).

Figure 2.3 Trend in dairy and beef cow numbers, NI, 1991 to 2006



Source: Department of Agriculture and Rural Development (2007)

2.2.3 Production

2.2.3.1 Republic of Ireland

Cattle are produced for slaughter at meat plants or local abattoirs, or for export as live animals. Overall cattle outputs on ROI were just over two million in 2006, of which 88 percent of cattle were slaughtered (84 percent at export meat plants and four percent at local abattoirs), and 12 percent were exported (live) (Table 2.1).

Table 2.1 ROI cattle outputs, 2006 v 2005 ('000 head)

	2005	2006 (e)	% change
Export meat plants	1,606	1,692	-6.8
Local abattoirs	80	80	-10.1
Live exports	185	250	+39.1
TOTAL	**1,871**	**2,022**	**-3.8**

Note: (e) = estimated
Source: Bord Bia (2007b)

With the volume of beef being produced at local abattoirs declining gradually and the progression of the major supermarket chains to centrally packed beef, Department of Agriculture-approved abattoirs (formerly known as 'export approved meat plants'; however the Hygiene package makes no distinction between abattoirs that can and cannot export) are supplying an increasing percentage of the domestic market requirements.

Animals slaughtered on ROI in 2006 were predominantly older than 18 months and younger than 30 months (Department of Agriculture, Fisheries and Food 2007b).

2.2.3.2 Northern Ireland

Over 460,000 cattle were slaughtered in NI in 2006 (Table 2.2).

Table 2.2 Cattle slaughterings in NI 2006

	No. of animals
Steers	189,282
Heifers	141,234
Young bulls	43,788
Cows	57,406
Mature bulls	2,346
Total	**434,058**
Over Thirty Months (OTM)/Older Cattle Disposal Scheme (OCDS)	
Steers/Heifers	104
Cows/Bulls	26,920
Emergency slaughter	5,241
Total	**32,265**
Total including OTMs	**466,323**

Note: On 23 January 2006, the Older Cattle Disposal Scheme replaced the Over Thirty Months Scheme
Source: Livestock and Meat Commission NI (2007)

2.2.4 Commercial beef production

The volume of 'commercial' ROI beef production was 569,000 tonnes carcass weight equivalent (cwe) in 2006, of which Department of Agriculture-approved abattoirs accounted for 96 percent (or 548,000 tonnes), while local authority-approved abattoirs accounted for 21,000 tonnes (Bord Bia 2007b). See Table 2.3.

Table 2.3 ROI beef balance sheet ('000 tonnes cwe)

	1997	1998	1999	2000	2001	2002	2003	2004	2005(e)	2006(e)
Gross Indigenous Production*	570	611	704	633	591	554	590	578	567	-
Net Production (Slaughterings)*	558	586	634	568	569	530	561	555	541	569
+ Beef Imports	19	15	10	12	21	16	18	30	33	33
- Beef Exports(1)	472	523	643	520	350	464	500	499	488	516
of which:										
Commercial	472	510	554	504	350	463	495	499	488	-
Stock Change (2)	30	-3	-80	-18	164	5	-5	0	0	-
Consumption (3)										
- '000 tonnes cwe	75	81	81	78	76	77	84	86	86	86
- kg/head	19.9	21.8	21.8	20.6	19.8	19.7	21.1	21.2	21.1	21.1

Note: - Figures unavailable
*Excludes animals removed under BSE control programmes
(1) Includes sales of intervention beef
(2)Changes in public stocks, market support schemes such as Purchase for Destruction Scheme and Special Purchase Scheme and private stock changes due to exceptional market conditions
(3) Residual figure after allowing for stock changes
(e) Estimated
Source: Bord Bia (2007b)

141,900 tonnes of beef and veal were produced in NI in 2006 (Meat and Livestock Commission 2007).

2.2.5 Imports

2.2.5.1 Republic of Ireland

Imports of 'commercial' beef were 33,000 tonnes in 2006 (Bord Bia 2007b). This brought total beef availability (including ROI beef production) for the year to 602,000 tonnes.

The main countries that beef was imported from during this period were United Kingdom (56.5%), Brazil (18.6%), Holland (16%), France (3%), Belgium (1.8%) and others (4.1%) (Central Statistics Office 2008).

Figures for NI beef imports are unavailable separately to overall UK figures.

2.2.6 Exports

2.2.6.1 Republic of Ireland

ROI exports approximately 90 percent of its beef produced, a volume of 516,000 tonnes (Bord Bia 2007b). ROI's beef export market has changed dramatically since the Bovine Spongiform Encephalopathy (BSE) crisis in 1996 and the resultant imposition of bans or stringent requirements on beef. Prior to this time the majority of beef exports were to non-EU countries, whereas nowadays the majority of ROI exports are going to other Member States (Table 2.4). In 2006, ROI exported an estimated 516,000 tonnes cwe of beef (€1.53/£0.88 billion) and 250,000 live cattle (€145/£92.40 million) (Bord Bia 2007b). During this period beef exports to European markets accounted for 93 percent (480,000 tonnes) and exports to the UK accounted for 45 percent (250,000 tonnes cwe) of total exports, Bord Bia (2007b).

Table 2.4 Beef exports to EU countries ('000 tonnes cwe)

	2005	2006 (e)
Total	488	516
UK	260	250 (€750m)
Rest of the EU,	191	230
of which to		
France	44	52 (€140m)
The Netherlands	40 (€120m)	45 (€155m)
Italy	42 (€150m)	51 (€220m)
Scandinavia	32	40 (€75m)
Spain	14	16 (€40m)
Portugal	9	11
Belgium	5 (€12m)	-
Germany	2	4.5
International Markets	37 (€90m)	38 (€100m)
Russia	27	30
Algeria	5	5

Note: No figures available
(e) = Estimated
Source: Bord Bia (2006; 2007b)

ROI supplies approximately 75 percent of UK beef imports (Department of Agriculture, Fisheries and Food 2005). Approximately one third of ROI beef exports to the UK go directly to the retail sector while processed beef (beef which has been included in, for example, ready meals and beef burgers) accounts for one quarter of total exports (Bord Bia 2007b).

Total live cattle exports increased by 65,000 head on 2005 levels at 250,000 head and were valued at just over €145 (£97) million. Exports to EU countries were 147,700 head. The key markets were Spain (72,000 head), Italy (67,000 head) and Holland (52,000 head). Live cattle exports to NI were 28,000 head in 2006 (Bord Bia 2007b). Live cattle exports to international markets decreased from 10,000 head in 2005 to 500 head in 2006 reflecting the absence of export subsidies.

2.2.6.2 Northern Ireland

In 2006, 18 percent (25,000 tonnes) of NI beef was sold in the 'home' market, 73 percent (104,000 tonnes) was sold in Great Britain (GB), while the remaining nine percent (13,000 tonnes) was sold to other EU countries primarily the Netherlands, ROI and France (Livestock and Meat Commission 2007).

NI, as part of the UK, was subject to a beef export ban from 1996 to 2006.

2.2.7 Beef consumption

According to trade figures, the current consumption level of beef in ROI is 86,000 tonnes cwe (Table 2.5). It ranks second to pigmeat in terms of meat types consumed.

Table 2.5 Meat consumption on ROI ('000 tonnes cwe)

Meat type	2004	2005	2006(e)
Beef	86	86	86
Pigmeat	149	150	150
Sheepmeat	20	20	20.5
Poultry	119	125	129

Note: (e) = Estimated
Source: Bord Bia (2006; 2007b)

Beef consumption fell dramatically in the wake of the 1986 crisis but the decline varied greatly within the EU (UK, 36%; France, 40%; Germany, 55%; Italy and Spain, 30%; and ROI, 15 to 20%) (Department of Agriculture, Fisheries and Food 2005).

Beef consumption in ROI has shown a steady increase since 2000 with consumption in 2006 up approximately 25 percent on levels in 2000 (Bord Bia 2007b).

Consumption figures for NI are unavailable separately to overall UK figures.

2.2.8 Retail and food service

Retail sales figures from Taylor Nelson Sofres show that the overall volume of beef sales at retail and food service level in ROI was 68,000 tonnes cwe in 2006 with the foodservice sector accounting for 25 percent of the total market (Bord Bia 2007b). Retail sales accounted for almost 75 percent of total beef consumption at 65,000 tonnes cwe.

Multiples account for 75 percent of retail sales with 20 percent of sales through butchers. The remainder is comprised of symbols, discounters and others.

The fast food burger market is a well-defined segment of the general eating out food market. McDonalds is the largest user of beef in Europe (Thankappan and Flynn 2006).

The leading producer companies (by market share) in ROI are Dawn Meats, AIBP and Kepak (Food For Thought 2006).

Data for NI is unavailable.

2.2.9 Food chain research

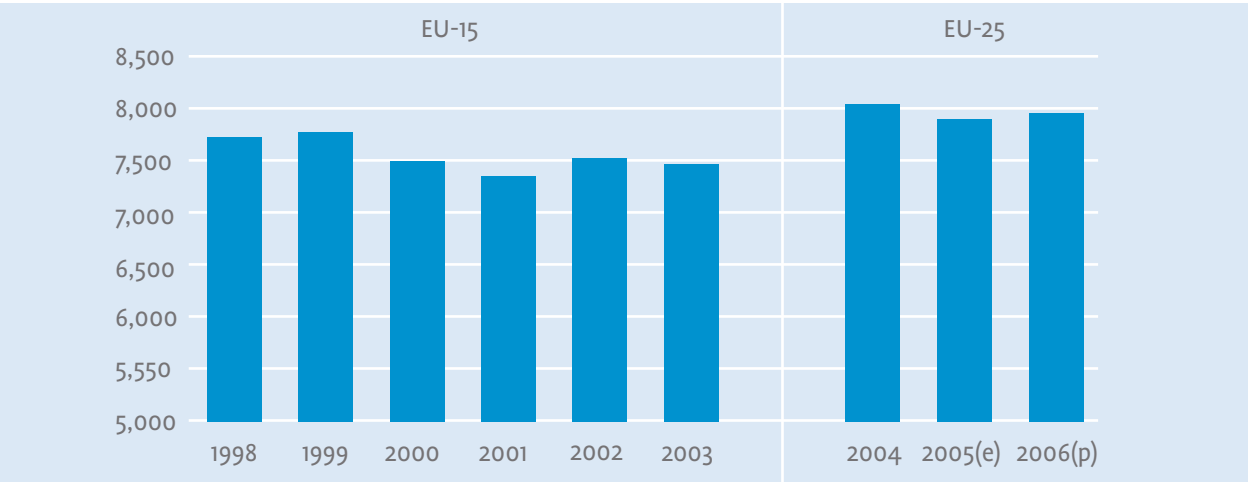
Food market researchers at Teagasc Ashtown Food Research Centre are currently undertaking a survey of beef and pig meat chains on ROI. The survey forms part of a wider EU research project, FOODCOMM, which Teagasc is undertaking in conjunction with EU research institutes in Finland, Germany, Poland, Spain and Britain. The key objectives are to elicit the perceptions of the key stakeholders in the beef and pigmeat supply chains (producers, processors, distributors and retailers) in order to establish if communication mechanisms can be improved.

2.3 The European context

2.3.1 Production

Beef production in the EU-15[2] countries was approximately 7.4 million tonnes cwe in 2003 and with the addition of ten new Member States, rose to 7.95 million tonnes cwe in 2004 (Figure 2.4).

Figure 2.4 EU net beef production, 1998 to 2006 ('000 tonnes cwe)



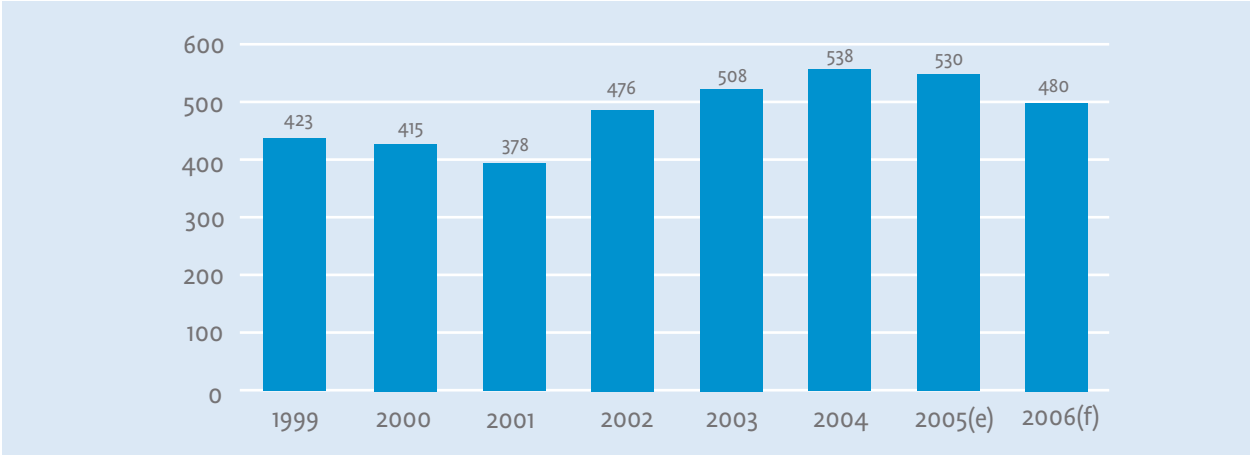
Note: (e) = estimated
(p) = predicted
Source: Bord Bia (2006)

[2] Refers to the 15 countries in the EU prior to the expansion on 1 May 2004 when when eight central and eastern European countries as well as Cyprus and Malta joined the organisation.

2.3.2 Imports

The volume of beef imported into the EU was 530,000 tonnes in 2005. The EU continues to be the principal target market for South American exporters such as Brazil (Figure 2.5).

Figure 2.5 EU beef imports, 1999 to 2006 ('000 tonnes cwe)



Note: (e) = estimated
(f) = forecast
Source: Bord Bia (2006)

2.3.3 Exports

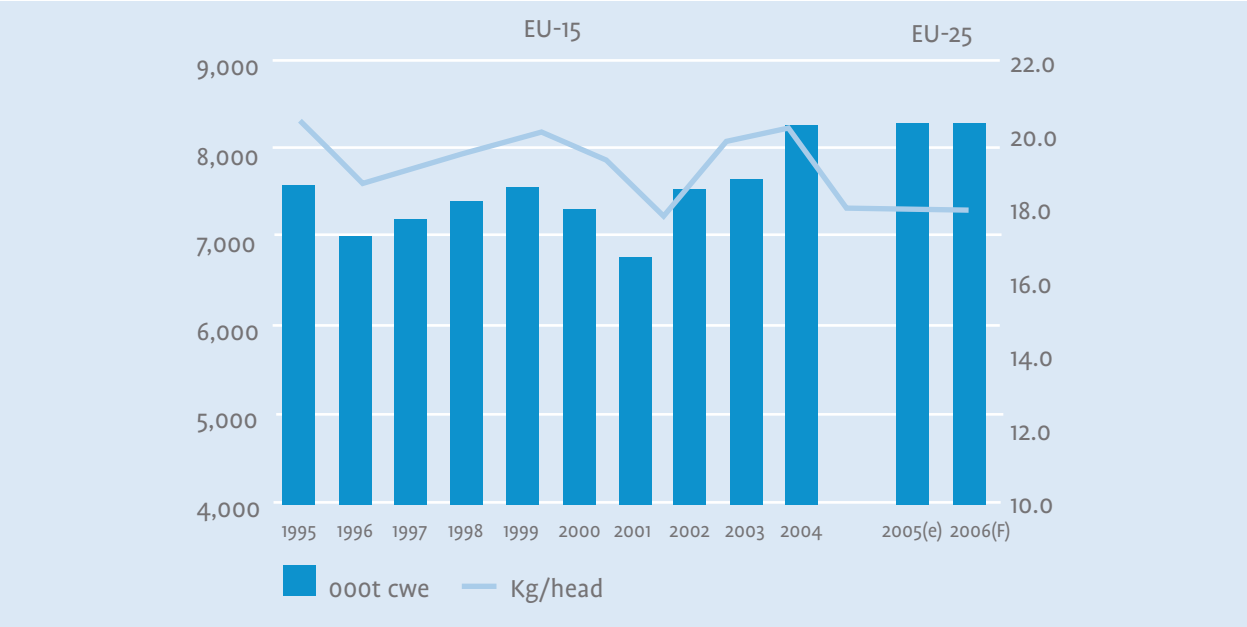
There has been a steady decrease in beef exports over the past ten years. The volume of EU beef exports was 300,000 tonnes cwe in 2005, down by 35 percent on 2005 and 80 percent on 1995 (Bord Bia 2006).

The EU is currently in a beef deficit situation thus exports are quite a low percentage of production (Bord Bia 2006).

2.3.4 Consumption

Per capita annual consumption of beef in the EU-15 stands at around 20.5kg, while on an EU-25 basis, per capita it stands at an estimated 7.8kg (Figure 2.6) (Bord Bia 2006).

Figure 2.6 EU beef consumption trends, 1995 to 2006



Source: Bord Bia (2006)

From the above figure, it can be seen that EU beef consumption fell during the BSE crises in 1996 and 2000.

France is the leading consumer of beef in the EU, representing 20% of total consumption. It is followed by Italy (17%), the UK (16%), Germany (13%) and Spain (8%) (Bord Bia 2006). ROI represents only one percent of beef consumption (Bord Bia, Personal Communication, April 2007).

2.4 The global supply chain

The volume of beef produced by the world's leading countries was 54 million tonnes in 2006 (Bord Bia 2007b).

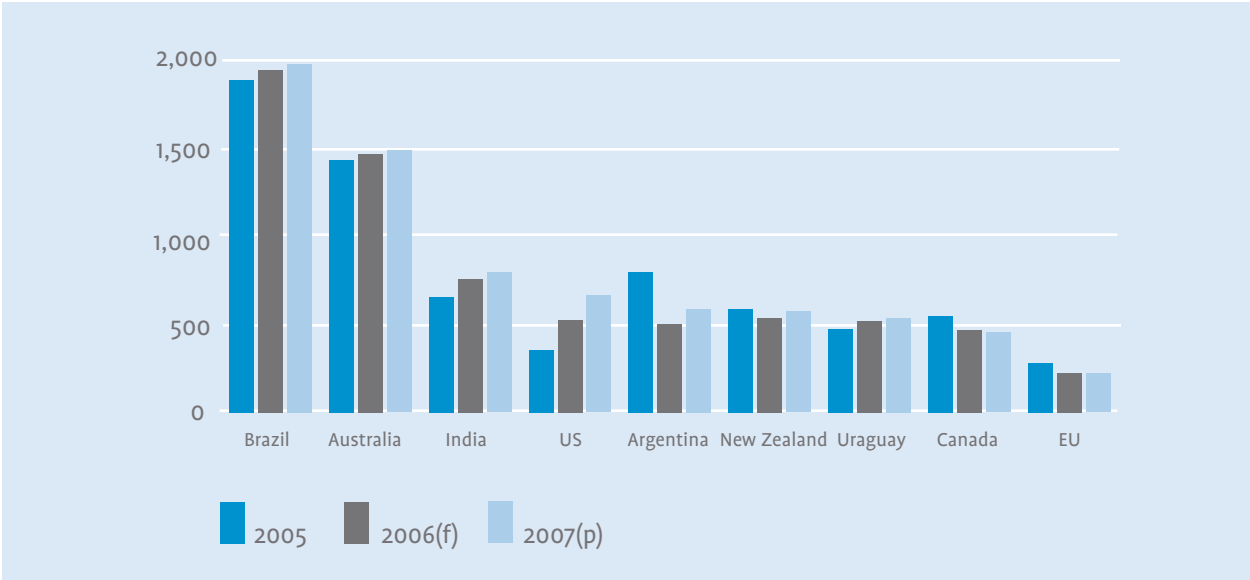
2.4.1 Exports

Brazil is the leading global exporter of beef, followed by Australia, India, the US, Argentina and New Zealand (Figure 2.7).

Chilled, fresh, and frozen exports account for just over 80 percent of Brazil's beef trade and prepared/preserved beef accounts for nearly 20 percent. Major markets for Brazil's beef exports include the EU-25, Russia, and Chile, while the EU and the US import processed beef (Valdes 2006).

Japan and Korea are the major markets for Australian beef, accounting for 405,796 and 149,660 tonnes, respectively, in 2006 (Meat and Livestock Australia 2007a; Meat and Livestock Australia 2007b).

Figure 2.7 Global beef exports, 2005 to 2007 ('000 tonnes cwe)



Note: (f) = forecast
(p) = predicted
Source: Bord Bia (2007b)

Brazilian beef exports accounted for 22% of its total production in 2005, while Australian exports accounted for 66% of its production (Boal 2006). The US accounted for 3%; New Zealand, 86%; Canada, 37%; Argentina, 24%; Uruguay, 77% and the EU, 3% (Boal 2006).

2.4.2 Consumption

Argentina was the leading consumer of beef globally in 2006 at 65.2kg per capita (Table 2.6).

Table 2.6 Per capita beef consumption (kg per person)

Country	2004	2005(p)	2006(f)
Argentina	64.2	61.9	65.2
US	43.2	42.8	43.8
Australia	37.5	37.3	37.5
Brazil	34.8	36.4	37.4
Canada	32.4	32.1	31.1
Uruguay	19.9	21.2	27.0
Mexico	22.4	22.6	23.1
EU-25	18.2	17.9	17.9
South Africa	15.0	15.6	15.8
Hong Kong	13.9	15.4	15.3
Russian Federation	15.7	15.0	14.9
New Zealand	15.8	15.6	14.7

Note: (p) = provisional
(f) = forecast
Source: USDA (2006)

3. Food Safety

3.1 Overview

Significant investment has occurred over the last ten to fifteen years to ensure that consumers have confidence in the beef supply chain on the island. This includes both the drafting and enforcement of national and European legislation, and also the development of quality assurance schemes.

Foodborne illness is caused as a result of the consumption of, or contact with, food that has been contaminated with some type of microbiological, biological, chemical or physical hazard (Table 3.1).

Table 3.1 Types of contaminants

Hazard	Example
Biological	Bacteria, viruses, yeasts, moulds, parasites
Biochemical	Prions
Chemical	Pesticides, toxins, cleaning products/substances, veterinary drug residues
Physical	Glass, metal, wood, string, dirt, bone, hair, insects, faeces

This chapter will look at the microbiological, biochemical and chemical aspects of the beef supply chain. This will include the hazards and risks associated with beef, and the controls in place to minimise any associated risk.

3.2 Microbiology

3.2.1 Introduction

Beef is one of the most perishable of all foods since it contains an abundance of all of the nutrients required for the growth of bacteria, yeasts and moulds. The high water content, corresponding to a water activity of 0.99, also makes beef a suitable substrate for the growth of most microorganisms (Jay 1986). Thus meat will rapidly spoil unless the contamination of microorganisms is minimised and the storage conditions inhibit the growth of the microflora present.

This section will describe the impact of foodborne illness and its associated pathogens and their relationship with beef and beef products; explore the chain of events that leads to the conversion of muscle to meat, post mortem, and their effect on beef contamination by microorganisms; and detail the measures that can be adopted throughout the food supply chain to produce a product of the highest microbiological quality and safety.

3.2.2 Foodborne human infections associated with beef[3]

3.2.2.1 Introduction

Traditionally certain pathogenic organisms (namely *Salmonella* and *Clostridium perfringens*) have been well documented as being associated with the consumption of beef. However, relatively recently new hazards have been recognised.

Verocytotoxigenic *Escherichia coli* (VTEC) O157:H7 was first recognised in 1982 in the US following a large outbreak of what was an unusual gastrointestinal illness (Riley, Remis et al. 1983). In 1993 a large multistate *E. coli* O157:H7

[3]Tracing individual episodes of human infection to a particular food is inherently difficult. Estimating the risks associated with consuming different foods is a complex epidemiological process. Disease risks from foods can only be derived from the analysis and interpretation of a large body of evidence. This evidence includes laboratory infectious disease surveillance data; hospital episode statistics; food intake surveys; outbreak surveillance data; death statistics; and special studies related to infectious disease outbreak investigations. It should be noted that caution must be exercised in attributing infections to specific foods.

outbreak in the US linked to undercooked ground beef patties underlined the importance of this pathogen (Rangel, Sparling et al. 2005).

Variant Creutzfeldt Jakob Disease (vCJD) was first described in 1996 in the UK and it is now widely accepted that the bovine spongiform encephalopathy (BSE) agent is responsible for the emergence of this new form of Creutzfeldt Jakob Disease (CJD) in humans (Pattison 1998).

Multidrug resistant *Salmonella* Typhimurium is now a major problem with over 60 percent of S. Typhimurium isolates from human samples being resistant to five antimicrobial agents in 2006 (Foley, McKeown et al., 2007) in ROI. Foods, including beef, are now known vectors for these organisms.

Consumption of beef rated relatively high as a disease risk in a major review of data from England and Wales for years 1996 to 2000 (Smerdon, Adak et al. 2001). At 41 cases per one million servings it was on a par with the estimated risk associated with eggs, less than half that for chicken and only a small fraction (6.5 percent) of the estimated risk associated with shellfish (Table 3.2).

Table 3.2 Estimated risks associated with food groups and type, England and Wales 1996 to 2000

Food Group/Type	Disease Risk*	Disease Risk Ratio	Hospitalisation Risk†	Hospitalisation Risk Ratio
Poultry	104	947	2,063	4,584
Chicken	111	1,013	2,518	5,595
Eggs	49	448	262	583
Red Meat	24	217	102	227
Beef	41	375	153	339
Pork	20	180	93	208
Lamb	38	343	128	285
Seafood	41	374	293	650
Shellfish	646	5,869	1,121	2,490
Milk	4	35	133	295
Vegetable/Fruit	1	NA	8	NA
Salad Vegetables	6	53	103	229
Cooked Vegetables	0	1	0	1
Fruit	0	2	1	1

Note: * Cases/1 million servings
† Hospitalisations/1 billion servings
NA, not applicable
Source: Smerdon, Adak et al. (2001)

3.2.2.2 Human outbreaks associated with beef

Data from population based studies and surveillance systems have been analysed to estimate the burden of infectious disease associated with beef. Beef is an uncommon source of foodborne illness on the island of Ireland (IOI).

Outbreak data from England and Wales

Between 1992 and 1999, 1,426 outbreaks of general foodborne infectious intestinal disease were reported. Of these, 16 percent were linked with the consumption of red meat. Over 5,000 people were affected with 186 hospital admissions and nine deaths. Beef (34 percent) and pig meat (32 percent) were the most frequently implicated red meat types. During the summer, outbreaks were mainly of *Salmonella* species and attributed to pig meat. In December, outbreaks of *Clostridium perfringens* linked with beef predominated. Most of the beef outbreaks (46 percent) were linked with commercially cooked beef. A fall in the number of outbreaks linked with foods containing red meat corresponds with a steady decline in red meat consumption over the last two decades (Smerdon, Adak et al. 2001).

A major study conducted on data from England and Wales during the period 1996 to 2000 (Adak, Meakins et al. 2005) demonstrated that only seven percent of cases of indigenous foodborne disease (n= 1,724,315) were attributed to beef consumption (Table 3.3). However, the high case mortality rate is related to deaths due to VTEC infections.

Table 3.3 Estimated annual impact of indigenous foodborne disease, by selected food group and type, England and Wales 1996 to 2000

Food Group/Type	Cases (%)	Death (%)	Case-Fatality Rate*
Poultry	502,634 (29)	191 (28)	38
Chicken	398,420 (23)	141 (21)	35
Eggs	103,740 (6)	46 (7)	44
Red Meat	287,485 (17)	164 (24)	57
Beef	115,929 (7)	67 (10)	58
Pork	46,539 (3)	24 (4)	53
Lamb	46,239 (3)	27 (4)	59
Seafood	116,603 (7)	30 (4)	26
Shellfish	77,019 (4)	16 (2)	21
Milk	108,043 (6)	37 (5)	34
Vegetable/Fruit	49,642 (3)	14 (2)	29
Salad Vegetables	37,496 (2)	11 (2)	28
Cooked Vegetables	6,870 (0)	2 (0)	35
Fruit	5,275 (0)	1 (0)	25

Note: *Deaths/100,000 cases
Source: Smerdon, Adak et al. (2001)

In general, the health care impact arising from beef is not high (Table 3.4), nevertheless the impact of beef-associated foodborne infections can be severe.

Table 3.4 Estimated annual healthcare impact of indigenous foodborne disease, by selected food group and type, England and Wales 1996 to 2000

Food Group/Type	General Practitioner Cases (%)	Hospital cases (%)	Hospital Days (%)
Poultry	159,433 (35)	9,952 (45)	41,645 (41)
Chicken	129,271 (28)	9,005 (41)	36,425 (36)
Eggs	19,554 (4)	552 (3)	3,410 (3)
Red Meat	80,805 (18)	1,231 (6)	10,935 (11)
Beef	34,981 (8)	429 (2)	4,284 (4)
Pork	11,923 (3)	219 (1)	1,685 (2)
Lamb	14,283 (3)	157 (1)	1,721 (2)
Seafood	23,998 (5)	828 (4)	3,690 (4)
Shellfish	12,861 (3)	134 (1)	752 (1)
Milk	40,755 (9)	3,681 (17)	14,176 (14)
Vegetable/Fruit	11,912 (3)	702 (3)	2,932 (3)
Salad Vegetables	9,874 (2)	660 (3)	2,671 (3)
Cooked Vegetables	1,184 (0)	27 (0)	168 (0)
Fruit	853 (0)	15 (0)	93 (0)

Note: Totals given are calculated on the basis of rounding to whole numbers.
Source: Smerdon, Adak et al. (2001)

While only two percent of hospital cases of foodborne infections were associated with beef in the period 1996 to 2000, ten percent of infectious intestinal disease deaths were linked to beef (Table 3.3).

Outbreak data from the EU
An extensive analysis and evaluation of reported data on EU foodborne disease outbreaks was presented in 2004. However, the data differed somewhat between Member States and details on settings and sources were not available for the majority of outbreaks (European Food Safety Authority 2005).

The most common cause of outbreaks in the EU in 2004 was *Salmonella*, causing the largest number of outbreaks (73.9 percent of 6,860 outbreaks) and the largest number of individual cases (68.9 percent).

Salmonella Typhimurium is the human pathogenic serovar most frequently associated with the consumption of beef. However, in the European Food Safety Authority (EFSA) review, this particular serovar was associated with less than one percent (0.93 percent) of all outbreaks. Bovine meat was implicated in only three of 400 *Salmonella* outbreaks for which data was reported. A *Campylobacter* outbreak with two people affected was also associated with beef consumption in the review.

Outbreak data from the island of Ireland
In Northern Ireland (NI), two possible beef-associated outbreaks have been recorded. A foodborne viral outbreak in 1997 in which 31 patients became ill. Seventeen patients were virologically confirmed and a suspect vehicle of prawn or beef was implicated. In 1999 a small outbreak involving eight people who had eaten beef lasagne was reported but there were no microbiological results to support this (Communicable Disease Surveillance Centre NI, Personal Communication, February 2007).

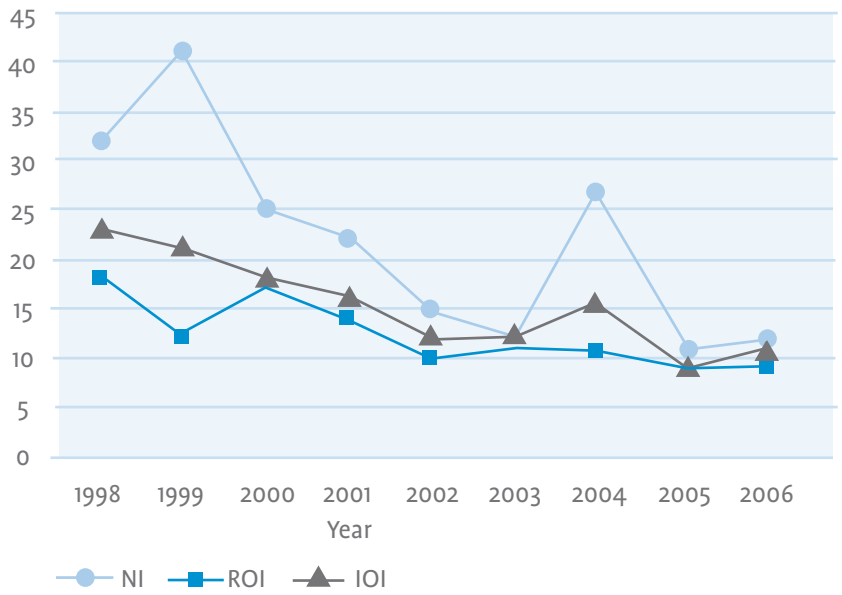
There were no confirmed reports of general outbreaks associated with beef in the Republic of Ireland (ROI) from 2001 to 2007 according to the Outbreak Surveillance Database (Health Protection Surveillance Centre, Personal Communication, January 2008).

3.2.3 Pathogens associated with beef

3.2.3.1 Salmonella
In 2006 there were 422 clinical reports of salmonellosis in ROI (Health Protection Surveillance Centre 2007a) and 203 reports in NI (Communicable Disease Surveillance Centre NI, Personal Communication, February 2007). Despite a general downward trend, there was an increase on 2005 figures - 349 in ROI (Health Protection Surveillance Centre 2006) and 180 in NI (Communicable Disease Surveillance Centre NI 2007a).

Figure 3.1 illustrates the recent overall downward trend in human salmonellosis cases[4].

Figure 3.1 Incidence rates of salmonellosis on the island of Ireland



Source: Adapted from Danis et al. (2003), Health Protection Surveillance Centre (2005a, 2006, 2007a) and Communicable Disease Surveillance Centre NI (2007b).

The characteristic peak of salmonellosis infections in late summer/early autumn coincides with the holiday season and overseas travel, higher temperatures and more outdoor food preparation and consumption.

[4] It is important to note that different sources of information were used in the two jurisdictions

Antimicrobial resistance
The increase in the numbers of antibiotic resistant strains of bacteria is of great concern to public health specialists. The use of antimicrobials in food animals contributes to the development of antimicrobial resistance and the dissemination of multi-drug-resistant bacteria such as *Salmonella* strains (Dechet, Scallan et al. 2006). Multi-drug resistant organisms limit effective medication choices in the event of serious illness.

S. Typhimurium is the human pathogenic serovar of *Salmonella* most frequently associated with the consumption of beef (EFSA 2005). *S.* Typhimurium definitive Type 104 (DT104) has been shown to be resistant to five or more antimicrobial agents including ampicillin, chloramphenicol, streptomycin, sulphamethoxazole, tetracycline; and R-type ACSSIT. Illnesses caused by multidrug-resistant *Salmonella* species are more difficult to treat. In the US, the proportion of human *S.* Typhimurium R-type ACSSIT isolates increased from 0.6 percent in 1979 to 34 percent in 1996 and was 30 percent in 2001 (Dechet, Scallan et al. 2006).

Antimicrobial resistance in *S.* Typhimurium from clinical samples in 2005 in ROI was as follows: ampicillin (73 percent); chloramphenicol (64 percent); streptomycin (72 percent); sulphamethoxazole (75 percent); and tetracycline (79 percent) (Health Protection Surveillance Centre 2006).

In NI, 65 percent (95 out of 106) of total *S.* Typhimurium human isolates in 2006 were *S.* Typhimurium DT1O4 (Communicable Disease Surveillance Centre NI, Personal Communication, January 2008) compared with 25% in ROI (Health Protection Surveillance Centre 2007a). In 1999, 142 reports of *S.* Typhimurium DT104 were received comprising 80 percent of reports of *S.* Typhimurium (177). Since then there has been a general annual decrease in the number and proportion of reports of *S.* Typhimurium DT104 reported in NI with four reports (12 percent) of *S.* Typhimurium being received in 2006 (Communicable Disease Surveillance Centre NI, Personal Communication, February 2007).

Large variation in the occurrence of antimicrobial resistance among EU member states was evident in data reported for 2004. For *S.* Typhimurium a considerable variation in the prevalence of resistant isolates was observed, especially for ampicillin (ranging from 17.9 to 66 percent) and tetracycline (ranging from 9.6 to 57.8 percent) (EFSA 2005).

It is notable that since 1998 when the typing work began in ROI, the relative proportion of salmonellosis caused by *S.* Typhimurium has declined somewhat from 42.7 percent in 2000 to 23 percent in 2006 (Health Protection Surveillance Centre 2007a). A review of *Salmonella* cases reported in NI indicates that the number of cases of *S.* Typhimurium as a percentage of total *Salmonella* human isolates constituted 18 percent in 2005 and 22 percent in 2006 (Communicable Disease Surveillance Centre NI, Personal Communication, January 2008). In the period 1999 to 2006, the percentage of *Salmonella* isolates due to *S.* Typhimurium ranged from 18 to 32 percent (Communicable Disease Surveillance Centre NI, Personal Communication, January 2008).

An outbreak of *S.* Typhimurium (multi-drug resistant) in ground beef occurred in the US in 2004 and involved 58 cases (Dechet, Scallan et al. 2006). There have been no confirmed outbreaks of *Salmonella* in beef on IOI.

3.2.3.2 Verocytotoxigenic E. coli (VTEC)
Certain strains of *E. coli* that result in serious human illness produce one or both of the Verotoxins (VT1 and VT2) and are referred to as VTEC. There are 150 different serotypes of VTEC and *E. coli* O157 is the most common VTEC reported in ROI, the UK and the US, although other serogroups can cause human illness. The primary reservoir of VTEC is cattle (Health Protection Surveillance Centre 2005b).

By comparison with the most common causes of bacterial infectious gastroenteritis, VTEC is much less prevalent but is of greater significance for several reasons. The proportion of VTEC patients experiencing severe symptoms

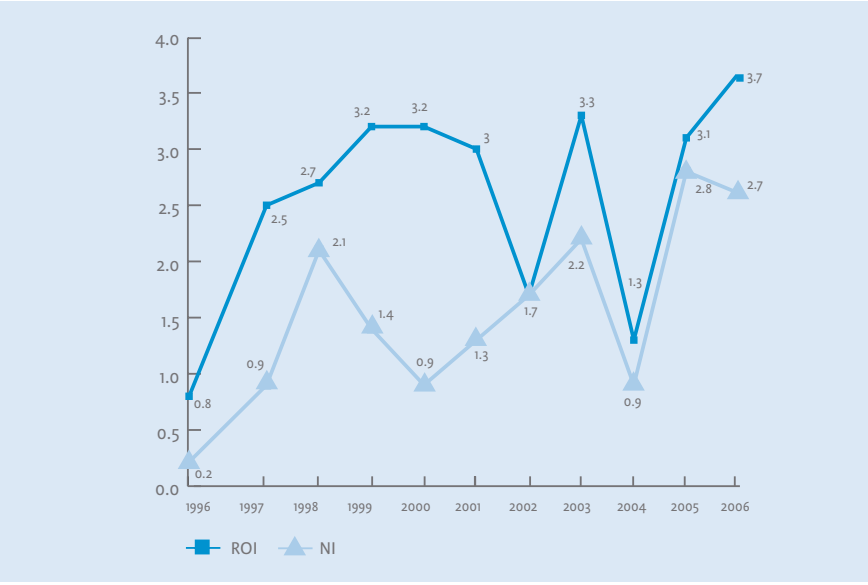
is high, with up to 70 percent of cases having bloody diarrhoea and two to ten percent progressing to a form of renal failure (Haemolytic Uraemic Syndrome).

Complications of VTEC infections are life threatening with associated deaths in 0.08 percent of cases. This compares with 0.04 percent for *Salmonella* and 0.005 percent for *Campylobacter* (Health Protection Surveillance Centre 2005a). In addition VTEC infections have a very low infectious dose, possibly only ten organisms compared to normally 100,000 in the case of *Salmonella*, and this facilitates the ease of transmission of VTEC infection (Health Protection Surveillance Centre 2005b).

VTEC can be transmitted by means of food, water, person to person and animal contact. The first reported cases of VTEC were linked to the consumption of undercooked minced beef (Rangel, Sparling et al. 2005) and since then the "burger bug" has been implicated in numerous minced beef associated outbreaks (Rangel, Sparling et al. 2005). Infections are rarely associated with meat cuts (Duffy 2001), however, mincing distributes any VTEC throughout the volume of the meat, where it may survive if cooking is uneven or inadequate (Boer and Heuvelink 2001).

Figure 3.2 indicates that there are considerable year to year variations in the level of human VTEC O157 infection on IOI. In the year 2006, levels were at an all time high with 168 notified cases on IOI (123 ROI and 45 NI) (Health Protection Surveillance Centre 2007a; Communicable Disease Surveillance Centre NI 2007b). These cases were not all food-related.

Figure 3.2 Incidence of VTEC O157 by year, NI and ROI



Source: Adapted from Danis et al. (2003), Health Protection Surveillance Centre (2007a) and Communicable Disease Surveillance Centre NI (2007b)

Many small VTEC outbreaks (or clusters) have been reported but large-scale (or general) foodborne outbreaks have not occurred on IOI to date.

There have been a number of high profile outbreaks in Great Britain (GB). In October 2005, an outbreak in a school in South Wales resulted in 157 reported cases and one death of a five year old child (Health Protection Agency 2005). The outbreak was associated with cooked meats used for school dinners. In 1996 in Lanarkshire in Scotland an outbreak resulted in 496 cases and 18 deaths (The Pennington Group 1997). This outbreak was also associated with commercially cooked meats.

In a review of *E. coli* O157 outbreaks in the US from 1982 to 2002 it was reported that 52 percent of outbreaks were foodborne and in almost half of these (41 percent) the vehicle was minced beef and five percent other beef products. Twenty-three percent of vehicles were unknown, 21 percent associated with fresh produce, while the remaining ten percent associated with other foods (Rangel, Sparling et al. 2005).

3.2.3.3 Other pathogens
While not usually associated with the beef, a number of other pathogens have been associated with occasional outbreaks of foodborne illness as a result of consuming beef.

Campylobacter
During the years 1980 to 1982, the 23 foodborne *Campylobacter* outbreaks reported in the US were reviewed (Food Safety Authority of Ireland 2002a) and in four of these 23 *Campylobacter* outbreaks beef was implicated as the vector of infection.

Cholera
In July 1988 an outbreak of cholera with 71 culture-confirmed cases of biotype E1 Tor occurred in Thailand. Epidemiological investigation revealed a significant association with consumption of undercooked beef possibly contaminated by an infected butcher (Swaddiwudhipong, Jirakanvisun et al. 1992).

Clostridium perfringens
This organism is almost always foodborne and accounts for 13 percent of outbreaks attributed to red meats in England and Wales between 1992 and 1999.

In ROI there were five cases in 2004, one in 2005 and none in 2006. No data is available on this pathogen for years prior to 2004 (Health Protection Surveillance Centre 2007b). However, in NI there have been between 10 and 29 cases annually from 2000 to 2006 (Communicable Disease Surveillance Centre NI, Personal Communication, January 2008).

Outbreaks in which cooked beef is implicated are well documented such as that reported relating to corned beef served in Ohio (144 cases) and Virgina (85 cases) in 1993 on St Patrick's Day (Center for Disease Control 1994).

Errors during preparation allow spores to survive and germinate. If beef dishes, especially stews, are reheated inadequately the ingested organisms may sporulate and produce toxins (Center for Disease Control 1994).

Tuberculosis
The risk of human exposure to *Mycobacterium* bovis, the cause of tuberculosis in cattle posed by the consumption of meat, was assessed (EFSA 2003). The level of risk was considered low given the veterinary measures in place in compliance with EU legislation. There is no evidence of involvement of contaminated meat as a vehicle since the mid 1990s in any EU Member State.

Clostridium botulinum
Human cases of botulism are very rare in Western Europe. However, because of a marked increase in the reported incidence of suspected cattle botulism in England, Wales and ROI since 2003, the evidence of a link between meat and milk associated with human cases in the UK was reviewed (Food Standards Agency 2006a). It was concluded that there was no evidence to suggest that any cases of botulism were associated with the consumption of meat or milk derived from animals in the UK.

3.2.4 Regulation of the supply chain

The Food Standard Agency (FSA) is the Central Competent Authority in the UK for food safety. The main objective of the FSA is to protect public health from risks which may arise in connection with the consumption of food and otherwise to protect the interests of consumers in relation to food. The FSA proposes legislation on issues across the food chain and is an enforcement body in its own right. The Department of Agriculture and Rural Development is responsible for implementing animal health and animal welfare requirements. District Councils (through Environmental Health Officers) are responsible from farm gate through to the retail and catering stages of the food chain.

In ROI, the Central Competent Authority is the Food Safety Authority of Ireland (FSAI). The Department of Agriculture, Fisheries and Food is responsible for the control of beef and beef products from production up to the point of retail, while the Health Service Executive, through Environmental Health Officers, is responsible from farm gate through to the retail and catering stages of the food chain. The Department of Agriculture, Fisheries and Food and the Health Service Executive exercise their functions through service contracts with the FSAI. Local authority veterinarians are responsible for small establishments.

3.2.5 Sources of microorganisms at primary production level

The intestinal tracts of cattle are the most important source of infection from pathogenic bacteria. In terms of importance of zoonotic disease on IOI these bacteria are *Salmonella*, VTEC and *Cryptosporidium*. Pathogens are transmitted through faeces to the hides of cattle and unless proper controls are followed, these can be carried on to the carcass during slaughter and ultimately to the meat itself.

High numbers of microorganisms are commonly found on the hides of cattle (Ayres 1955; Reid, Avery et al. 2002). Total numbers of organisms on the skin may exceed 10^9 cm^{-2} and represent the normal flora of the skin (staphylococci, micrococci, pseudomonads, yeasts and moulds) as well as organisms of faecal and soil origin. Contamination with faecal material has been shown to result in the direct or indirect transfer of enteric microorganisms to carcasses during the dehiding process (Sheridan 1988). Furthermore, the level of contamination present on the hide has been shown to be correlated with that found on finished carcasses (Byrne, Bolton et al. 2000).

3.2.5.1 The clean livestock policy

The clean livestock policy (CLP) was introduced in the UK following the 1996 outbreak in Lanarkshire, Scotland of *E.coli* O157:H7 (see Section 3.2.3.2). CLP is operational in both ROI and NI and it seeks to ensure a consistent approach to the assessment and categorisation of animals presented for slaughter and, in doing so, minimise the risk of food poisoning.

The cleanliness of livestock at slaughter depends on a number of factors including farm location; season; method of transport; and holding conditions at slaughter. Other factors such as where the cattle were fed/housed, i.e. wet pasture versus dry dusty areas, also influence the cleanliness of the animals.

A visual grading scheme forms the basis of the operation of the CLP. A Veterinary Inspector (VI) or Official Veterinarian (OV) in ROI or NI, respectively, assesses each animal presented for slaughter. Animals are ranked on a scale from one to five.

Animals in Categories one and two rank the cleanest and are considered safe for slaughter with no further precautions being required. Category three animals are rejected at first presentation ante-mortem and may be dealt with in a number of ways, including retention in the lairage on clean bedding to facilitate cleaning/drying and clipping to remove contaminated hair. Cattle in Category four are rejected for slaughter except in exceptional

circumstances, e.g. on animal welfare grounds or disease control reasons. Special provisions may have to be made on the slaughter line (i.e. cleaning after the slaughter) to prevent contamination of other cattle. Category five animals are rejected for slaughter.

While there have been concerns about the reliability of visual assessment for individual animals (Reid, Small et al. 2002), it remains the current best method available to select animals for hygienic slaughter.

The introduction of new food hygiene regulations (Regulation (EC) 852/2004, Regulation (EC) 853/2004 and Regulation (EC) 854/2004) on January 1, 2006 throughout the EU has meant that the status of CLP has changed from being mandatory to guidance. The key feature of these regulations is that they are more explicit in making the responsibility for the production of safe food lie with the Food Business Operator (FBO) based on the implementation of Hazard Analysis and Critical Control Point (HACCP) principles.

It is still a mandatory requirement that animals are clean and that they do not present an unacceptable risk of contaminating meat. Clean livestock has now become an operator control and the role of the VI/OV is to verify operator compliance with the legislation.

To support farmers, a number of guidance documents is available. In the UK, the FSA has produced 'Clean Beef Cattle for Slaughter – A Guide for Producers' (FSA 2004). In ROI, best practice advice has been formulated based on findings from Teagasc and other research (Teagasc 1999). Advice is also available from the FSAI (2005; 2006).

3.2.5.2 Carcass clipping

Although the aim is to achieve clean livestock, this can be challenging during the winter months and in regions where ground and weather conditions do not favour the production of clean animals (this is pertinent to areas on IOI). Therefore, in addition to management practices to promote cleanliness at primary production level, the most common method to clean animals is by clipping live animals on the farm or in the lairage. Though the application of ante-mortem clipping in the lairage, Category three and four animals may be rendered into a condition acceptable for slaughter. However, such clipping activities have been identified as a health and safety risk for operatives (Anon 1999) as a result of kicks from the animals in the pens or crushes.

An alternative approach is the application of online clipping, where hides are clipped post-mortem after stunning and bleeding, but before dehiding, to remove visible dirt, particularly along the ventral midline area where the initial knife opening occurs. Clippers attached to flexible vacuum hoses are typically used for such operations and dirt and hair are removed from the hide surface by the vacuum.

The potential application of online clipping in NI remains a controversial matter since the EC Regulation 853/2004 requires that all animals should be clean before being accepted into the slaughterhouse premises. Furthermore, EC Regulation 854/2004 stipulates that animals with hides, skins or fleeces posing an unacceptable risk of contamination to meat during slaughter cannot be slaughtered for human consumption unless they are cleaned beforehand. Thus it would seem that online clipping (post-mortem) is precluded on these two accounts. Nevertheless, in ROI it would appear that such post-mortem clipping is permitted.

Online clipping is an attractive proposition to the meat industry. It offers advantages under animal welfare and health and safety grounds compared to clipping in the lairage. Nevertheless, concerns that online clipping activities may result in higher rates of transfer of microorganisms from hides to carcass surfaces and generally contaminate the processing environment, have hindered its introduction.

A recent NI study has shown that hide clipping cattle does not adversely affect the microbiological quality and safety of carcasses. Online clipping (post mortem) was shown to produce carcasses of equal safety from clean, unclipped animals (McCleery, Stirling et al. 2007). This study suggests that online clipping offers a potential way in which cattle with visible dirt on their hides may be slaughtered in a hygienic manner.

3.2.5.3 The conversion of muscle to meat and influence on microbiological status
On slaughter, a series of events takes place which leads to the conversion of muscle into meat.

1. *Cessation of oxygen/blood circulation*
2. *Ability to synthesise and re-synthesise adenosine triphosphate (ATP) is lost since respiration has ceased*
3. *Because of a lack of ATP, actin and myosin combine to form actomyosin which leads to a stiffening of muscles (rigor mortis)*
4. *The oxygen supply falls giving a reduced oxidation/reduction potential*
5. *Supply of vitamins and antioxidants ceases, resulting in a slow development of rancidity*
6. *Temperature falls and fat solidifies; and*
7. *Glycolysis begins which converts most glycogen to lactic acid and the pH value falls from 7.4 to about 5.6. This pH depression also initiates protein denaturation (Lawrie 1966).*

These principal events take 24 to 36 hours following slaughter at the usual holding temperatures for beef of 2 to 4°C.

The redox potential of muscle has a great influence on the growth of microorganisms. With cessation of circulation the oxygen content and redox potentials in muscles gradually fall, leading to anaerobic conditions at a depth of greater than 10mm. Consequently strict aerobes can only grow on meat surfaces.

The pH value of meat is inversely proportional to the amount of lactic acid produced by muscular glycolysis following death: a pH value of 7.0 corresponds to almost none being produced and a pH value of 5.5 to approximately one percent lactic acid being produced.

Undue stress of animals prior to slaughter can result in the utilisation of glycogen reserves in muscles with consequent incomplete post mortem glycolysis and higher ultimate pH values in meat. Such effects can lead to pH values of meat varying from pH 5.5 to 7.0. Higher pH values will affect both the water holding capacity of meat thus affecting its organoleptic acceptability as well as its spoilage potential. An ultimate pH value of 5.5 is unfavourable to the growth of many bacteria; however, species such as *Pseudomonas* and *Enterobacter* can grow at their maximum rate in meat within the pH range 5.5 to 7.0.

3.2.5.4 Sources and types of microorganisms on meat
With the exception of the external surfaces, gastrointestinal tract and respiratory tract, the tissues of normal healthy animals contain few microorganisms. Therefore the interior of a block of muscle obtained from a freshly slaughtered healthy animal should be essentially sterile (McCleery and Rowe 2002).

Bacteria can potentially enter the tissues through the bloodstream from contamination on the sticking knife, but the ease with which sterile tissue can be obtained from healthy animals slaughtered in the normal way suggests that contamination from the blood circulatory system is not great.

The first major source of contamination affecting meat is from the skin or hide of a particular animal and others around it as discussed earlier. Evisceration is another crucial operation and one that has massive potential for the transfer of faecal microorganisms to the carcass, if not properly performed. The presence of systems to ensure proper evisceration without rupturing the gut or stomach is essential to avoid contamination of the meat from gut contents.

Under normal processing conditions, beef carcass contamination from the viscera is prevented by rodding, bunging and the intact removal of the visceral components. Rodding is a procedure used to prevent leakage from the rectum by tying and/or bagging of the bung. During rodding, the oesophagus is separated from the trachea and a clip is placed at the end of the oesophagus to prevent leakage.

Almost every other operation during slaughtering, cutting, processing, packaging, storage and distribution of meat can contribute further to the contamination of carcass surfaces. The associated organisms may be present in the processing environment or introduced from the hands and knives of abattoir workers. Consequently the composition of the microflora present on carcass surfaces reflects the various sources of contamination and effectiveness of the hygiene measures aimed at preventing the spread of infection operating within a particular meat plant.

Hygiene performance varied considerably amongst a number of abattoirs surveyed in NI (Murray, Gilmour et al. 2000). Indeed, another study conducted in ROI concluded that air was a potential vector of bacterial contamination in abattoirs and that design of slaughtering lines significantly affects the extent and transfer of airborne contamination (Prendergast, Daly et al. 2004).

3.2.5.5 Carcass decontamination

Contamination of meat with pathogens has always been a critical issue for the meat industry. Although in hygienically prepared meat the levels of pathogens are very low. The recognition that cattle are natural reservoirs for *E. coli* O157:H7 and its association with foodborne illness has resulted in several measures (including CLP) being introduced.

There has been considerable interest worldwide in the decontamination of carcasses and fresh meat (Huffman 2002; Koohmaraie, Arthur et al. 2005) by physical or chemical methods, or a combination of both. Article 3(2) of Regulation 853/2004 has recently permitted the use of substances other than potable water to remove surface microbial contamination from products of animal origin. The use of such substances should only be considered as an additional measure, to further reduce the load of pathogenic microorganisms, following the application of good hygienic and manufacturing practices.

The application of carcass surface decontamination processes using chemicals is permitted in the US. Such technologies offer strategies to seek to comply with the USDA's 'zero tolerance' programme, where *E. coli* O157:H7 is considered an adulterant. The need for such an approach was starkly illustrated when a Nebraska-based food processor was forced to recall 25 million pounds of frozen minced beef (the biggest product recall in history) after an outbreak of food poisoning in Colorado was traced to meat contaminated with this pathogen which had originated from the Nebraska plant (Anon 1998).

It is essential for meat processors to ensure that risk reduction measures adopted, safeguard against the potential for contamination of raw meat by VTEC. This is accomplished by controlling manufacturing systems. The potential additional safeguards offered by carcass bacterial decontamination procedures should also be considered, which can be divided into two types - those involving non-chemical and chemical washes.

The application of steam-vacuuming and hot water spray washes to reduce inoculated populations of *E. coli* O157:H7 on carcasses has been demonstrated (Dorsa, Cutter et al. 1996; 1997). Although Nutsch, Phebus et al. (1997) found that *E. coli* could not be detected on naturally contaminated beef carcasses following a steam pasteurisation process, a similar decontamination method did not completely eliminate *E. coli* O157:H7 from carcasses inoculated with this pathogen (Phebus, Nutsch et al. 1997). It is therefore possible that a protective effect may have resulted from the surface inoculation of faeces containing serotype O157:H7 in Phebus' study. Dorsa, Cutter et al. (1996) postulated that the additional moisture of a similar inoculum affected the collagen, lipids and proteins present on carcass surfaces perhaps leading to greater survival of this pathogen than that which might be expected from natural carcass contamination.

Sprays containing mixtures of lactic and acetic acids (two percent by volume, v/v) have been found to reduce aerobic and psychrotrophic counts on beef tissues (Goddard, Mikel et al. 1996) thus improving the overall microbial quality of these samples. Hot (55°C) acetic, citric and lactic acid sprays (1.5 percent v/v), however, have been shown to be ineffective at decontaminating a five strain mixture of *E. coli* O157:H7 from beef surfaces (Brackett, Hao et al. 1994) thus further demonstrating the acid tolerance of this pathogen. Sterile beef slices inoculated with *E. coli* O157:H7 were submerged (for ten seconds) in distilled water (control), one percent (v/v) acetic or one percent (v/v) lactic acid and stored for up to 21 days at 5°C (Dickson and Siragusa 1994). Although a reduction in the populations of this pathogen was observed for each of the treatments over the entire experimental period (samples sanitised with lactic acid exhibiting the greatest decline) viable *E. coli* O157:H7 were still isolated in all cases.

Sodium hypochlorite solutions of 250 ppm (200 ppm being the highest acceptable concentration approved by the Food and Drug Administration) added as a spray, did not result in a significant reduction in E. coli O157:H7 populations on beef surfaces compared to controls where water alone was used (Cutter and Siragusa 1995). Rinses consisting of ten percent trisodium phosphate did not eliminate this pathogen either (Fratamico, Schultz et al. 1996). Thus it appears that none of the reported decontamination treatments is completely effective at eliminating *E. coli* O157:H7 from beef carcasses. In fact, considering the acid tolerance exhibited by serotype O157:H7, it is possible that a reduction in competing background meat microflora and potential survival of this pathogen might actually result in an increased growth rate of *E. coli* O157:H7.

3.2.5.6 The implementation of microbiological testing and HACCP within abattoirs and cutting plants
In addition to implementing HACCP principles, occupiers of fresh meat slaughterhouses must carry out microbiological testing as outlined in Commission Regulation (EC) No 2073/2005. Testing requirements are divided into food safety and process hygiene criteria. Food safety criteria include specific requirements for a number of different food categories and associated microorganisms, for example, *Listeria* in ready-to-eat foods and *Salmonella* in minced meat, meat preparations and mechanically separated meat. Process hygiene criteria, on the other hand, encompass requirements for cattle carcasses (aerobic colony count, Enterobacteriaceae and *Salmonella*), minced meat and mechanically separated meat (aerobic colony count and *E. coli*) and meat preparations (*E.coli*) among others.

Data from such ongoing activities are used to demonstrate how well slaughter and dressing operations have been controlled to avoid contamination and to verify HACCP. A process control chart may be thus constructed over time.

The VI/OV has responsibility for inspecting all documentation and monitoring compliance with such legal requirements. Any deviation from the requirements must be with the approval of the VI/OV.

Advice is available from FSAI on the implementation of food safety management systems based on HACCP (FSAI 2002b) and (FSAI 2003) which also outlines the design and layout of premises.

3.2.5.7 Supervision of hygiene practices in abattoirs

The OV/VI has overall responsibility for overseeing checks on hygiene rules and plant operation. Meat inspector staff also play an essential role in this. Results of such checks are recorded and should non-compliance be evident, appropriate enforcement action is initiated.

The OV/VI carries out a number of activities including ante-mortem inspection; animal welfare checks; post-mortem inspection; hygiene checks slaughter and cutting; monitoring animal by-products and Specified Risk Material (SRM); health marking[5] and animal identification checks.

3.2. .8 Meat as a substrate for microbial growth

Lean beef tissue typically contains about 75 percent (wet/weight) water in which is dissolved a rich variety of readily available substrates for microbial growth, including carbohydrates, amino acids and lactic acid (Ingram and Simonsen 1980; Roberts 1989) (Table 3.5). The principal growth of microorganisms on meat is primarily at the expense of these soluble constituents and significant breakdown of the mass of protein cannot be demonstrated in normal spoilage.

Table 3.5 Approximate composition of adult mammalian muscle after rigor mortis

Component			wet weight
Water			75
Protein			19
Fat			2.5
Carbohydrates			1.2
Miscellaneous solubles			
Nitrogenous	Amino Acids	0.35	1.65
	Creatine	0.55	
	Minor elements	0.75	
Inorganic	K	0.35	0.65
	P	0.2	
	Other	0.1	
Vitamins - most B vitamins present in useful amounts			

Source: Ingram and Simonsen (1980)

[5]This is a stamp that is applied to fresh meat carcasses produced in approved premises in accordance with the regulations, under veterinary supervision. It is an internationally-recognised symbol indicating that the meat has been inspected and passed as fit for sale for human consumption.

Glucose is preferentially utilised as a growth substrate until its diffusion rate becomes limiting at which point amino acid catabolism begins (Roberts 1989). This results in the release of ammonia and sulphurous compounds that can be detected organoleptically as putrid odours and flavours (Gill and Newton 1978; McMeekin 1981).

3.2.5.9 Meat spoilage

The initial microflora of beef carcasses is likely to be very diverse, although it is mainly mesophilic comprising micrococci, staphylococci, *Bacillus* spp., coryneforms, Enterobacteriaceae, flavobacteria, pseudomonads, lactic acid bacteria and *Brochothrix thermosphacta* (Dainty, Shaw et al. 1983).

Depending on the storage conditions used, distinct microbial populations have been shown to develop in beef, ultimately resulting in spoilage of the product. The type of flora that develops will be determined by the availability of oxygen, the substrate pH and the temperature of the product (Gill 1988). Microbial spoilage may be defined as any change in product odour, flavour and/or appearance that provides overt indication of microbial activity, irrespective of how offensive such changes are to particular consumers (Gill 1986).

The formation of off-odour during meat spoilage generally precedes slime formation, being detected at microbial population levels of $\log_{10}$ 7.0 to 7.5 cfu cm^{-2}. Slime formation is evident when bacterial numbers increase by approximately another log cycle to $\log_{10}$ 7.5 to 8.0 cfu cm^{-2}. Slime results from the coalescence of surface colonies.

Although many genera of microorganisms are found in fresh beef, only a few are found in spoiled beef. During aerobic storage at refrigeration temperatures (<10°C) the typical meat flora is dominated by psychrotrophic aerobic Gram-negative motile and non-motile rods identified as *Pseudomonas*, *Acinetobacter* and *Psychrobacter* species (Dainty and Mackey 1992). If the surface of the meat becomes dry, then yeasts and moulds tend to replace the bacteria. Since meat is usually refrigerated in Western countries, the vast majority of meat spoilage is mediated by Gram negative rods.

At temperatures in the range 10 to 20°C Enterobacteriaceae, micrococci and staphylococci can also be involved in the spoilage process. Temperatures above 20°C promote the growth of many mesophilic bacteria - principally *Clostridium perfringenes* and Enterobacteriaceae.

Enterobacteriaceae have been found to contribute more towards the total meat microflora with increasing temperatures (Ingram and Simonsen 1980). Increasing the storage temperature will accelerate the growth rates of all organisms capable of growth at colder temperatures and will also alter the relative growth rates of competing species (Gill 1988). Additionally, at higher temperatures an increasing proportion of both psychrotrophs and mesophiles in the initial flora will be capable of initiating growth (Gill and Newton 1978). This occurs because other environmental conditions that are inhibitory at near-minimum growth temperatures are not inhibitory at higher temperatures, thus allowing the growth of additional psychrotrophic species, while mesophiles can initiate growth only after products enter their growth temperature range (Pooni and Mead 1984).

3.2.6 Specific meat types

3.2.6.1 Minced meat

Comminuted meat is widely regarded as more perishable than whole cuts of meat because of the greater availability of nutrients contained in the meat juice and the fact that surface microbes are distributed throughout the mass during mincing (Ingram and Simonsen 1980). If mincing is performed under strictly controlled hygienic conditions it should not greatly change the gross microbial content. Gill and McGinnis (1993) recovered between 10^4 and 10^7 cfu g^{-1} bacteria from beef trimmings minced in retail outlets.

3.2.6.2 Vacuum packaged meats

The packaging of fresh meats in essentially gas-impermeable bags or wraps is a common practice. Vacuum packing significantly increases the shelf-life of meat at low temperatures by restricting the growth of aerobic bacteria that would otherwise cause overt spoilage.

In such a system, lactic acid bacteria become dominant and inhibit the growth of other microflora through the production of metabolic products. When vacuum packed beef is reopened, spoilage events proceed as normal with the removal of the inhibitory conditions within the pack.

3.2.7 Meat microflora during (carcass) storage

The effect of chilling on the microbial flora of carcasses during storage depends on several conditions. Fast chilling at low temperatures with high air speeds and low humidity may reduce bacterial numbers. Under less rigorous conditions, growth of psychrotrophic organisms can occur, thus altering the proportion of psychrotrophs to mesophiles.

Provided the chilling facilities are properly maintained, aerial contamination should be minimal and not exceed 102 organisms m^{-2} min^{-1} which would contribute approximately 14 organism cm^{-2} of carcass surface per day (Ingram and Simonsen 1980). Thus at this processing stage, the major source of contamination is likely to be from the surface of the carcass itself. The extent to which this contamination is spread to freshly cut surfaces during deboning processes can have an important effect on the keeping quality of the meat.

Contamination that builds up on equipment through inadequate sanitation is likely to contain a high proportion of psychrotrophic bacteria. Products that undergo extensive handling are more likely to become contaminated with bacteria of human origin.

3.2.8 Handling meat in butcher shops/meat counters

All food business operators must comply with EC Regulation 852/2004, which requires them to establish and operate food safety programmes and procedures based on the principles of HACCP. All staff should furthermore receive adequate training and/or instruction in food hygiene. In NI the FSA provides advice to food premises in meeting the requirements of this legislation (FSA 2006b). In ROI, the FSAI provides advice and guidance in relation to butchers shops and meat counters (FSAI 2004).

The strict segregation of raw and ready-to-eat foods is critical at this stage in the food chain, a recommendation that featured in The Pennington Report (The Pennington Group 1997).

3.2.9 Handling and cooking meat in the domestic setting

Raw meat can carry harmful bacteria so handling all meat properly is important to stop bacteria from spreading and to avoid food poisoning. Fresh meat purchased by consumers may be contaminated with one or more pathogens. Therefore proper food preparation (in particular thorough and effective cooking and avoiding cross-contamination) of meat forms the last line of defence (Kennedy et al. 2005) for consumers.

Whole cuts of beef, suck as roast beef and steaks can be cooked to preference (i.e. rare) as long as they are cooked on the outside, however, minced beef products such as beef burgers, rolled meats and kebabs, should be throughly cooked and never served rare or pink in the middle. Vulnerable people, including older people, babies and toddlers, pregnant women and people who are unwell, should avoid eating beef that is rare or pink.

Research funded by ***safefood*** demonstrated that consumers on the island of Ireland used various methods to check that meat was cooked:

- *Steam coming off it – 40 percent;*
- *When it tastes hot enough – 38 percent;*
- *By looking at it – 36 percent;*
- *Checking the juices – 5 percent;*
- *By own experience – 5 percent;*
- *Cut it open to see inside – 3 percent;*
- *Following cooking instructions – 3 percent; and*
- *Use of a meat thermometer/T-sticks – 1 percent (Bolton 2006).*

Additional evidence from ROI suggests that consumers make subjective assessments about whether meat products are properly cooked (Mahon, Cowan et al. 2006). In this study 83 percent of respondents reported looking at colour, 74 percent timed the process, and three percent used a thermometer.

In terms of qualitative advice about how to judge that meat is properly cooked, consumers should cut into the middle with a clean knife and check that it is piping hot all the way through (steaming), there is no pink meat left and that the juices run clear.

3.2.9.1 Temperature control

The main growth limiting factor for bacteria on raw meat is temperature. At temperatures below 5°C, bacteria will multiply slowly, and so the growth of food spoilage and food poisoning bacteria will be limited. For this reason, the maintenance of the cold chain is essential for consumers to minimise the potential for the growth of the microflora present. This should ensure that meats do not spoil until past their use by date.

3.2.9.2 Storage and handling to prevent cross contamination

There is great potential for cross contamination from raw meat and poultry to ready-to-eat foods. It is therefore essential that all steps are taken during food storage and preparation to prevent such cross contamination from taking place. This involves advising those involved in food preparation to correctly wash their hands before food preparation and after handing raw meat and poultry. The need to keep raw and ready-to-eat foods completely separate by adequately decontaminating utensils and cutting boards between use (or using separate utensils and cutting boards) should be stressed.

Consumers mentioned the practice of resting meat after cooking during the qualitative research conducted for this review. This practice allows the meat fibres to relax after the cooking process, improving the texture of the product and its perceived juiciness. From a food safety perspective it is important that the meat is not allowed to cool down to temperatures where bacteria could grow on the cooked meat (below 63°C). Practically during resting, the cooked meat should be covered to keep it hot using tin foil or by placing a lid over the roasting dish and placing it in a warm area. The length of time for which the meat is rested for should not allow its temperature to cool down appreciably. When the meat is served, it should be piping hot all the way through.

3.2.10 Transmissible spongiform encephalopathy

Transmissible spongiform encephalopathies, or TSEs, are a group of progressively degenerative conditions that affect the nervous system of both animals and humans. They are characterised by a 'sponge-like' appearance when brain tissue is examined under a microscope. Brain function is impaired resulting in adverse effects on both mental and physical ability which worsen over time and are untreatable and always fatal. In addition to cattle, TSEs are known to affect sheep, goats, deer, antelope, mink and cats, while in humans four TSEs have been identified including Kuru, CJD (including vCJD), Gerstmann-Sträussler-Scheinker syndrome and fatal insomnia. These diseases have a number of common signs and symptoms and all TSEs are caused by an infectious agent called a prion.

3.2.10.1 Prions

Unlike most infectious diseases which are spread by microbes, the infectious agent in TSEs is a protein called a 'prion' (Alper, Cramp et al. 1967; Pruisner 1982). Prions are normally found in the membranes of cells throughout the body. However, their function has not been fully resolved.

Most TSEs are sporadic and occur in animals with no modifications in their prions. However, the prions associated with inherited TSEs have been shown to exhibit modifications and are more resistant to the normal protein-recycling systems in the body (Asante and Collinge 2001; Qin, O'Donnell et al. 2006). Prions can be transmitted through contact with infected tissue, body fluids, or contaminated medical instruments but are not transmitted by casual contact or via breathing. Unlike other microbes, sterilisation procedures such as boiling or irradiating materials will not affect the infectivity of prions.

3.2.10.2 Bovine spongiform encephalopathy

Bovine Spongiform Encephalopathy is the TSE associated with cattle. More commonly known by its acronym, BSE, it is really a descriptive name for the changes that occur in the nervous system of infected adult cattle. Described as 'Mad-Cow Disease', BSE has a long incubation period, taking from four to six years for infected cattle to show signs of the disease.

BSE was first confirmed in cattle in the UK in 1986 (Collinge, Sidle et al. 1996). Since then, cases have been confirmed in a number of EU countries including Austria, Belgium, Czech Republic, Denmark, France, Finland, Germany, Greece, Italy, Luxembourg, the Netherlands, Poland, Portugal, ROI, Slovakia, Slovenia, Spain and the UK. Cases have also been

described in Liechtenstein, Switzerland, the US, Canada, Israel and Japan. However, the incidence in the UK has been disproportionately high compared to the incidences in other countries.

In NI, there have been 2,177 cases of BSE between 1988 and 2007 (Department of Agriculture and Rural Development 2008). Approximately 600 of these were cattle born between January 1989 and July 1996 (subsequent to the July 1988 ban on feeding ruminant-derived protein to ruminants in the UK) with 16 cases recorded during the period August 1996 and August 2005 (subsequent to the August 1996 prohibition on feeding mammalian meat-and-bone meal (MBM) to all farmed livestock in the UK) (Department of the Environment Food and Rural Affairs 2006).

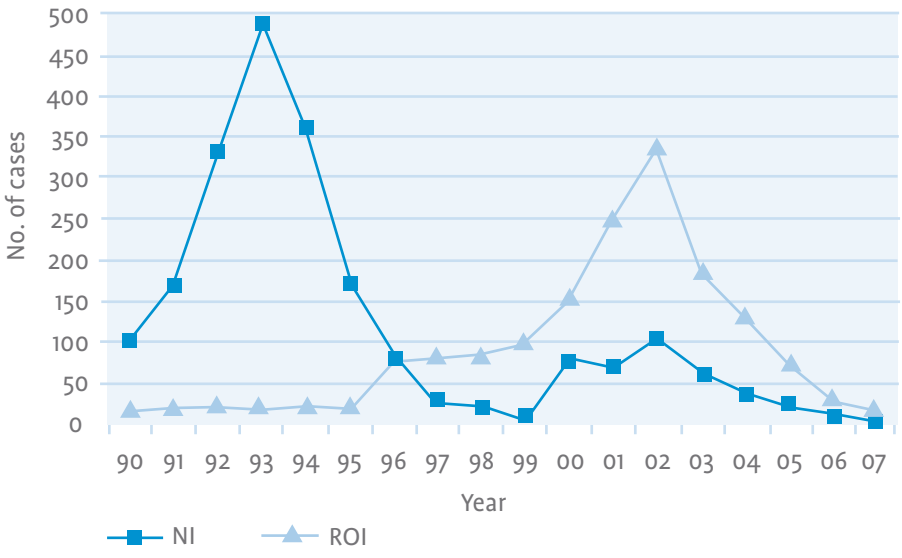
There were ten confirmed cases of BSE in NI in 2006, while there were 12 in 2007 (Department of Agriculture and Rural Development 2008).

ROI recorded approximately 1,552 cases of BSE from 1989 to 2005 with 189 cases recorded between 1989 and 1996 inclusive and 1,363 recorded between 1997 and 2005 inclusive. There were 41 confirmed cases in 2006 and 25 in 2007 (Department of Agriculture, Fisheries and Food 2008).

Approximately 182,000 cases of BSE were recorded in GB from 1986 to 2005 (FSA 2006c).

See Figure 3.3 for a graphical representation of BSE cases on IOI from 1990 to 2006.

Figure 3.3 BSE cases on IOI 1990 to 2006



Source: Adapted from Department of Agriculture, Fisheries and Food (2008) and Department of Agriculture and Rural Development (2008).

The age profile of cattle contracting BSE in ROI is increasing, with very few incidences of animals younger than six years being found with the disease. Up to December 2004, 99.5 percent of cases in ROI were born before January 1998 (Department of Agriculture, Fisheries and Food 2005a), suggesting no new infections after the 1996 ban on feed MBM.

3.2.10.3 Cause of BSE outbreak
Despite a considerable amount of research, the exact origins of BSE are still uncertain. However, the current consensus is that the BSE epidemic was facilitated by the practice of including MBM in cattle feed.

MBM was produced in a process called rendering where otherwise unused tissue was taken from the animal carcass and incorporated into animal feed. Tissue from animals (or even a single animal) with sporadic BSE may have been incorporated into this feed and its extensive use in the UK subsequently facilitated the rapid spread of BSE. Evidence for this comes from laboratory-based studies which have shown that cattle can contract BSE if they are fed infected brain tissue. In addition, since the full ban on the administration of MBM to ruminants (1988) and of all mammalian protein to all farmed animals (1996) was introduced in the UK and subsequently in ROI and across Europe (Department of Agriculture, Fisheries and Food 2005a), the number of BSE cases has plummeted (Figure 3.3). In the UK in 1992 there were 37,000 cases while in 2006 the incidence had dropped to 124 cases (FSA 2007).

3.2.10.4 Variant creutzfeldt-Jakob disease
Creutzfeldt-Jakob Disease (CJD) is a TSE that causes a rare and fatal form of dementia in humans, usually occurring between the ages of 40 and 80 years. In 1996 scientists discovered a new strain of CJD that occurs mainly in younger people and termed this new illness, variant CJD or vCJD (Will, Ironside et al. 1996).

The clinical picture of vCJD is characterised by neurological signs with psychiatric presentation. The disease may last 12 to 15 months before resulting in death. The suspected route of transmission has been the consumption of infected beef. A small number of cases of vCJD have also occurred due to blood transfusions from infected humans.

The discovery of vCJD coincided with the BSE epidemic in the UK during the 1990s giving rise to a suspicion of a possible causal relationship between these TSEs which coincided in their geographical distribution. Subsequent research showing greater similarity of the vCJD prion to that associated with BSE, rather than to the classical human CJD prion, prompted researchers to conclude that the consumption of BSE-infected meat was the most likely cause of vCJD in humans (Collinge, Sidle et al. 1996). Supporting this, the interval between the most likely period for the initial extended exposure of the population to potentially BSE-contaminated food (1984 to 1986) and onset of initial variant CJD cases (1994 to 1996) is consistent with known incubation periods for CJD (Center for Disease Control 2006). In addition, certain individuals who have developed vCJD are known to have eaten meat products potentially infected with BSE (Will, Ironside et al. 1996).

The largest number of vCJD cases worldwide has been in the UK with 162 cases from 1996 to 2006 (six deaths) (Eurosurveillance 2006). This is followed by France where there have been 21 cases (two deaths) (Eurosurveillance 2006). There have been four cases in ROI (three of which have died) (Eurosurveillance 2006) and three cases in NI (two of whom have died) (The National CJD Surveillance Unit 2005) up to December 2006.

The number of vCJD cases and mortalities in the UK reached a peak in 2000 (28 deaths) with the numbers falling off since. Two new cases of vCJD were diagnosed in Britain in the first half of 2006. Given the long incubation period, most of these cases are likely to be due to exposures which occurred prior to the instigation of any controls (late 1980s). It is highly likely that these, and subsequent controls, have been instrumental in reventing more people being exposed to the infectious agent (The National CJD Surveillance Unit 2005).

3.2.10.5 Control monitoring
Regulation (EC) No 999/2001, which entered into force in July of 2001, requires all Member States to ensure that beef and beef products comply with the controls specified in the Regulation which are designed to reduce the risk of livestock contracting TSEs including BSE. Consequently, the Regulation is also designed to reduce the risk of exposure of humans to BSE. The specified controls include compulsory testing of cattle over 30 months of

age (previously all cattle 'over thirty months' were banned from the food chain in the UK - the OTM rule) and the removal of SRM in cattle produced within the EU and in beef imported from Third Countries. Any consignments containing SRM are rejected and destroyed.

The OTM rule and SRM controls, as well as the feed recall scheme, were covered by the so-called Florence Agreement of June 1996 which set the framework for the eventual lifting of the ban on the export of British beef. The OTM rule and the feed ban are accepted as "equivalent measures" to those taken elsewhere (such as whole herd slaughter when BSE cases are confirmed). Proposed changes must be agreed by the other EU Member States before they can be implemented.

Control 1: MBM ban
The inclusion of MBM in livestock feed has been prohibited on IOI since 1996. Consequently, all cattle born prior to 1996 that would have been exposed to MBM through contaminated feed were, and are, excluded from the food chain. This was followed by an EU-wide ban on feeding processed animal proteins to farm animals in January 2001 [Regulation (EC) No 999/2001].

The MBM ban does not extend to blood, gelatin or tallow, once these do not originate from OTM bovines, suspect BSE cases or SRM [Regulation (EC) No 853/2004]. Fishmeal and non-ruminant gelatin are also permitted in non-ruminant animal feed as is dicalcium phosphate obtained under certain conditions.

Most gelatin used in animal feed is of pig or fish origin. Tallow of non-bovine origin, imported bovine tallow and bovine tallow produced in registered premises may still be used in animal feed.
The FSA in the UK has advised against any relaxation of the ban on feeding ruminant protein to ruminants echoing the views of the Spongiform Encephalopathy Advisory Committee that recycling of animal material within any species used for human or animal food is undesirable (FSA 2000). In addition, the FSA recommends the ban on intra-species recycling be extended to include intra-species recycling of blood, gelatin and tallow (FSA 2000).

Control 2: Removal of Specified Risk Material (SRM)
This is the principal public health control and involves the removal of the organs and tissues that are most likely to contain BSE [Commission Decision 2000/418/EC]. These parts are known as SRM and a comprehensive specification of these can be found in Appendix A.

Removing SRM reduces the risk of exposure to BSE infected matter or cattle by 99 percent. The controls were first introduced for cattle in 1989 and for sheep and goats in 1996. All meat and meat products imported into the EU has to be certified as SRM-free.

All cutting plants/butcher shops must be authorised, registered and monitored for the removal of SRM under the Community TSE Regulation 999/2001. Prior to 1 January 2006, the vertebral column (backbone) of bovine animals over 12 months was regarded as SRM and thus was not permitted in products or as a product for human consumption; however, this age threshold was raised to 24 months. This legislation applies to products such as T-bone steak. The revised definition of SRM is contained in Commission Regulation (EC) No 1974/2005 which amends Annexes X and XI to Regulation (EC) No 999/2001.

Control 3: the 'Over Thirty Months' rule and BSE testing
It was evident from the outset that the disease primarily manifested in cattle over 30 months of age. EC Commission Decision (2000/764/EC) was adapted in ROI and UK and requires that all bovine animals over thirty months sent for slaughter are tested for BSE. In 1996 in the UK, animals older than 30 months were prohibited from entering the food chain – the OTM rule. This, along with the removal of SRM, was an effective measure in the control of BSE in the food chain. This control remained in place for almost ten years.

In November 2005, following a review of the OTM, a new testing system was introduced in the UK. Cattle aged over thirty months can now enter the food chain, but only if they have tested negative for BSE. Otherwise the animal is destroyed.

Control 4: Mechanically recovered meat ban
Mechanically recovered meat (MRM) is meat that is stripped from the bone at high pressure because it is impossible to remove by hand. It was traditionally used in the production of low-cost meat products such as burgers, sausages, pies and mince.

MRM made from bovine vertebral column was banned in the UK in 1995 and this ban was extended in 1998 to MRM from the vertebral column of all grazing animals. The production of MRM from all ruminant bones is now prohibited throughout the EU with the exception of sheep or lamb, excluding the vertebral column and the skull of older sheep. MRM may be produced from pig and chicken bones.

3.3 Chemical contaminants and residues

3.3.1 Introduction
The incidences of chemical residues in beef are largely due to the use of veterinary medicinal products at primary production level, while chemical contaminants can occur due to environmental exposure to substances such as pesticides and pollutants.

3.3.2 Veterinary medicinal products
There are several pieces of EU legislation pertaining to the definition, licensing and marketing of veterinary medicinal products (VMPs) in the EU[6,7]. These do not include medicated feedingstuffs or any additives for use in the formulation of feedingstuffs[8,9].

The European Agency for the Evaluation of Medicinal Products co-ordinates the scientific evaluation of the safety, quality and efficacy of medicinal products for human and veterinary use for licensing throughout the EU. Decisions agreed under this system are binding on Member States and there is no scope to take a national decision on a product out of line with a majority Community opinion.

The Irish Medicines Board is the designated competent authority for the licensing of VMPs in ROI although the Department of Agriculture, Fisheries and Food can authorise the use of certain medicines in exceptional circumstances[10]. In the UK, and hence in NI, the Veterinary Medicines Directorate is responsible for the licensing of VMPs. VMPs ontrolled under this legislation are not for sale to the general public and require a prescription for use by authorised personnel.

Current EU legislation requires the establishment of a maximum residue level (MRL) for all pharmacologically active substances in VMPs marketed in the EU for administration to food-producing animals. The conditions for establishing a MRL are set out in Council Regulation (EEC) No. 2377/90.

[6]Directive 2004/28/EC of the European Parliament and of the Council of 31 March 2004 amending Directive 2001/82/EC on the Community code relating to veterinary medicinal products (OJ L 136, 30.4.2004, p. 58)
[7]Council Directive No. 2001/82/EC of 6 November 2001 on the Community code relating to veterinary medicinal products (OJ L 311, 28.11.2001, P. 1)
[8]Council Directive 90/167/EEC of 26 March 1990 laying down the conditions governing the preparation, placing on the market and use of medicated feedingstuffs in the Community (OJ L 092 , 07.04.1990, P. 42 – 48)
[9]Council Directive of 23 November 1970 concerning additives in feeding-stuffs (70/524/EEC) (OJ L 270, 14.12.1970, p. 1)
[10]Part III of the Animal Remedies Regulations, 2005 (S.I. No. 734 of 2005), which implements Directive 2001/82/EC as amended by Directive 2004/28/EC

Under Council Directive 96/23/EC, each Member State is required to implement residue surveillance plans and to submit their programmes annually to the European Commission for approval. Third Countries wishing to export animal products to the EU are similarly required to satisfy the European Commission that their residue surveillance measures provide equivalent guarantees for EU consumers.

3.3.2.1 ROI National Residue Monitoring Programme

The National Residue Monitoring Programme in the ROI is carried out by the Department of Agriculture, Fisheries and Food. A number of drug residues are analysed for, in addition to banned substances and certain contaminants. Samples are taken from domestic food-producing species and from products imported from Third Countries mostly on a routine targeted basis but also on suspicion, including follow-up investigations.

The bovine sector accounted for 18 positive samples in the results of the 2006 ROI National Residue Monitoring Programme. Seventeen of the samples were detected in animals that were detained on suspicion by the Department's veterinary inspectors in slaughter plants. By contrast, only one (0.04 percent) of the 2,213 bovines tested using standard selection criteria, showed positive for antibiotic residues, which is a more representative picture of the bovine sector as a whole and is below the level of 2005 (i.e. 0.3 percent) (Personal Communication, Department of Agriculture, Fisheries and Food, January 2008).

The results for 2003 to 2005 (Department of Agriculture, Fisheries and Food 2004; 2005b; 2006) are presented in Appendix B. The total number of bovine meat and tissue samples analysed increased by approximately 27 percent between 2003 and 2005. The number of positive samples never exceeded 0.7 percent of the total analysed. The positive VMP residues detected were antibiotics.

3.3.2.2 NI surveillance for veterinary medicine residues

The Department of Agriculture and Rural Development in NI collects and analyses samples (and also carries out follow-up investigations) for the National Surveillance Scheme on behalf of the Veterinary Medicines Directorate. Samples taken in NI are analysed at the Agri-Food and Biosciences Institute at Newforge Lane, Belfast. The results of the National Surveillance Scheme are published quarterly in the Medicines Act Veterinary Information Service and in the Veterinary Medicines Directorate annual report in July each year. The overall conclusion regarding VMP residues in the Annual Report on Surveillance for Veterinary Residues in Food in the UK for each year from 2003 to 2006 was that in the UK (including NI) authorised uses of VMPs did not result in residues of human health concern (Veterinary Residues Committee 2007).

3.3.3 Growth hormones

Within the EU, there are two principle pieces of legislation concerning prohibited substances used in cattle production, namely Directives 96/22/EC and 2003/74/EC. The latter piece of legislation refers to an opinion of the Scientific Committee on Veterinary Measures Relating to Public Health regarding the assessment of potential adverse effects to human health from hormone residues in bovine meat and meat products.

This opinion drawn in 1999 on behalf of the European Commission evaluated the safety of commercial hormones used in cattle. Of these, six were found to pose a risk. In particular, an increased risk of adverse health effects was identified in prepubertal children. No threshold level and therefore no acceptable daily intake (ADI) could be established for any of the six hormones evaluated when administered to cattle for growth promotion purposes. The prohibited substances include stilbenes, stilbene derivatives, their salts and esters, thyrostatic substances, oestradiol 17β and its ester-like derivatives and beta-agonists. Substances having oestrogenic (other than oestradiol 17β and its ester-like derivatives), androgenic or gestagenic action are also provisionally prohibited until more complete scientific information is made available to the Commission.

No residues of growth promoters covered by the EU hormone ban were found during the 2005 ROI National Residue Monitoring Programme, continuing the consistent absence in recent years of banned hormonal growth promoters in ROI beef and other meat.

Since 1997, a total of 15 studies have investigated the levels of β-agonist compounds in meat of bovine origin in ROI. Most of these studies were carried out by the Department of Agriculture, Fisheries and Food as part of the National Residue Monitoring Programme but local authority sampling was also conducted from time to time. The studies involved both targeted and suspect sample analyses. All samples were of ROI origin. A total of 12,957 sample test results are recorded in the National Food Residue Database (Teagasc 2007). These covered eight different matrices namely bovine feed, kidney, liver, muscle, retina, the injection site from slaughtered animals and urine from both live and slaughtered animals. Over the eight-year sampling period, a total of five specific β-agonists were assayed for, as well as non-specified β-agonists. The former include Brombuterol, Cimbuterol, Clenbuterol, Mabuterol and Ractopamine. No non-compliances were recorded in any year for any β-agonist.

Over a four year period from 2003 to 2006, the Annual Report on Surveillance for Veterinary Residues in Food in the UK details several hormones detected in samples taken from cattle that were at or above the reference point. These include testosterone, nortestosterone, progesterone, oestradiol and zeranol (which probably resulted from fusarium mould contamination of the feed). Although the geographical location of these samples is not stated in the reports, it nonetheless advises that follow-up investigations carried out by the State Veterinary Service in the UK or DARD in NI found no evidence of abuse on the farms (Veterinary Residues Committee 2007).

A ***safe*food** sponsored cross border collaboration investigated the prevalence of beta-agonist growth promoters in red meat (Traynor, Crooks et al. 2003). The work carried out on this project led to the development of a versatile and reliable testing kit for the detection of these compounds and this is now routinely used by the Department of Agriculture, Fisheries and Food as part of its National Residue Monitoring Programme.

3.3.4 Other banned substances

Phenylbutazone is legally prescribed as a painkiller and anti-inflammatory in the treatment of joint problems in horses. In humans, this compound is known to cause, in rare cases, serious blood disorders in humans, such as aplastic anaemia and hence is banned.

Over a four year period from 2003 to 2005, the Annual Report on Surveillance for Veterinary Residues in Food in the UK detailed the presence of phenylbutazone residues in samples taken from cattle. The incidence never exceeded 0.7 percent of samples. On at least one occasion, the case of contamination was attributed to exposure to medicated pony feed on the same farm (Veterinary Residues Committee 2007).

The 2005 ROI National Residue Monitoring Programme returned one out of 11,609 samples positive for phenylbutazone. Follow-up investigations found no evidence of illegal use of this substance (Department of Agriculture and Food 2006).

Furazolidone is an antibiotic substance from the nitrofuran group which has been banned in the EU on public health grounds since 1995. It was identified during the 2003 and 2005 ROI National Residue Monitoring Programmes in 11 samples and six samples from cattle, respectively. The Department carried out follow-up investigations on the farms in question including further testing which did not yield positives (Department of Agriculture, Fisheries and Food 2004; 2006).

3.3.5 Environmental contaminants

The ROI National Residue Monitoring Programme for years 2003 to 2005 also targeted pesticide residues (organochlorine and organophosphorus compounds), chemical elements (e.g. heavy metals) and mycotoxins. As can be seen from Appendix B, these agents were not detected in samples taken from cattle (Department of Agriculture and Food 2004;2005b;2006b).

In the 2005 UK Annual Report on Surveillance for Veterinary Residues in Food, lead was detected in two of 90 cattle kidney samples tested. There were at concentrations of 551 and 780 µg/kg which are above the reference point for lead (Veterinary Residues Committee 2005). Lead was not detected during the 2006 UK sampling programme. However, cadmium was detected in four of 89 cattle kidney samples tested at concentrations between 1,320 and 1,980 µg/kg which exceeded the reference point for cadmium (Veterinary Residues Committee 2006).

3.3.6 Feed additives

There are several pieces of EU legislation, subsequently transposed into the national legislatures of MS, concerning the authorisation of different additives for use in the manufacture of animal feed (Appendix C). The procedure for authorisation and marketing of feed additives is dynamic with new amendments continuously added to the list of the authorised additives in feedingstuffs.

There are currently seven authorised feed additives for administration to cattle for the purposes of fattening. These include the preservative propane-1,2-diol (E490), the binding agent calcium aluminate (E598), the gut flora stabilising microorganisms *Saccharomyces cerevisiae*, *Bacillus cereus* (var. toyoi) and *Enterococcus faecium* and the prophylactic antibiotics flavophospholipol (E712) and monensin sodium (E714).

In ROI, the Department of Agriculture, Fisheries and Food is the designated competent authority for issuing national marketing authorisations for animal feed constituents. In the UK, and hence in NI, the FSA's Animal Feed Unit supports these assessments with the technical assistance of the Health and Safety Executive, the Veterinary Laboratories Agency and other advisers.

4. Nutrition

4.1 Introduction

Meat is a staple food in the diet on the island of Ireland (IOI) and usually forms the basis of main meals. Beef is one of the more popular meats consumed.

The dietary recommendations in the UK and the Republic of Ireland (ROI) do not provide quantitative guidelines specifically on the consumption of beef and beef products. The dietary guidelines classify meat, fish, eggs and alternative protein sources (such as beans and nuts) as a food group. The UK Balance of Good Health recommends that approximately one eighth of the total amount of food we eat should come from these sources. The ROI dietary guidelines provide more quantitative recommendations stating that two servings[11] of this food group should be consumed daily.

This following section provides an overview of the nutritional value of beef and beef products. It also summarises the current intake of beef on the IOI and the contribution of beef and other meats to nutrient intakes.

4.2 Nutritional composition of beef

4.2.1 General

Beef is conventionally seen as a protein food along with other meats. Protein is made up of smaller sub units called amino acids. There are in the region of 20 amino acids found in protein. Of these 20 there are nine amino acids that humans require but cannot make and must therefore be obtained through the diet. Meat contains these 'essential' amino acids in similar proportions when compared to the theoretically optimal composed protein for humans. Beef and other meat protein are termed 'high biological value protein' due to the content of these essential amino acids.

The nutrient composition of meat is dependent on the fat to muscle (lean) ratio. The macronutrient content of the fat and lean portions of beef (separated by domestic methods as opposed to careful dissection) is given in Table 4.1.

Table 4.1 Typical values for the composition of beef per 100g edible material

	Water (g)	Protein (g)	Fat (g)	Energy (Kcal)	(kJ)
Lean	71.9	22.5	5.1	136	571
Fat	35.0	18.9	53.6	558	2305

Source: Chen, Brown et al. (1995)

The total fat content of beef depends on the anatomical position that the cut originated from on the animal (See Appendix D). On some cuts of beef there is visible fat that can be easily removed while some other cuts have a marbling effect throughout. There has been a consumer drive towards leaner cuts of meat and this has resulted in reduced fat content of beef cuts over the last couple of decades (Table 4.2). The fat content will also depend on the extent to which the cut has been trimmed at the retail level.

[11] A portion size of lean cooked meat is two ounces or 57g

Table 4.2 Changes in the fat content of some retail joints of beef (lean and fat included)

	Fat Content (g/100g)	
	1970s[a]	1990s[b]
Forerib	25.1	19.8
Rump steak	13.5	10.1
Sirloin steak	22.8	12.7
Stewing steak	10.6	6.4
Topside	11.2	12.9

Source: [a] Paul and Southgate (1978), [b] Chen, Brown et al. (1995)

Ruminant animals hydrogenate much of the fat that they ingest and as a result their meat contains a higher proportion of saturated fat than non-ruminant animals. Approximately 40 percent of the fat that beef contains is in the saturated form (Table 4.3).

Table 4.3 The fatty acid profile of selected cuts of beef (lean cuts)

Cut of beef	Fat (g/100g)	Saturates (g/100g)	Monounsaturates (g/100g)	Polyunsaturates (g/100g)
Beef topside	2.7	1.1	1.2	0.2
Rump steak	4.1	1.7	1.7	0.3
Silverside	4.3	1.6	2.0	0.2
Beef Mince	9.6	4.0	3.6	0.6

Source: Chen, Brown et al. (1995)

Beef is an equally good source of monounsaturated fat as it is of saturated fat. Beef also contains small amounts of essential n-3 polyunsaturated fatty acids (PUFAs) and conjugated linolenic acid which is thought to be beneficial for cardiovascular health.

Another nutritional characteristic of beef is its rich content of inorganic constituents such as iron, selenium zinc and copper. Iron from meat such as beef is of particular importance in the diet. There are two types of iron available from food – haem and non-haem iron. Meat and meat products are a rich source of haem iron. Haem iron is more bio-available and its absorption is less influenced by other factors in the diet such as phytates.

Beef is also a good source of B vitamins and in particular vitamin B_{12}. The content of fat-soluble vitamins such as vitamins A and D in beef is dependent on the fat content. Therefore leaner cuts of beef will have lower, albeit still significant amounts of fat-soluble vitamins compared to beef cuts with more fat.

4.2.2 Effects of processing and cooking on nutritional composition

4.2.2.1 General

Following slaughter the carcass is usually divided into primal cuts, which are then distributed to the retail meat trade. Some trimming of fat may take place at this point but more usually takes place during further butchering in the retail sector. With the removal of primal cuts of meat from the carcass there still remains a substantial amount of fat and muscle that cannot be sold in an unprocessed state. This is removed by conventional trimming involving a knife. This is then incorporated into products such as meat pies, burgers, sausages and processed corned beef. These products will have higher levels of fat and salt compared to non-processed cuts of beef due to the processing steps (Table 4.4).

Table 4.4 Nutritional content per 100g of fresh and processed beef products

Type of Beef	Energy (Kcal)	Protein (g)	Fat (g)	Saturated fat (g)	Iron (mg)	Sodium (mg)
Beef, fillet steak, fried, lean	184	28.2	7.9	3.4	2.3	68
Beef, minced, stewed	209	21.8	13.5	5.9	2.2	73
Beef, mince, extra lean, stewed	177	24.7	8.7	3.8	2.3	75
Beef, topside, roasted, well-done, lean	202	36.2	6.3	2.6	2.9	62
Beefburgers, fried	329	28.5	23.9	10.7	2.8	470
Corned Beef	205	25.9	10.9	5.7	2.4	860
Steak and Kidney pie, individual	310	8.8	19.4	8.4	1.3	460
Beef Casserole, made with canned cook-in-sauce	136	15.1	6.5	2.7	1.2	557
Beef curry, chilled, frozen and reheated	137	13.5	6.6	3.1	N	540
Beef Stew	107	12.0	4.6	1.5	1.18	357
Beef, stir fried with green vegetables	141	11.8	8.0	2.7	1.91	319

Source: Food Standards Agency (FSA) (2002)

In the retail sector leaner cuts are becoming more widely available. In butchers' shops consumers can ask for any excess visible fat to be removed from the cuts of meat they are purchasing. This trend for removal of visible fat is also been accompanied by a trend for butchers to sell products that require less preparation at home. Many of these products have added sauces or ingredients such as stuffing. These additional ingredients can increase the salt and fat content of the original beef products.

Mince is a very versatile beef product. Traditionally mince is produced from a combination of lean meat and fat. The greater the proportion of lean meat used in the production of the product, the lower the fat content. For example, 'extra lean stewed minced beef' contains approximately 8.7g fat per 100g compared to 'standard minced beef' which contains 13.5g fat per 100g (FSA 2002). Increasingly leaner, lower fat versions of minced beef are available on the market. However, it must be noted that there is no legal definition of what constitutes 'lean'.

4.2.2.2 Preparation methods in the home

When preparing beef in the home or catering sector there are a number of steps that can be taken to reduce the fat content of beef. These include:

- *Removing the visible fat. The removal of visible fat from a raw piece of fillet steak can reduce the fat content by approximately 22 percent;*
- *Avoiding the use of additional fat during preparation, for example, mince contains some fat and will cook very well without the addition of fats or oils (dry frying); and*
- *Using healthier cooking methods such as dry frying, grilling, roasting on a rack or stir frying will also result in a lower fat product compared to other methods (FSA 2002).*

Cooking methods which involve water, stock or wine, e.g. boiling and stewing, will reduce the content of the B vitamins in beef. The B vitamins are water-soluble and will therefore leech into the liquid. These vitamins can be brought back into the food chain by using the liquid that the beef was cooked in to make gravy or sauces. However, boiling is not a commonly used method for cooking beef. Stewing and casseroling do not result in this problem because the sauce is generally consumed.

4.3 Dietary composition patterns

4.3.1 Current consumption of beef on IOI

4.3.1.1 Adults

Ninety-nine percent of ROI adults (n=958) included in the North South Ireland Food Consumption Survey (NSIFCS), conducted during 1997 to 2000, consumed meat and meat products (Appendix E) (Cosgrove, Flynn et al. 2005).

Eighty-six percent of males and 74 percent of females consumed beef[12] with a mean daily intake of 39.1g/day (Table 4.5).

[12]The study included veal with beef

Table 4.5 Mean daily intakes (g/day) of beef, meat products and beef burgers in male and female consumers in ROI by age group and by social class occupations and education level

	Beef g/day	Meat products g/day	Beef burger g/day
Men			
18-35 years	36.8[a] (130)	12.4 (68)	15.0 (83)
36-50 years	46.6[ab] (134)	11.2 (61)	13.4 (52)
51-64 years	48.9[b] (104)	12.5 (36)	11.3 (19)
Women			
18-35 years	26.4 (88)	6.6 (38)	11.8 (51)
36-50 years	25.4 (135)	8.0 (56)	9.7 (48)
51-64 years	30.3 (83)	7.0 (25)	11.5 (8)
Education			
Primary	43.6[a] (131)	10.8 (51)	10.8 (39)
Intermediate	39.4[ab] (144)	9.4 (60)	15.4 (59)
Secondary	31.7[b] (163)	10.0 (66)	12.4 (60)
Tertiary	32.9[b] (218)	10.0 (101)	12.1 (98)
Occupation			
Professional, managerial and technical	38.7 (270)	9.0 (111)[a]	11.4 (83)
Non-manual	30.6 (117)	9.2 (47)[a]	12.0 (58)
Skilled manual	38.5 (155)	12.5 (65)[b]	14.7 (53)
Semi-skilled and unskilled	32.4 (105)	8.9 (50)[a]	13.9 (50)

Notes: Meat products include white and black pudding, pâté, luncheon meat, donor kebab, corned beef, pastrami, rissoles. They exclude sausages.
Figures in brackets signify the sample number
[a,b] differences between categories using analysis of variance $p<0.01$
Source: Cosgrove, Flynn et al. (2005)

The mean intake of beef burgers among this group was 12.7 g/d. The intake of meat products was 10.0 g/day and this included white pudding, black pudding, pâté, luncheon meat, donor kebab, corned beef, pastrami and rissoles (Cosgrove, Flynn et al. 2005).

Men consumed more beef (including veal) at all age groups ($p<0.01$) compared to women. Among both sexes the older age groups (51 to 64 years) consumed more beef. Males aged 18 to 34 years and females aged 36 to 50 years consumed the least amount of beef among the groups.

There was a social class and education gradient associated with beef intake. Those with lower education, i.e. up to primary level, consumed the most beef compared to those who obtained secondary and tertiary education. Skilled manual occupations had the highest consumption of meat products compared to the other social class occupations.

The mean serving size of all meats consumed in the ROI cohort was 77g with men consuming a significantly larger ($p < 0.001$) portion (85g) than women (68g). The mean serving of beef (including veal) among all ROI consumers was 121g/day, which was the highest serving size of all meats consumed. The mean serving size for processed meat was 37g. The mean intake of meat consumed as an individual portion was 100g/day while the mean intake of meat consumed, as part of a composite food was 38g/day. Females were more likely to consume beef as a composite food. Overall, the younger age groups consume a greater amount of meat from composite meals than the older age groups. The majority of burgers consumed as part of a composite meal were either fried or grilled, with many being consumed from takeaway outlets.

Although the NSIFCS is the most detailed analysis on IOI of meat intake, fieldwork was conducted between 1997 and 1999. This time period immediately followed the Bovine Spongiform Encephalapathy (BSE) outbreak in 1996 and consumption of beef may have been influenced by this food scare (see Figure 2.6).

There have been a number of more recent surveys that have provided information on beef and meat consumption among adults on IOI including the Survey of Lifestyle, Attitudes and Nutrition (SLAN) (Health Promotion Unit 2003) and the Eating for Health Survey (Health Promotion Agency 2001).

The SLAN study of adults in ROI did not report specific beef intakes but did find that 39 percent of respondents reported consuming the recommended two servings daily of meat, fish and poultry. More females (40.5 percent) than males (38 percent) consumed the recommended two servings per day (Health Promotion Unit 2003).

The Eating for Health Survey carried out in NI in 1999 (Health Promotion Agency 2001); found that 69 percent of adults surveyed reported eating red meat once or twice a week or less often. Thirty one percent reported eating it three times a week or more often. This survey also found that men reported eating red meat more often than women with 27 percent of women eating red meat three or more times a week compared to 36 percent of men.

The National Diet and Nutrition Survey (NDNS) of adults in the UK reported a mean daily intake of beef of 42g for men and 35g for women (19 to 64 years) (Gregory, Lowe et al. 2000), with children (4 to 18 years) consuming an average of 19g/day (Finch, Doyle et al. 1998), and older adults (65+) 28g/day (Henderson, Gregory et al. 2002).

In Europe, meat intakes have been reported to be higher in northern European countries compared to southern European countries (Helsing 1995). Using a standard dietary methodology (i.e. 24-hour recall method) with approximately 36,000 men and women aged 35 to 74 years, (Linseisen, Kesse et al. 2002) found that there was a greater difference in the types of meats consumed across Europe rather than the overall total amounts. In general southern European countries consumed a higher proportion of beef/veal and poultry and less pork and processed meats. The reported red meat intakes in this study varied from 24 to 57 g/day in women and from 40 to 121 g/day in men.

4.3.1.2 Children and adolescents

The preliminary analysis of the National Children's Survey in ROI (Irish Universities Nutrition Alliance 2005) which included 293 boys and 301 girls aged 5 to12 years showed that the intakes of fresh meat, processed meat and meat dishes was 29, 45 and 37 g/day, respectively, among the whole population studied.

The consumption of processed meat and meat products in this group was higher than the intake of fresh leaner cuts of meat. The average intake by this group of processed meats, burgers (beef and pork), sausages, meat pies/pastries and meat products, was 7, 10, 2 and 19 g/day respectively. Among this population 37 percent consumed beef and 53 percent consumed beef dishes.

The mean intake of beef (including veal) in this group was 5 and 6 g/day, respectively. The contribution of beef and veal dishes to actual beef intake was estimated to be 21 and 22 g/day, respectively, for boys and girls. However, the non-meat components of these dishes have not been disaggregated from the meat components of these foods. Analysis of the data shows that the contribution to beef intake from composite foods is overestimated by 74 percent. However, based on these figures it can be estimated that beef dishes may contribute similar amounts to beef intakes as individual portions and therefore be an important contributor to intake.

The Eating for Health Survey in NI found that one quarter of the children surveyed reported eating red meat with 26 percent boys and 22 percent girls eating red meat on most days or more often (Health Promotion Agency 2001). No data was available on beef alone.

4.3.2 Contribution of beef to nutrient intake

In the NSIFCS meat and meat products were found to account for 12 percent of energy intake and to contribute to over ten percent of the intake of many other nutrients (Table 4.6). Meat and meat products contributed in particular to protein, vitamin B_{12}, zinc, niacin, vitamin D, vitamin B_6, thiamin and iron.

Table 4.6 Percentage contribution of all meat to mean daily nutrient intake in the North South Ireland Food Consumption Survey (n-958)

	Men	Women
Energy	12.9	10.7
Protein	31.4	26.9
Total Fat	19.4	14.9
Saturated Fat	18.3	14.0
Monounsaturated Fat	22.3	16.9
Polyunsaturated Fat	13.3	9.7
Sodium	21.6	17.1
Iron	15.8	11.6
Copper	12.0	10.2
Zinc	32.2	25.1
Total vitamin A	8.8	8.6
Vitamin D	23.8	16.6
Vitamin E	8.7	5.8
Thiamine	16.7	13.4
Riboflavin	14.7	11.8
Niacin	28.9	26.3
Vitamin B6	16.3	14.8
Vitamin B12	32.4	25.4
Panthothenic Acid	20.1	17.2

Source: Cosgrove and Kiely (2005)

It should be noted that meat and meat products contributed to all the major fatty acid subgroups. They also contribute to approximately one fifth of sodium intake and this may reflect the fact that a large proportion of processed meats was consumed by the population. No breakdown was given in this study on the contribution of beef alone to nutrient intakes.

The ROI cohort of NSIFCS was classified into non-consumers, low (<41g/d), medium (41 to 72 g/d) and high (>72 g/d) red meat consumers (Cosgrove, Flynn et al. 2005). The authors found that the consumption of red meat was associated with a more micro-nutrient dense diet. Red meat consumers had higher zinc, niacin and vitamin B_{12} intakes compared to non-consumers and high consumers had a higher iron intake compared with low consumers. It was also found that red meat consumers had a lower prevalence of inadequate intake of vitamin A, riboflavin, vitamins B_6 and C. High consumers of beef, however, were found to have a lower compliance with carbohydrate recommendations and had a less fibre dense diet compared to non-consumers of red meat.

5. Beef and Health

5.1 Introduction

Beef is an important source of iron in the diet which is essential in the prevention of anaemia. It is perceived, however, as a high fat and saturated fat product and a number of epidemiological studies have indicated that a high consumption of red meat is associated with negative health effects (Key, Fraser et al. 1998; Hu, Stampfer et al. 1999; Kelemen, Kushi et al. 2005). A key feature of these studies, however, is the lack of discrimination between processed and fresh cuts or between fatty and leaner cuts of meat. Wider aspects of the diet were also not considered, including the consumption of fruit and vegetables.

In this chapter the health impacts of beef consumption on iron status, cardiovascular health and cancer risk will be briefly outlined.

5.2 Beef and iron status and anaemia

Iron has a very fundamental role in the body in the transportation of oxygen to various organs. Iron is also required for oxygen storage in muscle and required to drive forward many biochemical reactions in the body.

Iron deficiency anaemia is the most common nutritional disorder in the world. Although it is most common in the developing world it is still a major problem in the developed world. The public health implications of iron-deficiency anaemia include (Vejayaraghavan 2004):

Impacts on maternal health and infants:

- *Increase proportion of maternal deaths;*
- *Higher incidence of low birth weight; and*
- *Intrauterine malnutrition.*

For children there is evidence indicating:

- *Impaired psychomotor development; and*
- *Impaired intellectual performance and changes in children's behaviour.*

For all individuals:

- *Increased infections; and*
- *Increased fatigue and thus reduced work capacity.*

Dietary intake is the single most important factor determining the risk of developing iron deficiency anaemia. The richest source of bioavailable haem iron in the diet is meat, particularly liver and red meat. Iron is also found in lower levels in foods such as eggs, vegetables and cereals, but in some cases this is in non-haem form and more likely to be influenced by other factors during absorption in the gut.

Dietary iron intakes on the Island of Ireland (IOI) have been found to be low among a significant proportion of the population especially children and women of child bearing age. In the North South Ireland Food Consumption Survey (NSIFCS) mean daily iron intakes below the average requirement (AR) of 10mg per day were recorded in 50.2 percent of 18 to 35 year old women and 45.5 percent of 36 to 50 year old women (Hannon, Kiely et al. 2001). The iron intakes of ten percent of the women actually fell below the lower reference nutrient intake (LRNI) for women. This study indicates that many menstruating women on IOI are at risk of ron-deficiency anaemia. Among men, two percent had intakes below the AR and 0.6 percent had intakes below the LRI.

In the National Children's Survey of 5 to 12 year olds in the Republic of Ireland (ROI), 34 percent girls and 13 percent boys were reported to have inadequate intakes of iron (McCarthy and Hannon 2005). No data from large scale dietary surveys is available for other age groups on iron intakes or iron status measures of the population on IOI.

In Great Britain (GB) the National Diet and Nutrition Survey (NDNS) provided data on both intakes and iron status. The analysis of iron stores in the blood indicated that women had lower iron stores than men (Rushton, Henderson et al. 2004). In older adults, meat and fish consumption were positively associated with iron status (Doyle, Crawley et al. 1999).

Among children in GB, aged 1.5 to 4.5 years, one in 12 (and one in eight among the younger group of 1.5 to 2.5 years) had low haemoglobin levels (Gregory, Collins et al. 1995). It was also highlighted that those infants over reliant on cows milk were more likely to have low iron stores because iron rich foods were being displaced in the diet (Thane, Walmsley et al. 2000). Among the 4 to 18 year old group, adolescent girls were found to be at the highest risk of low iron stores (Thane, Bates et al. 2003). Overall, the NDNS surveys have shown that iron status (indicated by blood haemoglobin, serum ferritin and other blood-based indices) is not associated with total iron intake alone but is generally related positively with meat and fruit consumption (promoters of iron absorption) in toddlers and school aged children, particularly adolescent girls.

Low iron status and anaemia have been shown to be more common among low and non-meat eaters, particularly among women (Worthington-Roberts, Breskin et al. 1998; Gibson and Ashwell 2003; Thane, Bates et al. 2003). Studies with vegetarians have indicated that while they have lower iron status when compared to non-vegetarians, they still manage to attain adequate intakes (Cosgrove, Flynn et al. 2005).

5.3 Beef and cardiovascular health

Cardiovascular disease (CVD), which includes stroke and coronary heart disease, is a leading cause of death on IOI and indeed worldwide. Some of the major risk factors for CVD, which include high blood cholesterol and triglyceride levels, hypertension, obesity and diabetes are modifiable through the diet (World Health Organisation 2003).

Beef and other meats contain nutrients that are known to exert cardio-protective properties such as B vitamins, selenium and n-3 fatty acids. However, meat has been associated with an increased risk of CVD due to the current contribution of meat and meat products to total fat and saturated fat intake. A high fat and saturated fat intake increases blood cholesterol and triglyceride levels and are associated with an increased risk of CVD (Stanner 2005). Many prospective studies have shown a positive association between red meat intake and cardiovascular disease (Key, Fraser et al. 1998; Hu, Stampfer et al. 1999; Kelemen, Kushi et al. 2005)

As well as the key feature of these high CVD risk diets, a higher intake of red meat, other features include low fruit and vegetable and fibre intakes and higher intakes of processed meat. Conversely, it has been shown that in some Mediterranean regions, a lower prevalence of CVD may be associated with a diet which is high in red meat but also high in fruit and vegetables (Linseisen, Kesse et al. 2002). The data demonstrates that red meat

alone will not influence CVD risk and it is therefore important to consider the overall diet rather than focus on a specific food.The majority of studies that have investigated the association between red meat and CVD have not dissociated lean from untrimmed cuts and processed from unprocessed cuts. Since these factors have a large influence on the nutritional content of the meat consumed then they are important factors to consider.

It has been well established that vegetarian diets are associated with a reduced risk of CVD (Kestin, Rouse et al. 1989). Twenty six men were randomly assigned to receive two of three diets over six week periods - a lactoovo vegetarian diet (all plant protein and low in fat); a low fat diet that contains lean meat; and a high fat meatcontaining diet. The lean meat and lacto-ovo vegetarian diets were associated with similar reduction in cardiovascular risk factors such as blood cholesterol and blood pressure. The authors concluded that substituting lean meat for some vegetable protein did not negate the benefits associated with a vegetarian diet. Other intervention studies have noted that the consumption of lean red meat did not influence blood lipids in patients with CVD (Watts, Ahmed et al. 1988) and the ability of blood to clot (Li, Siriamornpun et al. 2005).

As well as the saturated fat content of red meat, which is known to raise blood cholesterol, beef is an equally good source of monounsaturated fatty acids (MUFA) and contains small amounts of n-3 polyunsaturated fatty acids. MUFA has similar effects to PUFA, lowering total cholesterol and low density lipoprotein, but has no effect on high density lipoprotein-C. To protect against CVD reducing the total and saturated fatty acid (SFA) content of meat is important. Lean cuts of meat are higher in PUFA and MUFA and lower in SFA compared to untrimmed cuts.

5.4 Beef and cancer

In 2007 the report of the Expert Panel of the World Cancer Research Fund (WCRF)/American Institute for Cancer Research (AICR) was published (WCRF/AICR 2007). This report contained a comprehensive review of the scientific evidence linking diet, physical activity and weight with cancer. One the basis of the evidence the Panel offered ten significant recommendations towards the prevention of cancer.

The influence of red meats (including beef, goat, lamb and pork) and processed red meats (preserved by smoking, curing, or salting, or by the addition of preservatives) on the development of cancer were including in this review.

In relation to processed meat the report found:

- It to be a convincing cause of colorectal cancer. The report summarised that this is based on substantial evidence with a dose response relationship apparent from cohort studies. Meta-analysis of the data demonstrated that there was a 21 percent increase risk per 50g processed meat consumed per day.

- That there is suggestive increase risk between processed meat and cancers of oesophagus, stomach and prostate. in the case of each cancer the evidence is limited and often inconsistent.

The report highlighted that the mechanisms whereby processed meat does or can lead to these cancers has not been defined conclusively. However, plausible mechanisms include nitrates that are used as preservatives leading to increased production of N-nitroso compounds that are suspected carcinogens and mutagens; the production of heterocyclic amines and polycyclic aromatic hydrocarbons during cooking processed meat at high temperatures; and the promotion of the formation of N-nitroso compounds and free radicals by haem iron.

In relation to red meat the report found:

- It to be a convincing cause of colorectal cancer. This was based on a substantia l of evidence from a cohort and case-control studies, showing a does response relationship. Meat-analysis of the data demonstrated that there was a 15 percent increase risk per 50g red meat consumed per day.

- That there is a suggestive increased risk between red meat and cancers of oesophagus, lung, pancreas and endometrium. In the case of each cancer the evidence is limited and often inconsistent.

There are a number of plausible mechanisms for an association between red meat and cancer identified in the report. These include the generation of N-nitroso compounds by stomach and gut bacteria, the production of heterocyclic amines and polycyclic aromatic hydrocarbons during cooking processed meat at high temperatures and the production of free radicals by free radicals by free iron.

The WCRF/AICR made both individual and public health recommendations in relation to meat:

- People who eat red meat to consume less than 500g (17.5 oz; cooked) a week, very little if any to be processed.

- The population goals should be for an average consumption of red meat to be no more than 300g (11 oz; cooked) a week very little of which to be processed.

In making this recommendation the Expert Panels recognised the valuable contribution that lean red meat can make to the diet particularly in relation to iron, vitamin B_{12} and protein. The red meat recommendation is realistic and allows individuals to enjoy red meat at least two to three times per week, the current dietary recommendations on IOI.

With respect to processed meat the current dietary advice on IOI recommends limiting the consumption of these foods and this would support the recommendations of the WCRF/AICR. However, it is important to consider current dietary practices in relation to processed meat. Currently approximately half the meat consumed on IOI is processed, and therefore a more realistic achievable interim goal for many people would be to reduce their intake of processed meats slowly.

It should be noted that ther are many other dietary factors that are associated with cancer risk. Being a healthy weight, basing diets on plant foods such as fruits and vegetables and whole grains, and avoiding foods that promote weight gain are equally as important for cancer risk as the quantity and type of meat consumed.

5.5 Type II diabetes and weight status

There is a positive association between total meat and processed meat intake and Type II diabetes and weight (Cosgrove and Kiely 2005; Williamson, Foster et al. 2005). Processed meat contains more total and saturated fat and hence more calories when compared to unprocessed leaner cuts of meat. There is no evidence that lean red meat will increase the risk of Type II diabetes and weight gain. In fact due to the lower fat and saturated fat content of lean red meat when compared to processed meat, the consumption of moderate amounts of lean red meat as part of a healthy balanced diet is likely to have a positive effect on reducing the risk of weight gain and Type II diabetes (Cosgrove and Kiely 2005; Williamson, Foster et al. 2005).

6. General

6.1 Introduction

The following chapter covers other aspects of the beef food chain, including traceability, labelling, quality assurance schemes, and training, which have not been discussed in detail in earlier sections. Other issues, though not of a food safety nature but which were of concern to consumers during consumer research, will also be iscussed such as organic production, animal welfare and foot and mouth disease.

6.2 Traceability

6.2.1 Introduction

In recent years, high profile 'scares' such as Bovine Spongiform Encephalopathy (BSE) have focused attention on how the beef supply chain operates, from production through processing, and finally distribution. Such 'scares' have the potential to seriously damage consumer confidence in the food chain, whether they present real or perceived food safety risks. They have also highlighted deficiencies in traceability systems and also in European Law. The consequence of this was the formulation and adoption of EU Commission Regulation (EC) No. 178/2002 which lays down the general EU principles and requirements of food law including traceability and recall requirements. This regulation was implemented as of 1 January 2005.

In the Republic of Ireland (ROI), the traceability, or more specifically country of origin of meat, particularly beef, has been the focus of much debate in recent times. In June 2006, legislation was enacted making country of origin labelling of beef in restaurants and other catering establishments compulsory.

6.2.2 Traceability requirements

Regulation (EC) No 178/2002 was introduced to increase consumer confidence in the safety of all foods consumed and to ensure that all businesses involved in the production, manufacture, distribution or retail of food and drink items have a reliable traceability system in place.

Article 18 of regulation No. 178/2002 requires that traceability of 'food, feed, food producing animals, and any other substance intended to be, or expected to be, incorporated into a food or feed shall be established at all stages of production, processing and distribution.' This system effectively means that the principle of 'one-up, one-down' traceability should be established at each point in the supply chain.

In the event of a foodborne hazard being identified in a particular batch of beef, or a case of foodborne illness associated with the consumption of beef having been reported, a full traceability system will permit identification of where that product has originated; the raw materials involved in its production; the company that handled the product since it was produced; how it has been stored during transit; and the final destination of the product. This information enables a rapid and targeted recall of potentially hazardous product, thereby preventing any further food safety problems.

6.2.3 Traceability along the beef food chain

Beef traceability for cattle reared on the island is guaranteed by a number of measures. These include:

- *An individual cattle identification system;*
- *Individual identification data on cattle and their movements from birth to slaughter, which are recorded in a central computer database;*

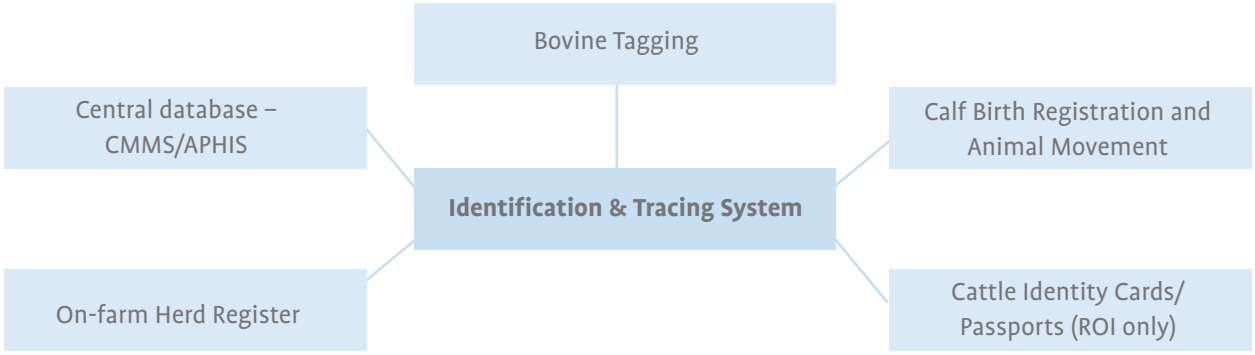
- *The compulsory individual cattle passport accompanying all intra-Community movements of the animals (ROI only); and*

- *The systematic recording at slaughterhouses of a reference code for each carcass, corresponding to each animal's individual identification number and the indication of this code (or a related one) at the different steps of the beef processing chain up to the retail outlets.*

6.2.3.1 From birth and during rearing
The EU requirements concerning the establishment of a system for the identification and registration of bovine animals and also regarding the labelling of beef and beef products, are set out in Council Regulation (EC) No. 1760/2000.

The bovine animal identification and tracing system on the island of Ireland (IOI) has five key elements (Figure 6.1).

Figure 6.1 Bovine animal identification and tracing system on the island of Ireland (IOI)



1. Bovine tagging
Calves are tagged at birth with a unique identification number, registered on a central registration database and, in ROI only, are issued with a passport.

2. Calf birth registration
All calf births are registered on a central jurisdictional database. The database holds the following information on the origin and identity of each animal: ear tag number, sex, breed, date of birth, herd of origin, and ear tag number of dam.

3. Cattle identity cards/passports
In ROI, a passport is issued to record all the movements of the animal and accompanies it throughout its life within the EU. It must be presented for verification each time an animal is moved. In Northern Ireland (NI), however, cattle identity is fully computerised thus negating the need for passports. This system has been in place since 1988, largely as a means of monitoring movements for the purpose of animal disease control.

4. On-farm herd register
A herd register must be maintained on each holding. The register records information on all births, purchases, sales and deaths of bovine animals on the holding. All cattle keepers must notify the relevant Department

(Department of Agriculture and Rural Development in NI or the Department of Agriculture, Fisheries and Food in ROI) of the birth, death (including stillbirths) and movement of cattle.

5. Central database
The movement of all bovine animals, including birth and deaths, is also captured on a central database in each jurisdiction. In ROI, this database is called the Cattle Movement Monitoring System (CMMS). In NI the database is termed APHIS (Animal and Public Health Information System). The databases also incorporate Calf Birth Registration.

Republic of Ireland – 'Cattle Movement Monitoring System' (CMMS)
The CMMS became fully operational at the beginning of 2000. Each year, the Department of Agriculture, Fisheries and Food publish a CMMS statistics report [for 2006 report see Department of Agriculture, Fisheries and Food (2007)].

In ROI, the National Beef Assurance Scheme Act, 2000 provided for the further development of the animal identification and tracing system, including the use of the system to verify the origin, identity and life history of cattle before entering the food chain (Department of Agriculture, Fisheries and Food 2003a).

Computer equipment linked to the central database is installed at livestock markets, meat plants and live export points to record electronically all movements of cattle to and from these premises. In the case of private sales, the movements are recorded by the Department's Cattle Movement Notification Agency on the basis of notifications from farmers and subsequently loaded onto the central database.

On each sale day the mart records all movements of cattle through its premises. This data is transmitted electronically to the central database on completion of each sale. CMMS has two functions at meat plants: to record the movement of the animal into the plant; and to check the animal details against the CMMS database in order to verify the origin, identity and life history of the animal against the database before the animal proceeds for slaughter.

The CMMS system for local authority licensed abattoirs is also similar to that for meat plants; however, because of the small size and low throughput of these plants, they are not linked on-line to the central mainframe. Instead the CMMS clearance checks are conducted by the District Veterinary Offices of the Department of Agriculture, Fisheries and Food based on written notifications of intention to slaughter sent by fax from the abattoirs.

The CMMS system for live exports involves recording the movement of the animal into the export lairage and the CMMS database is interrogated to verify the origin, identity and life history of the animals prior to acceptance for export. Additionally, the export destination is recorded.

Validation procedures have been built into CMMS such that only valid data is accepted onto the database and errors and irregularities are flagged.

A new project has been initiated to progress the development of an Animal Movement System (AMS). The new system will replace the current bovine animal identification and tracing databases as well as incorporating the identification requirements for sheep and pigs. The AMS, which will be based on leading edge internet-based technology, will allow farmers to fulfil their notification obligations and provide access to their herd details on-line. The Ams project is a major undertaking and will take a number of years to be completed.

Northern Ireland – 'Animal and Public Health Information System' (APHIS)
The computerised database in NI is available online and allows users to register cattle births and deaths; apply for new or replacement ear tags; authorise a tag agent or breed society to act on their behalf; provide advance movement notification of animals moving to market or abattoir; download current and historical herd lists and use these with farm recording software; view post mortem details of slaughtered animals; and view details of Brucellosis and Tuberculosis herd tests (Department of Agriculture and Rural Development 2007).

Legislation on cattle identification, notification and record keeping legislation in NI includes Cattle Identification (No.2) Regulations (NI) 1998; Cattle Identification (Enforcement) Regulations (NI) 1998; and Cattle Identification (Notification of Births, Deaths and Movements) Regulations (NI) 1999.

Further information can be obtained from the Department of Agriculture and Rural Development at *http://www.dardni.gov.uk/index/animal-health/animal-identification-registration-movements*

6.2.3.2 At the slaughterhouse
To be eligible for slaughter cattle for human consumption, if over 30 months of age and born on or after August 1, 1996, must be tested for BSE (as discussed in Section 3.2.10). If there are instances where the date of birth on the passport (ROI only) is not fully supported by other evidence e.g. an animal presented at a meat plant with more than four hard teeth, Department of Agriculture, Fisheries and Food/Department of Agriculture and Rural Development officials carry out a herd register inspection. If entries into the herd book are not in the correct order it may fail to pass this herd register inspection.

The EUROP classification system
When an animal arrives at the slaughterhouse, it is slaughtered and spilt into two half carcasses. At this point, the animal is classified according to a standard obligatory classification system called EUROP. The criteria for classifying cattle into the EUROP classes are specified in EU directives (EC 1208/1981) supplemented by national regulations.

The classification is based on a visual inspection of the carcass, where shape (the distribution of meat on the carcass) is classed using the letters E to P (E=most shape, P=least shape), and the amount of visible fat on the meat using numbers one to five (one=least fat, five=most fat). Assessment is conducted by a certified cattle-classifier. Machines have also been developed to classify carcasses, using technology known as Video Image Analysis and are in use in all major abattoirs in ROI (Allen and Finnerty 2001). Classification is controlled by the EU through national competent authorities, namely the Department of Agriculture and Rural Development in NI (assisted by the Livestock and Meat Commission) and by the Department of Agriculture, Fisheries and Food in ROI.

The EUROP standard is also used as the basis of a payment schedule to producers, as well as for price-reporting purposes. Some slaughterhouses have developed their own additional criteria for sorting the meat including, for example, colour and veterinary history.

6.2.3.3 Guidance for industry
GS1 (formerly known as EAN International) has developed guidelines in the application of EAN.UCC (i.e. barcoding) standards in implementing Regulation (EC) 1760/2000. In addition, GS1 Ireland[13] has completed a Beef Traceability Case Study (GS1 Ireland 2005) with partners in the industry, namely Kepak and Super Valu.

[13]GS1 is a leading global organisation dedicated to the design and implementation of global standards and solutions to improve the efficiency and visibility of supply and demand chains globally and across sectors.

6.2.3.4 DNA Traceback™ – IdentiGEN

DNA TraceBack™ is a meat traceability system developed by IdentiGEN[14] (IdentiGEN 2006). This system allows for traceability back to an individual animal and is used by large retailers such as Superquinn and Tesco. DNA samples are taken from carcasses at slaughter. These samples are then analysed, recorded and stored on a database. DNA samples can be taken from products at retail level and compared with the records in the database to verify the origin and production history.

6.3 Labelling

6.3.1 Introduction

Labelling allows consumers to make informed decisions about the food they eat and also builds confidence in products. The general labelling of food products is governed by Council Directive 2000/13/EC on the Labelling, Presentation and Advertising of Foodstuffs, while specific meat labelling requirements are set out in an amendment to this directive, Commission Directive 2001/101/EC. Labelling legislation pertaining to country of origin of beef is outlined in the Beef Labelling Regulation 1760/2000.

6.3.2 General food labelling requirements

Council Directive 2000/13/EC sets out general provisions on the labelling of pre-packaged foodstuffs to be delivered to the ultimate consumer. This includes name of the food, ingredient list, quantitative ingredient declaration (QUID), net weight, use by/best before date, place of origin, special storage instructions and name and address of the manufacturer/seller.

Directive 2000/13/EC is implemented in ROI by the European Communities (Labelling, Presentation and Advertising of Foodstuffs) Regulations 2002 (S.I. No. 483 of 2002) and in NI by the Food Labelling Regulations (NI) 1996 (SR NI 1996 No. 383), as amended. Enforcement of this legislation in ROI lies with the Food Safety Authority of Ireland (FSAI), the Department of Agriculture, Fisheries and Food, and the Office of the Director of Consumer Affairs; and with District Councils in NI.

Directive 2003/89/EEC, amending directive 2000/13/EC, concerns the labelling of allergens in foodstuffs. This legislation requires food manufacturers to indicate the presence of potential allergens (from a list of 12 as laid down in the Directive) if they are used as ingredients in pre-packed foods, including alcoholic drinks, regardless of their quantity.

The general food labelling legislation is currently under review at EU level.

6.3.3 Specific meat labelling requirements

Commission Directive 2001/101/EC, an amendment to the General Labelling Directive, sets out specific rules regarding the labelling of meat. This Directive only applies to the labelling of products which contain meat as an ingredient and does not apply to the labelling of meat cuts and anatomical parts which are sold without further processing. However, organs such as offal, including the heart, intestine and liver, have to be labelled as such and not as 'meat'.

Mechanically recovered meat (MRM) is not covered by the definition of meat and therefore must be designated as MRM and by the name of the species. However, there is provision for a certain part of the fat and connective tissue content, where it adheres to the muscles, to be treated as meat, subject to maximum limits laid down

[14] an international provider of DNA-based solutions to the food and agriculture industries.

in the definition. The Directive also provides for the systematic indication of the species from which the meat comes, so that for example 'bovine meat' is distinguished from 'pig meat'.
On IOI there is no legislation in place that stipulates the compositional standard of processed beef products. The only requirement is that the beef content is "quided", meaning that the percentage of beef in the product is stated in the ingredient listing if mentioned in the name of the product (only muscle meat counts). Pictorial representation or graphics that selectively emphasise certain ingredients may also trigger this requirement.

The meat labelling requirements have been transposed into legislation in ROI [European Communities (Labelling, presentation and advertising of foodstuffs) (Amendment) Regulations, 2003 (S.I. No. 257 of 2003)] and NI [Meat Products Regulations (NI) 2004]. Guidance notes on Directive 2001/101/EC have been issued on IOI (FSA 2003; FSAI 2003a). The FSAI has also issued a guidance note on general meat labelling (FSAI 2005).

6.3.4 Specific beef labelling requirements around traceability and country of origin

In 2000, the EU introduced the Beef Labelling Regulation 1760/2000 which requires all beef retailers and producers to provide information on the source of the beef on the product label. The legislation lays down the principles for establishing a system for the identification and registration of bovine animals and sets out the procedures for the labelling of beef and beef products, both compulsory and voluntary.

The Beef Labelling Regulation (EC) 1760/2000 is implemented in ROI by the European Communities (Labelling of Beef and Beef Products) Regulations 2000 (S.I. No 435 of 2000) and the EC Amendment Regulations 2002 (S.I. No 485 of 2002). It is implemented in NI by the Beef Labelling (Enforcement) Regulations (NI) 2001 (No. 271).

6.3.4.1 Compulsory beef labelling

Food business operators are required to label beef with the following information as laid out under Regulation (EC) 1760/2000:

1. *The reference number or code of the animal or group of animals from which the beef was derived.*

2. *The country of the slaughterhouse and approval number. The indication should read: 'Slaughtered in (name of country) (approval number)'.*

3. *The country of the cutting hall and approval number. The indication should read: 'Cutting in (name of country) (approval number)'.*

4. *The origin of the beef.*

   (a) If the beef is derived from animals born, raised and slaughtered in the same country, the indication on the label may be given as "Origin: (name of country)". For example, 'Origin: Northern Ireland'.

   (b) If the beef is derived from animals from different countries the label must indicate:

      (i) Country of birth
      (ii) Country (or countries) of fattening
      (iii) Country of slaughter, e.g. 'Born in Italy' 'Reared in France' 'Slaughtered in Ireland'.

By way of derogation, beef imported into the EU from Third Countries for which not all the information referred to above is available, shall be labelled with the words: 'Origin: non-EC'; 'Slaughtered in (name of Third Country).

This legislation also covers beef sold over the counter (that is, packaged on the premises from which it is purchased). The information must be clearly displayed on or close to the product. The only exception to the compulsory beef labelling system is for minced meat (see Section 6.3.5).

6.3.4.2 Restaurants and other catering establishments
In July 2006, new legislation introduced in ROI, Health (Country of Origin of Beef) Regulations (S.I. 307) 2006, requires all restaurants and other catering establishments to provide information to consumers on the country of origin of any beef served on the premises. Previous legislation obliged food businesses to keep only records of foods handled on the premises. Guidance has been issued to caterers in relation to this new legislation (FSAI 2007).

Such legislation does not currently exist in NI.

6.3.4.3 Voluntary beef labelling
Food business operators wishing to place information on the label, that is additional to the compulsory requirements of the labelling legislation, must first submit an application for approval to the competent authority where the sale or production of beef takes place. The responsibility lies with the Department of Agriculture, Fisheries and Food in ROI and the Department of Agriculture and Rural Development in NI. Such information can include identification number, sex and breed, or method of production (e.g. organic, grass fed or extensively reared).

6.3.5 Minced meat and meat preparations
Regulation (EC) 853/2004 defines 'minced meat' as "boned meat that has been minced into fragments and contains less than one percent salt".

European Parliament and Council Regulations 1760/2000 (discussed in Section 6.3.4) and Commission Regulation No. 1825/2000 lay down the requirements for the labelling of fresh, frozen and minced beef.

Food Business Operators (FBOs) producing minced meat must ensure that the raw materials used to prepare minced meat must comply with the requirements for fresh meat and derive from skeletal muscle, including adherent fatty tissues.

The raw material used to prepare minced meat must not derive from:

- *Scrap cuttings and trimmings (other than whole muscle cuttings). (Small trimmings and cuttings obtained from whole muscle , are considered fit for human consumption once the microbiological quality of the minced meat is guaranteed at all times);*
- *Mechanically separated meat;*
- *Meat containing bone fragments or skin; or*
- *Meat of the head with the exception of the masseters, the non-muscular part of the linea alba , the region of the carpus and the tarsus, bone scrapings and the muscles of the diaphragm (unless the serosa has been removed).*

Article 10 of Regulation (EC) 2076/2005 grants derogation from the above requirements for a transitional period which ends on 31 December 2009. However, the FBO must check the raw materials entering the establishment to ensure compliance with the name of the product (Table 6.1) in respect of the final product.

Table 6.1 Composition criteria for minced meat

	Fat content	Connective tissue: meat protein ratio
Lean minced meat	≤ 7%	≤ 12
Minced pure beef	≤ 20%	≤ 15
Minced meat containing pigmeat	≤ 30%	≤ 18
Minced meat of other species	≤ 25%	≤ 15

Note: checked on the basis of a daily average

Unless the competent authority authorises boning immediately before mincing, frozen or deep-frozen meat used for the preparation of minced meat or meat preparations must be boned before freezing. It may be then stored only for a limited period (not specified in the legislation).

When prepared from chilled meat, minced meat must be prepared in the case of animals other than poultry, within no more than six days of their slaughter; or within no more than 15 days from the slaughter of the animals in the case of boned, vacuum-packed beef and veal.

Immediately after production, minced meat and meat preparations must be wrapped or packaged and be chilled to an internal temperature of not more than 2°C for minced meat and 4°C for meat preparations, or frozen to an internal temperature of not more than -18°C. These temperature conditions must be maintained during storage and transport. Minced meat must not be re-frozen after thawing.

In addition to the requirements of Directive 2000/13/EC on the labelling, advertising and presentation of foodstuffs, FBOs must ensure that packages intended for supply to the final consumer containing minced meat, meat preparations and meat products are clearly labelled by the manufacturer so as to inform the consumer of the need for thorough cooking prior to consumption. As and from January 1, 2010 the above labelling will not be required in respect of minced meat, meat preparations and meat products made from poultrymeat.

Regulation (EC) 2076/2005 requires for the transitional period (i.e. four years ending on the December 31, 2009) that the labelling of minced meat must also display the following words: 'percentage of fat under' and 'connective tissue: meat protein ratio under'.

6.3.6 Health/identification marks

A health mark is a mark applied to a carcass, whereas an identification mark is applied in all other cases (as specified in the annex to 853).

Council Directive 853/2004/EC states that food business operators must ensure that 'products of animal origin' have a health/identification mark (in compliance with certain criteria laid down in Regulation (EC) 854/2004) to facilitate traceability. For that purpose, the following information must appear on the packaging or, in the case of a non-packaged product, in the accompanying documents:

- *Abbreviated name of the country in which the establishment is located, e.g. IE for ROI, or UK for the United Kingdom.*

- *Identification of the establishment or factory vessel by its official approval number; and*
- *The abbreviated form of 'European Union': EC.*

All the letters and figures must be fully legible and grouped together on the packaging in a place where they are visible from the outside without any need to open the packaging. This enables an enforcement officer to identify the factory in which the product was packaged. All such establishments, that meet the specified hygiene requirements and are licensed/approved, are allocated a code number which is part of the health/identification mark along with the code of the particular country. The competent authority in each country is obliged to maintain a list of approved premises.

Health/identification marking is an important element of any traceability system; however, it should not be confused with, or related to, country of origin as is often the case. A product produced in one country, exported to another country where it is repackaged and relabelled, can bear the identification mark of the factory in which the latter activities took place.

6.3.7 Nutrition labelling

The nutrition labelling of foodstuffs is governed by Council Directive 90/496/EEC, as amended. This piece of legislation states that nutrition labelling is compulsory when a health claim is made. In this instance, and in other instances where nutrition labelling is provided voluntarily, the information given must consist of one of two formats - group one (the 'Big Four') or group two (the 'Big Eight'). Group one consists of energy value, protein, carbohydrate and fat; while, group two consists of the latter four plus sugars, saturates, fibre, and sodium. Nutrition labelling may also include starch, polyols, mono-unsaturates, polyunsaturates, cholesterol and any minerals or vitamins that are listed in the legislation.

Nutrition information must be given 'per 100g or 100ml'. It may also be given 'per serving size', provided that the serving size is also stated.

This piece of legislation applies to prepackaged foodstuffs to be delivered to the ultimate consumer and also foodstuffs intended for supply to 'mass caterers', i.e. restaurants, hospitals, canteens, etc. It does not however, apply to non-prepackaged foodstuffs packed at the point of sale at the request of the purchaser or prepackaged with a view to immediate sale.

The nutrition labelling legislation is currently under review at EU level.

6.4 Third Country import controls

Imports from Third Countries are covered primarily by the general food hygiene legislation or 'Hygiene Package', specifically Regulation (EC) No 853/2004, which lays down specific rules for food of animal origin and Regulation (EC) 854/2004 which governs official controls on products of animal origin intended for human consumption.

6.4.1 European Commission, Food and Veterinary Office

The function of the Food and Veterinary Office (FVO) is to ensure effective control systems through the evaluation of compliance with the requirements of EU food safety/quality, veterinary and animal health legislation, both within the EU and in Third Countries exporting to the EU. The FVO does this mainly by carrying out inspections in Member States and in Third Countries exporting to the EU.

Each year the FVO develops an inspection programme, identifying priority areas and countries for inspection. In order to ensure that the programme remains up to date and relevant, it is reviewed mid-year. The FVO makes recommendations to the country's competent authority to deal with any shortcomings revealed during the inspections. Following an inspection, the competent authority can be requested to present an action plan to the FVO on how it intends to address any shortcomings. Together with other Commission services, the FVO evaluates this action plan and monitors its implementation through a number of follow-up activities.

In its role, the FVO, where appropriate, will highlight areas where the Commission may need to consider clarifying or amending legislation or areas where new legislation might be required. In addition, the FVO produces other reports, such as summaries of the results of inspections or the annual EU-wide pesticide residues monitoring reports. The FVO also publishes an annual report on its activities, which reviews the progress of its inspection programme and presents the global results.

6.4.2 Border inspection posts

Imports of animals and animal products from Third Countries must come through designated Border Inspection Posts (BIPs) and be subjected to a series of checks before they are allowed access to the EU market.

Third Country import controls can be undertaken in any one Member State before the product is allowed to circulate freely in other Member State, which effectively means that each Member State is dependent on every other state to ensure that imports are controlled. It should be noted that the BIP is not always in the country of final destination of the product. The BIPs are situated in strategic locations in each Member State and are under the supervision of the relevant competent authority of the Member State. The Food and Veterinary Office of the European Commission routinely audits the controls carried out in these BIPs.

The list of BIPs operating within the EU is drawn up in Commission Decision 2001/881/EC, as amended. There are currently five BIPs on IOI, namely Dublin Airport, Dublin Port, Shannon Airport, Belfast International Airport and Belfast Port.

Council Directive 97/78/EC governs the organisation of veterinary checks on products entering the EU from Third Countries. Such imports must be accompanied by health certification signed by an official veterinarian in the country of export and must be presented at the BIP at point of entry into the EU. The animal products must be appropriately wrapped, packaged and labelled with an identification mark. The importer must be registered with the competent authority and must give 24 hours advance notification to the latter.

All consignments from Third Countries undergo a 100 percent documentary and identity check, while physical checks are carried out at frequencies laid down in EU law under Commission Decision 94/360/EC.

The frequency of physical checks on fresh bovine meat is 20 percent. Sampling for laboratory analysis may also be carried out. Foods failing to comply with the control checks may be detained for further examination, returned to the exporting country or destroyed. All rejections are notified to the EU Commission and a public health risk communicated to all Members States via the Rapid Alert System for Food and Feed (RASFF).

When a shipment has met the required conditions it is released for free circulation within the EU. However, copies of the health certificate and the BIP clearance document must accompany the consignment to its destination. The aforementioned Directive has been transposed into national legislation in NI by the 'Products of Animal Origin (Third Country Imports) Regulations (NI) 2006', and in ROI by European Communities (Importation of Animal and Animal Products from Third Countries) Regulations, 1994 (S.I. No. 292 of 2000); as amended.

The Competent Authority in the Member State carries out initial monitoring of controls at BIPs. In the case of ROI, this is done by the Department of Agriculture, Fisheries and Food on behalf of the FSAI and in NI by the Department of Agriculture and Rural Development. The FVO is required to inspect BIPs; the frequency and scope of which is defined based on risk analysis, as outlined by Commission Decision 2005/13/EC. Where the operation or the facilities for checking product at a BIP is considered inadequate, approval of the BIP may be withdrawn.

The Department of Agriculture and Rural Development (2006) recently published a code of practice for the importation of live animals, including cattle, into NI. This voluntary code is intended to provide all potential importers with the guidance necessary to minimise the risk of importing animal disease into NI.

6.4.3 Brazilian beef imports

Concerns have been raised about the importation of Brazilian beef in IOI and indeed the EU in general. For instance, in 2007 an Irish Farmers' Association (IFA) report expressed concerns about the risk of contamination with foot and mouth disease (FMD), hormones, traceability and movement controls, as well as environmental and social concerns (Irish Farmers' Association 2007).

Arguments in support of the continued importation of beef from Brazil cite that only FMD-free areas are used; there is adequate residue control and sufficient traceability in place; and such activities promote free trade and provide beef at a competitive price for consumers.

A number of FVO reports since 2001 have highlighted deficiencies in the control system operate by the Brazilian authorities for exports of meat to the EU (mission reports can be downloaded from the FVO website, http://ec.europa.eu/food/fvo/index_en.htm).

A Commission proposal to introduce increased restrictions and controls on imports of beef from Brazil was endorsed by the EU Standing Committee on the Food Chain and Animal Health in December 2007. Member States agreed that, from 31 January 2008, beef will only be allowed to be imported from an approved and restricted list of holdings in Brazil which are fully in line with EU import requirements and which meet strict criteria (European Commission 2007).

The animals on those approve holdings must have been kept in one of the EU approved territories for at least 90 days and must remain on the listed holdings for at least 40 days prior to slaughter. If animals from non EU-authorised territories are introducted to a listed holding, another 90-day standstill is required for all animals on that holding.

All animals on the listed holdings must be identified and registered in the national identification system for cattle. The list will be established on the basis of information to be communicated by the competent authorities in Brazil. The FVO will carry out inspections in order to verify that all EU import requirements are met.

The EU will list all holdings approved for export in the EU Trade Control Expert System (TRACES). The list of eligible holdings may be reviewed in light of the outcome of these inspections. Consignments of de-boned and matured beef (allowed to age for a period of 24 hours so that the lactic acid levels in the meat kill off any FMD virus present) which were certified and dispatched prior to the entry into force of the descision will be allowed to be imported until 15 March 2008.

The decision follows the most recent FVO inspection in November 2007, which identified a number of serious and repeated deficiencies in Brazil's animal health and traceability systems. These include non-compliance with EU requirements regarding holding registration, animal identification and movement controls for bovine animals.

Despite a series of warnings from the Commission after previous inspections, the Brazilian authorities failed to take the appropriate measures to correct these problems and to fully meet EU requirements. Therefore, the Commission felt it is necessary to increase the restrictions on Brazilian beef imports in order to maintain a high level of protection for animal health in the EU, while avoiding the alternative of an outright ban.

6.5 Product recall

The objective of a product recall is to protect public health by informing consumers of the presence on the market of a potentially hazardous foodstuff and by facilitating the efficient, rapid identification and removal of the unsafe foodstuff from the distribution chain. There are two levels of product recall:

1. *Recall – the removal of unsafe food from the distribution chain extending to food sold to the consumer, and*

2. *Withdrawal – the removal of an unsafe food from the distribution chain not extending to food sold to the consumer.*

In addition to laying down the requirements for product traceability and recall, Regulation (EC) No. 178/2002 (mentioned earlier) also established RASFF which is a notification system operated by the European Commission to exchange information on identified hazards between Member States. In each Member State there must be a single liaison contact point to deal with alerts arising within that State or issued by RASFF. The single liaison contact point for NI is the FSA (UK) and the FSAI in ROI.

Notifications of alerts are issued by the single liaison contact point within each Member State to official agencies and food businesses relating to an identified hazard and are classified as either one of two categories, "For Action" or "For Information". Action is required when there is an identified direct or indirect risk to consumers. Information alerts do not require action, but relate information concerning a food or feed product that is unlikely to pose a risk to health, e.g. inform relevant authorities of consignments blocked at border inspection posts.

The FSAI has issued a Guidance Note relating to Product Recall and Traceability (applicable only to food) and also a Code of Practice on Food Incidents and Food Alerts (FSAI 2002; 2004a). A similar guidance document on product recall and traceability has been issued by the FSA (2004).

In ROI, a "National Crisis Management Plan" was developed by the FSAI in conjunction with all of the official agencies so that a structured, coordinated and efficient response to any food safety crisis can be employed when the event arises.

The FSA in the UK set up an Incidents Taskforce in 2006 to strengthen existing controls in the food chain so as to reduce the possibility of food incidents occurring and also to improve the management of such incidents when they do occur.

One food alert was issued on IOI in 2006 pertaining specifically to beef. This alert was issued 'for information only' and concerned the recall of meat and other products by Dunbia Meats Ltd., a company based in Dungannon, Co. Tyrone. The products were recalled as an 'over thirty month' cow had entered the food chain without being tested for BSE. While the risk to consumers was extremely low, the products were however illegal under the TSE regulations and should not have entered the food chain (FSA 2006).

6.6 Quality assurance schemes

6.6.1 Introduction

The emergence of various quality assurance schemes, though not all, has arisen in response to several developments in the EU/IOI food sector, e.g. BSE, foodborne illnesses and contaminants, animal welfare and the environment, and in particular are a means of satisfying retailers in meeting their due diligence requirements in the sourcing of beef.

6.6.2 Northern Ireland

6.6.2.1 Farm Quality Assurance Scheme

The NI Beef and Lamb Farm Quality Assurance Scheme (FQAS) was established in 1991 and was the first beef assurance scheme in the UK. The scheme is concerned with giving assurances to farmers' customers (abattoirs, wholesalers, retailers and consumers) about the quality of the farm on which their beef and lamb has been produced (Livestock and Meat Commission NI 2006).

Participation in the scheme by farmers is voluntary. A specified Product Standard, which goes beyond the relevant, minimum legislation and demands 'best practice' is followed by approved producers. The Scheme's Standard (codes of practice) and Rules are drawn up by a Technical Committee comprised of producer and processor representatives, the Livestock and Meat Commission (a non-departmental public body), and Government. There are seven main elements to the Scheme's Product Standard –animal husbandry; stockmanship and welfare; animal health; animal nutrition; animal traceability – identification; sourcing and records; housing and handling; transport; and environmental care.

Producers are regularly inspected by an independent Product Certification Body to ensure that they conform to the standard. The certification body is accredited by the United Kingdom Accreditation Service to the European Procedures Standard EN45011. Farm inspection takes place every 18 months so that it alternates between summer grazing and winter housing to cover all aspects of production. These inspections are by appointment but random spot checks are conducted on ten percent of approved farms each year. Animal feed and urine is sampled on-farm and tested for residues. This procedure ensures that only those producers who fully comply with every individual code of practice of the standard are approved.

Non-conformances are dealt with firmly – in the first instance the farmer is usually given a month after the farm inspection to take any remedial action – failure to produce evidence that this has been done will lead to suspension from the scheme. Monitoring of the delivery of standards between inspections is assisted by the Department of Agriculture and Rural Development who reports to the certification body any individual pollution incidents, delays in disease testing, drug residue detections and convictions for various offences. Overall performance of the scheme, in terms of the incidence of non-conformances, is monitored on a monthly basis by the scheme manager. Reports are produced to show longer term improvements in the farm practices of assured producers.

Meat plants in NI must in addition comply with a voluntary Processor Standard (Livestock and Meat Commission NI 2003) in order to be entitled to maintain the description "Northern Ireland Farm Quality Assured" on their products supplied into the food chain.

In addition to a quality assurance scheme for farms, all NI beef abattoirs participate in the Assured British Meat Abattoir Assurance Scheme. This is a required condition for participation by the plants in FQAS and for the use of the FQAS logo and description "Farm Assured" by plants.

In 2006, the proportion of NI FQAS beef reached 87 percent of the total prime kill. This is driven by the fact that all ten prime beef slaughtering companies are now participating as processor members (Northern Ireland Beef and Lamb Quality Assurance Scheme, Personal Communication, January 2008).

6.6.3 Republic of Ireland

6.6.3.1 National Beef Assurance Scheme

Following the BSE crisis in 1996, measures were adopted to tighten up the conditions of production and processing of cattle and beef in ROI and to provide assurances to consumers and buyers as to the safety of cattle and beef from ROI. Notwithstanding this, it was considered that further measures were necessary to allay consumer concerns and to safeguard markets at home and abroad for beef and beef products from ROI. Accordingly, the National Beef Assurance Scheme Act, 2000 providing for the implementation of a National Beef Assurance Scheme was enacted into national law (Department of Agriculture, Fisheries and Food 2003b).

The purpose of the Scheme is to provide additional guarantees about the safety of cattle and beef from ROI by:

- *The development of common high standards of production and processing according to legal requirements;*
- *The enforcement of these standards through a process of registration, inspection and approval; and*
- *The enhancement of the animal identification and tracing system.*

The Scheme applies to all persons engaged in the primary production and processing of cattle and beef (farmers, marts or assembly centres, dealers, live exporters, slaughterhouses, meat processors and bovine animal feed manufacturers). The Scheme also introduces special measures for food businesses regarding the supply of primary product to these premises.

The combination of the measures introduced under the National Beef Assurance Scheme and the legislative requirements already in force in relation to food hygiene provide assurances in relation to cattle and beef across the entire food chain in ROI.

Under the Act, only persons meeting the prescribed standards will be approved to participate in the cattle, beef and feedingstuffs industry. These standards, which are set out in the Second Schedule of the Act, are already contained in existing legislation for the most part. However, there is also provision under the Act for the making of regulations to address gaps in this legislation, for example tampering with or falsification of ear-tags and animal identity cards/passports.

The Act provides for the mandatory inspection, approval and registration of all participants. As it was envisaged that it would take some time to complete this process, the Act provided for transitional measures under which all participants are deemed to be provisionally approved until they have been either granted or refused approval by the Minister. Following detailed discussions over a long period of time, arrangements were put in place to commence implementation of this aspect of the Scheme with the inspection and approval of farms to coincide with the annual disease test of herds. However, only a small number of inspections took place as the Union representing veterinarians refused to co-operate unless they were paid centrally for the cost of the inspections. Discussions are continuing to resolve this impasse (Department of Agriculture, Fisheries and Food 2003b).

A comprehensive system of animal identification is already in place for cattle on ROI (as discussed in Section 6.2.3). The National Beef Assurance Scheme provides for the enhancement of the animal identification and tracing system, including the use of the system to validate the origin, and identity of animals before they enter the human food chain. This aspect of the Scheme is being implemented (Department of Agriculture, Fisheries and Food 2003a).

6.6.3.2 Bord Bia Quality Assurance Scheme

While the National Beef Assurance Scheme ensures that legislation is being met, Bord Bia developed the Beef Quality Assurance Scheme (BQAS) to enable beef plants meet the ever increasing demands of customers and consumers. The scheme is kept under review to ensure that it continues to reflect the emerging requirements of the marketplace. It was developed by an expert group representing Bord Bia, Teagasc, the FSAI, the beef industry (Producers and Processors), Industry Advisors and the Department of Agriculture, Fisheries and Food (Bord Bia 2007).

There are two standards, one lays down the requirements for producers (Bord Bia 2004a) while the other lays down the requirements for processors wishing to participate in the scheme (Bord Bia 2004b). They replaced the previous revisions (number 02) issued in 1995.

The BQAS is an integrated scheme involving the farmer, the beef plant and participating customers. While quality and safety must begin at farm level the beef plant acts as the pivotal basis of control. The beef plant, as both the purchaser of cattle and the seller of the product, is uniquely placed to marry both the supply and demand links and, in addition, also has the core expertise and facilities to demonstrate compliance through audit. Because of its central role the beef plant can ensure that cattle are purchased only from approved farmers and at the same time can ensure that the product does not lose quality during subsequent handling, storage and despatch.

Given that quality and safety can never be inspected into beef, the controls must begin on the farm. Farmers who participate in the scheme must:

- *Give a signed declaration.*
- *Agree to abide by a code of practice covering issues like stockmanship, welfare, nutrition, use of veterinary medicines, animal traceability and environmental controls.*
- *Allow a detailed farm inspection first by a trained meat plant inspector and subsequently on a random basis as part of Bord Bia's overall audit of compliance with the requirements of the scheme.*

Within the beef plant, the scheme lays down a number of key essential requirements covering both product and process. For example, cow beef is not eligible; only certain classification categories can be included; there are procedures covering hygiene, chilling, and product traceability along the production chain. Member plants must also develop a food safety management plan based on the principles of Hazard Analysis and Criteria Control Points (HACCP).

Control of the scheme is via independent plant audits (including random farm inspections) which are routinely carried out. Plants that meet the requirements of the quality assurance scheme are entitled to use the quality assured logo on produce, packing and/or point of sale materials.

There are currently 35 plants registered as approved members of the beef quality assurance scheme. These are categorised as follows: slaughter and cutting plants, 21; cutting plants, 11; and slaughter only plants, 3 (Bord Bia 2007).

Only products that are derived from fresh meat that has undergone no treatment other than refrigeration (chilling or freezing) are eligible for inclusion in the scheme.

6.7 Training

All food business operators must ensure that food handlers are supervised and instructed and/or trained in food hygiene matters commensurate with their work activity. This is in accordance with Chapter XII Annex II of EC Regulation 852/2004 on the hygiene of foodstuffs. Meeting this requirement is about having the necessary skills to do the job. There is no legal requirement to attend a formal training course or obtain a qualification; although many businesses may want their staff to do so. The necessary skills may also be obtained in other ways, such as through on-the-job training, self-study or relevant prior experience.

Training is a major focal point in quality assurance schemes on the island, and also in quality standards such as British Retail Consortium, EFSIS (European Food Safety Inspection Service) and ISO 22000.

6.7.1 Northern Ireland

In NI, guidance in relation to food hygiene instruction/training/supervision has been issued by the Department of Health UK (1995a; 1995b) and the Local Authorities Coordinators of Regulatory Services (LACORS 2006).

6.7.2 Republic of Ireland

The FSAI (2000) has a clearly defined food safety training policy. It established the Food Safety Training Council (FSTC), which comprises representatives from education and training, the food industry, and inspectors from the official agencies with responsibility for food safety, such as health boards and local authorities. The FSTC advises the FSAI on the contribution to food safety through training; levels of skills required for best practice in food safety; and guidelines for assessing the impact of food safety training in the work environment. The Authority, with input from the FSTC, has set training standards for the foodservice, retail, and manufacturing sectors. These standards are outlined in a series of food safety training guides covering three levels of skills: induction, additional, and for management.

They have also published a Guidance Note on the Inspection of Food Safety Training and Competence (FSAI 2003b). The purpose of this document is to establish a consistent approach to the inspection of the training and competence of operational staff dealing with food, and the provision of advice to food businesses in relation to training. In conjunction with this, they have developed a number of training programmes including:

1. *'Domestic Abattoir Training Programme' for workers in all domestic meat abattoirs.*

2. *'Food Safety and You', induction training programme for new staff in the food service industry. This programme is available in eight languages including Lithuanian, Latvian, Mandarin, Polish Portuguese, Romanian, Spanish and English.*

3. *'Food Safety Training for Management in the Chinese Food Sector' specifically for staff in Chinese food restaurants and takeaways.*

Industry has also taken a lead in the training of staff. IBEC (Irish Business and Employers Confederation) has initiated a programme through European Social Fund funding, in conjunction with FÁS, aimed at training workers in the meat sector (FÁS 2005) as well as a web-based foundation course for food handlers.

6.8 Organic production

6.8.1 Introduction

'Organic' is a term used to describe a particular method of production at farm level, and is as such a 'process claim' rather than a 'product claim'. Organic food constitutes a relatively small but growing part of the food supply chain on IOI.

Organic produce must be produced in accordance with the standard practices set out by the European Council Regulation 2092/91 as amended and monitored by certifying bodies in each country (Appendix F). Claims for organic farming include consideration and application of production methods that do not damage the environment; concern for animal welfare; sustainability; and the production of high quality goods.

Organic farming avoids the use of synthetic fertilisers, chemicals and/or additives. Produce which has been produced by genetic modification or contains any such produce cannot be considered organic. This is also the case for produce that has been treated with ionising radiation.

The organic sector on IOI is regulated by the Department of Agriculture, Fisheries and Food (ROI) and the Department of Agriculture and Rural Development (NI). Farmers, growers, processors and importers have to undergo a stringent annual inspection process before receiving a licence from one of the certification bodies to sell their produce as organic. All food produced to these standards is permitted to be labelled with the word "organic".

6.8.2 Production requirements

The EU's rules pertaining to organic beef relate to the time the animal must spend in the fattening phase (a minimum of 12 months) and what it is fed, a maximum of pasture and, for young animals, natural milk, preferably from its own mother. The rules encourage rearing practices that safeguard the health and welfare of the animals. Animals must be allowed to circulate freely, ensuring they get plenty of exercise. While density is low, the animals are kept in groups, in respect of their natural preference.

The treatment of illnesses should within reason rely on natural substances (phototherapeutics and homeopathic products), and the use of growth-promoting hormones is categorically prohibited. Surgical operations, such as the removal of horns, must be limited to those which are essential to the animal's well-being.

Checks are carried out by an appointed public authority or by an inspection body recognised in each Member State to ensure that standards are being met. They span the entire production process from the farming to the labelling stage, including every aspect of processing and packaging.

6.8.3 Labelling requirements

EC Regulation 2092/91 (as amended) also governs the marketing of organic produce and includes requirements on labelling of products at the point of sale. An organic product produced according to EU regulations, should bear the indication 'organic' on the labelling, advertising material or commercial documents. Packaged organic food must indicate the name and/or code number of the organic certification body. The name and address of the producer/other must also be included. Organic products imported from Third Countries must be produced in conformity to EU standards.

6.8.4 Authenticity

While the farming systems can differ substantially, it is difficult to distinguish between the end products of organic faming and their conventionally produced counterparts. There is no recognised scientific test to differentiate between organic and conventional produce. However, the presence of certain pesticide residues, growth promoters or genetically modified material in a food product could indicate that the food was not produced to organic standards, which would prohibit it from being labelled organic.

6.8.5 Food safety and nutrition aspects of organic produce

The question of whether organic food is significantly different to conventional food with respect to nutritional content or safety is still a matter of public and scientific debate, with published literature supporting both sides of the argument (Bonti-Ankomah and Yiridoe 2006). However, while the nutritional composition and quality of foods can be influenced by the farming system used, other factors can also have an effect. These factors include variations in plant or animal varieties, climatic conditions, prevailing soil types and farming practices such as irrigation, crop rotation and fertilising regimes (FSAI 2004b).

Organic foods are subject to the same stringent food safety regulations as all food consumed, distributed, marketed or produced on IOI and as such are considered as safe as any other food on the market.

6.9 Animal welfare

Animal welfare legislation protects all animals that interact with humans. Staff from the Veterinary Public Health Service of the Department of Agriculture, Fisheries and Food (ROI) and the Veterinary Service of the Department of Agriculture and Rural Development (NI) monitor and enforce animal welfare regulations during their regular farm visits.

Currently EU farmers must follow the general requirements of Directive 98/58/EC, which governs the welfare of farm animals and also the legislation and codes of practice in the countries in which they are based. In the UK the Department of the Environment, Food and Rural Affairs (2003) issued a code of recommendations on the welfare of cattle.

In January 2006, the European Commission adopted the Community Action Plan on the Protection and Welfare of Animals (European Commission 2006). This Action Plan includes a five-year legislative work plan (2006 to 2010) that outlines EU policy initiatives for implementing animal welfare principles in all EU sectors and in relations with Third Countries.

The Action Plan provides initiatives in five broad areas of animal welfare, namely:

- *Upgrading minimum standards for animal protection and welfare;*
- *Giving high priority to promoting policy-oriented research and the application of the "three Rs" principle (Replacement, Reduction and Refinement of the use of animals in experiments) to animal testing;*
- *Introducing standardised animal welfare indicators;*
- *Ensuring animal handlers and the general public are more involved and informed on animal welfare issues; and*
- *Supporting and initiating further international initiatives to raise awareness of, and create greater consensus on, animal welfare.*

Directive 91/628/EEC stipulates welfare conditions for the transport of animals and the departments of agriculture in each jurisdiction monitor compliance through non-discriminatory checks. Compliance with legislation on the transit of animals is ensured through specific roadside checks. Animal transporters in NI must comply with the Welfare of Animals (Transport) Order (NI) 1997.

The EU adopted detailed welfare rules at slaughter in 1993 which are set down in Directive 93/119/EC on the protection of animals at the time of slaughter or killing and implemented in ROI by the European Communities (Protection for Animals at Time of Slaughter) Regulations, 1995 (S.I. No. 114 of 1995) and in NI by the Welfare of Animals (Slaughter or Killing) Regulations (NI) 1996, as amended. Implementation of the Directive is the responsibility of both departments of agriculture, through Officials Veterinarians Inspectors (OVs) in NI and VIs in ROI.

Guidelines on animal welfare for beef cattle farmers have been published by Teagasc in ROI (Fallon, Earley et al. 2003).

6.10 Foot and mouth disease

Foot and mouth disease has no implications for the human food chain (Prempeh, Smith et al. 2001). While bovine foot and mouth disease is transmissible to humans, it crosses the species barrier with difficulty and with little effect (Bauer 1997). This is borne out by the low incidence in humans recorded during past outbreaks (Armstrong, Davie et al. 1967), some of which reached epidemic proportions among livestock.

7. Conclusions

7.1 Introduction

Nutritionally, beef is a nutrient dense food high in protein, B vitamins and zinc. It is also the principal source of bioavailable iron in the diet. Nevertheless, beef is often considered negatively and several studies have shown a link between a diet rich in meat to diseases such as cardiovascular disease and cancer. However, these studies made no differentiation between leaner and fattier cuts of meat or processed and unprocessed meat. More recent data has shown that the overall balance of food groups in the diet is more important than just looking at meat intake alone in predicting disease risk.

As with other foods beef is a rich medium for the growth of bacteria and general food safety and hygiene messages apply when handling raw meat. Of particular significance to beef is the organism *E. coli* and specifically Verocytotoxigenic (VTEC) O157:H7. This organism is particularly virulent and the causative agent of several large scale outbreaks in the UK and US. Infection can result in long lasting health effects and sometimes death in vulnerable groups. As a result of these outbreaks the foci for change to control this organism has been at the farm and slaughter house level. To date there have been no outbreaks of VTEC 0157:H7 on the island of Ireland (IOI).

Similarly the emergence of Bovine Spongiform Encephalapathy (BSE) in the mid 1990s forced a major re-think of animal production methods. Since 1987 there have been 2,136 cases of BSE in NI and 1,552 cases in ROI. In 1996 a link was established and subsequently confirmed between the consumption of BSE infected beef and the development of a new disease, new variant Creutzfeldt-Jakob disease (CJD). As of January 2007, there have been four cases (including one mortality) of variant CJD (vCJD) in ROI, and three cases in NI (two of whom have died).

The age of infected animals has increased year on year suggesting no new infections in cattle born since 1996 following the ban on meat and bone meal (MBM).

The consequence of these developments was a dramatic drop in confidence and lack of trust in the beef food chain. To some extent the 2001 foot and mouth outbreak, although not a food safety issue, further undermined consumer confidence. Nevertheless, since then economic data shows that sales have increased and ***safe*food** consumer research indicates that most of the consumer trust lost has been regained and that beef is most definitely back on the menu.

This review collates and considers the information available in the public domain (regulatory and scientific) on the health and food safety implications of the beef food chain. On the basis of the evidence the review highlights a number of issues for stakeholders in the beef food chain, including producers, processors and distributors, as well as retailers, consumers and public health professionals.

7.2 Conclusions

7.2.1 Primary producers and processors

The legacy of BSE has led to positive developments such as the establishment of national food safety bodies such as the Food Safety Authority of Ireland (FSAI) and Food Standards Agency (FSA) as well as enhanced monitoring and traceability systems. Apart from occasional individual cases this disease is now under control and restrictions such as the Over Thirty Month (OTM) rule rescinded, thus restoring consumer confidence in the food chain.

Similarly, outbreaks of VTEC O157 have resulted in a review of best practices and regulations governing the beef food chain, particularly at the farm and slaughter areas. While this and other VTEC organisms in the food chain still pose a threat, there is an increased recognition that other environmental factors, such as water, are significant sources of contamination.

Overall, the primary production and processing aspects of the food chain are well controlled and regulated. Nevertheless, it is essential that meat processors take appropriate measures to ensure that the contamination of raw meat with VTEC and other pathogens is minimised. This can be facilitated by:

- *Ensuring cattle are clean when presented for slaughter;*
- *By strictly controlling manufacturing systems; and*
- *By considering the potential additional safeguards offered by carcass bacterial decontamination procedures.*

7.2.2 Distributors

- *It is essential and indeed a legal requirement, that the chill chain is maintained throughout the food chain.*
- *Traceability is also an essential feature of the beef supply chain and food business operators have a legal responsibility in this area.*

7.2.3 Retailers and caterers

- *The retailer and caterer represent the front line of the food industry to consumers. Food business operators have a legal responsibility in ensuring food safety.*
- *Worker hygiene and hygienic practices are legal requirements and are central in the prevention of cross-contamination.*
- *HACCP and training are at the core of good food safety practice. The increasing numbers of non-English speaking employees in the food chain has put even more emphasis on the need for training in the medium of their native languages.*
- *Cross-contamination of raw and cooked foods should be avoided and separate utensils and chopping boards used.*
- *Minced meat, burgers, rolled meats and kebabs should always be cooked al, the way through until well done. Customers should not be given the option.*
- *Adherence to food safety regulations can be promoted as a business asset.*
- *When cooking and serving beef, where possible visible fat should be removed and low fat cooking methods and sauces/accompaniments used.*

7.2.4 Consumers

- *Beef is a nutritious food and should not be overlooked as an excellent source of iron, particularly by young women and children.*
- *The consumption of lean red meat in association with fruit and vegetables and wholegrains, has been shown to have a positive effect on cardiovascular health. The addition of vegetables to a beef dish also has a positive effect on the mineral and vitamin content. It is important to promote and support a balanced diet encompassing all the food groups.*

- *When choosing cuts of beef, choose fresh unprocessed cuts and where possible lean cuts or trim the fat following purchase.*

- *Children consume most of their meat intake as processed meats, which tend to be higher in salt and fat and lower in nutrients compared to lean meat. Furthermore, inadequate intakes of fresh, unprocessed, lean meat negatively impacts on the iron status of young children. Healthy eating messages for children should promote the consumption of lean beef and composite dishes, as well as encouraging increased consumption of fruit and vegetables.*

- *The addition of ingredients such as creams and sauces can alter the nutritional profile of a dish in terms of increased fat, salt and calories.*

- *Cooking methods, such as grilling, dry frying and stir-frying should be chosen. When roasting, cuts should be placed on a rack to allow the juices to drip onto a tray below.*

- *Portion size control is important. Evidence suggests that beef is consumed in larger portion sizes than other meats. The recommended portion size for beef is approximately 57g (2oz). It is advised that people who eat red meat should consume less than 500g (approximately 17.5oz; cooked) a week, very little if any to be processed*

- *Consumers should be advised with respect to the correct handling, storage and preparation of foods. This extends to steps taken to eliminate the potential risk of cross-contamination from raw to ready-to-eat foods. Consumer research suggested that consumers were confident about how beef and beef products should be cooked; however, consumers should be reminded that:*

    - *All surfaces, including hands and utensils, should be cleaned to prevent cross-contamination. Beef, both raw and cooked, should be stored in a refrigerator at less than 5°C.*

    - *Growth of pathogenic bacteria can occur if the cold chain is not maintained during transport to the home. Raw meat should be packed in separate bags or containers away from other foods, particularly ready-to-eat foods, to avoid potential cross-contamination. The use of insulated bags or freezer bags is recommended during transportation. Food should be refrigerated or frozen as soon as possible following purchase.*

    - *Frozen meat must be fully defrosted before cooking. The safest way to do so is in the fridge. It should be placed on the bottom shelf on a plate or tray to prevent juices from dripping onto any other foods.*

    - *Whole cuts of beef, such as roast beef and steaks can be cooked to preference (i.e. rare) as long as they are cooked on the outside; however, minced beef products such as beef burgers, rolled meats and kebabs, should be thoroughly cooked and never served rare or pink in the middle. Vulnerable people, including older people, babies and toddlers, pregnant women and people who are unwell, should avoid eating beef that is rare or pink.*

    - *To check that minced or comminuted meats are cooked properly, cut into the middle with a clean knife and check that it is piping hot all the way through (steaming), there is no pink meat left and that the juices run clear.*

Appendices

Appendix A: Specified risk material in cattle from June 2006

Age	Parts classified as SRM
All ages	The tonsils, the intestines, from the duodenum to the rectum and the mesentery.
Over 12 months	Skull excluding the mandible but including the brains and eyes and spinal cord.
Over 24 months	The vertebral column, including the dorsal root ganglia, but excluding the vertebrae of the tail, the spinous and transverse processes of the cervical, thoracic and lumbar vertebrae, the median sacral crest and the wings of the sacrum.

Source: Department of Agriculture and Rural Development (2006)

Appendix B: Results of the national residue monitoring programme in ROI from 2003 to 2005

Chemical group	Bovine samples analysed			Positive samples		
	2005	2004	2003	2005	2004	2003
Group A - (Prohibited Substances) Substances having anabolic effect and unauthorised substances						
Stilbenes, stilbene derivatives and their salts and esters	291	266	195	0	0	0
Antithyroid agents	254	238	235	0	0	0
Steroids	2,083	1,711	1,501	0	0	0
Resorcylic acid lactones including zeranol	496	383	354	0	0	0
Beta-agonists	1,416	1,350	1,423	0	0	0
Substances which are prohibited and for which no MRL could be established	870	652	426	6	0	11
Total analysed	**5,383**	**4,600**	**4,134**	**6**	**0**	**11**
Group B - Veterinary Drugs and Contaminants: B1 - Antibacterial substances, including sulphonomides, quinolones*						
Antibacterial substances, including sulphonomides, quinolones	4,780	4,063	4,001	35	66	26

Chemical group	Beef samples analysed			Positive samples		
	2005	2004	2003	2005	2004	2003
Group B - Veterinary Drugs and Contaminants: B2 - Other veterinary drugs						
Anthelminitics	597	559	519	0	0	0
Anticoccidials, including nitroimidazoles	113	105	87	0	0	0
Carbamates and pyrethroids	97	75	63	0	0	0
Sedatives	36	31	24	0	0	0
Non-steroidal anti-inflammatory drugs	157	125	49	1	0	0
Other pharmacologically active substances	153	75	0	0	0	0
Total analysed	1,153	970	742	1	0	0
Group B - Veterinary Drugs and Contaminants: B3 - Other substances and environmental contaminants						
Organochlorine compounds	62	75	94	0	0	0
Organophosphorus compounds	59	57	31	0	0	0
Chemical elements	141	138	126	0	0	0
Mycotoxins	31	33	25	0	0	0
Total analysed	293	303	276	0	0	0
Overall total analyses	**11,309**	**9,936**	**9,153**	**42**	**66**	**37**

Note: * Includes samples taken under joint Food Safety Authority of Ireland/Department of Agriculture, Fisheries and Food programme
Source: Department of Agriculture, Fisheries and Food (2004, 2005, 2006)

Appendix C: EU legislation concerning the authorisation of different additives for use in the manufacture of animal feed

- *Council Regulation (EEC) No 2377/90 of 26 June 1990 laying down a Community procedure for the establishment of maximum residue limits of veterinary medicinal products in foodstuffs of animal origin (OJ L 224, 18.8.1990, p. 1)*
- *Council Directive of 23 November 1970 concerning additives in feeding-stuffs (70/524/EEC) (OJ L 270, 14.12.1970, p. 1)*
- *Council Directive of 30 June 1983 concerning certain products used in animal nutrition (82/471/EEC) (OJ No L 213, 21.7.1982, p. 8)*
- *Council Directive of 16 February 1987 fixing guidelines for the assessment of additives in animal nutrition (87/153/EEC) (OJ L 64, 7.3.1987, p. 19)*
- *Commission Directive 94/40/EC of 22 July 1994 amending Council Directive 87/153/EEC fixing guidelines for the assessment of additives in animal nutrition (OJ No. L 208, 11.08.1994, p. 15)*
- *Commission Directive 95/11/EC of 4 May 1995 amending Council Directive 87/153/EEC fixing guidelines for the assessment of additives in animal nutrition (OJ No. L 106, 11.05.1995, p. 23)*

Appendix D: Nutrient content of selected beef products and dishes (per 100g)

Type of Beef	Energy (Kcal)	Energy (KJ)	Protein (g)	Fat (g)	Satu-rated fat (g)	Iron (mg)	Zinc (mg)	So-dium (mg)
Beef, braising steak, raw, lean	139	582	21.8	5.7	2.4	1.5	6	64
Beef, braising steak, raw, lean & fat	160	670	20.7	8.6	3.8	1.4	5.6	60
Beef, braising steak, braised, lean	225	944	34.4	9.7	4.1	2.7	9.5	62
Beef, braising steak, braised, lean & fat	246	1029	32.9	12.7	5.3	2.6	8.7	60
Beef brisket, raw, lean	139	584	21.1	6.1	2.5	1.7	3.4	59
Beef brisket, raw, lean & fat	218	905	18.4	16	6.7	1.5	2.9	50
Beef, fillet steak, raw, lean	140	586	21.2	6.1	2.8	2.1	2.8	44
Beef, fillet steak, raw, lean & fat	155	648	20.9	7.9	3.8	2	2.7	43
Beef, fillet steak, fried, lean	184	772	28.2	7.9	3.4	2.3	5.1	68
Beef, fillet steak, fried, lean & fat	192	805	28	8.9	3.9	2.3	5	67
Beef, fillet steak, grilled, lean	188	791	29.1	8	3.6	2.3	5.2	70
Beef, fillet steak, grilled, lean & fat	200	839	28.7	9.5	4.4	2.3	5.1	67
Beef, fore rib/rib-roast, raw, lean	145	606	21.5	6.5	2.9	1.7	3.5	61
Beef, fore rib/rib-roast, raw, lean & fat	253	1052	18.8	19.8	8.9	1.5	2.9	52
Beef, fore-rib/rib-roast, roasted, lean	236	988	33.3	11.4	5.1	2	7.4	57
Beef, fore-rib/rib-roast, roasted, lean & fat	300	1250	29.1	20.4	9.2	1.8	6.1	54
Beef, mince, raw	225	934	19.7	16.2	6.9	1.4	3.9	80
Beef, mince, micro-waved	263	1096	26.4	17.5	7.6	2	5.2	91
Beef, minced, stewed	209	870	21.8	13.5	5.9	2.2	5	73
Beef, mince, extra lean, stewed	177	742	24.7	8.7	3.8	2.3	5.6	75
Beef, rump steak, raw, lean	125	526	22	4.1	1.7	2.1	3.8	60
Beef, rump steak, raw, lean & fat	174	726	20.7	10.1	4.3	2.7	3.5	56
Beef, rump steak, barbequed, lean	176	741	31.2	5.7	2.4	3.2	5.1	78
Beef, rump steak, barbequed, lean & fat	203	849	29.5	9.4	4	3	4.8	74
Beef, rump steak, fried, lean	183	770	30.9	6.6	2.5	3	5.2	78
Beef, rump steak, fried, lean & fat	228	953	28.4	12.7	4.9	2.7	4.7	71
Beef, rump steak, grilled, lean	177	745	31	5.9	2.5	2.5	5.6	74
Beef, rump steak, strips, stir fried, lean	208	875	32.3	8.8	3.3	2.6	5.8	78
Beef, rump steak, strips, stir fried, lean & fat	248	1038	29.7	14.4	5.6	2.4	5.2	71

Type of Beef	Energy (Kcal)	Energy (KJ)	Protein (g)	Fat (g)	Satu-rated fat (g)	Iron (mg)	Zinc (mg)	So-dium (mg)
Beef, silverside, raw, lean	134	564	23.8	4.3	1.6	2	3.8	62
Beef, silverside, raw, lean & fat	215	894	20.4	14.8	5.9	1.7	3.2	53
Beef, silverside, pot-roasted, lean	193	811	34	6.3	2.5	2.8	5.2	58
Beef, silverside, pot-roasted, lean & fat	247	1034	31	13.7	5.6	2.5	4.6	54
Beef, sirloin steak, raw, lean	135	566	23.5	4.5	2	1.6	4	70
Beef, sirloin steak, raw, lean & fat	201	837	21.6	12.7	5.6	1.5	3.5	62
Beef, sirloin steak, grilled, rare, lean	166	697	26.4	6.7	3	2.1	4.8	63
Beef, sirloin steak, grilled, rare, lean & fat	216	900	25.1	12.8	5.8	2	4.3	60
Beef, sirloin steak, grilled, medium-rare, lean	176	737	26.6	7.7	3.4	1.4	4.3	65
Beef, sirloin steak, grilled, medium-rare, lean & fat	213	888	24.8	12.6	5.6	1.3	3.9	60
Beef, sirloin steak, grilled, well-done, lean	225	943	33.9	9.9	4.4	2.7	6.1	81
Beef, sirloin steak, grilled, well-done, lean & fat	257	1073	31.8	14.4	6.5	2.5	5.5	76
Beef, topside, raw, lean	116	491	23.0	2.7	1.1	1.9	4	77
Beef, topside, raw, lean & fat	198	824	20.4	12.9	5.4	1.7	3.5	67
Beef, topside, roasted, medium-rare, lean	175	736	32.2	5.1	2.1	2.5	5.6	66
Beef, topside, roasted, medium-rare, lean & fat	222	930	29.9	11.4	4.8	2.3	5.1	62
Beef, topside, roasted, well-done, lean	202	849	36.2	6.3	2.6	2.9	6.5	62
Beef, topside, roasted, well-done, lean & fat	244	1020	32.8	12.5	5.2	2.6	5.8	57
Beefburgers, fried	329	1370	28.5	23.9	10.7	2.8	6.3	470
Beefburgers, grilled	326	1355	26.5	24.4	10.9	2.5	6.1	400
Corned Beef	205	860	25.9	10.9	5.7	2.4	5.5	860
Steak and Kidney pie, individual	310	1295	8.8	19.4	8.4	1.3	1.4	460
Beef Casserole, made with canned cook-in-sauce	136	570	15.1	6.5	2.7	1.2	4.0	557
Beef curry, chilled, frozen and reheated	137	575	13.5	6.6	3.1	N	N	540
Beef Stew	107	449	12.0	4.6	1.5	1.2	2.7	357
Beef, stir fried with green vegetables	141	509	11.8	8.0	2.7	1.9	2.0	319

Source: Food Standards Agency (2002)

Appendix E: Mean daily intakes (g) of meat† in Irish men and women consumers

	Total population (n=958)						Men (n=475)						Women (n=483)						
	%	Mean	SD	Percentile			%	Mean	SD	Percentile			%	Mean	SD	Percentile			
				5	50	95				5	50	95				5	50	95	**
Bacon and ham	92	33.0	27	5	26	87	93	42.1	32	6	35	104	90	23.7	18	3	19	59	**
Beef	80	39.1	32	6	31	91	86	46.8	38	7	37	116	74	30.5	22	6	25	73	**
Lamb	38	22.8	19	6	16	60	41	28.1	22	6	21	72	36	16.9	13	6	13	39	**
Pork	42	26.9	20	6	24	66	46	30.6	24	7	24	73	39	22.7	15	5	20	52	**
Poultry	89	36.7	27	6	31	88	87	41.3	30	7	36	99	91	32.4	22	6	29	74	**
Offal	8	13.6	11	3	11	46	7	15.3	14	3	10	55	9	12.2	9	2	11	32	NS
Burger	27	12.7	9	4	10	32	32	14.0	10	5	11	34	22	10.8	7	4	9	35	*
Sausage	64	16.1	13	4	11	41	71	19.6	14	4	15	49	57	11.7	9	3	9	29	**
Meat products	30	10.0	9	1	8	30	35	12.0	10	2	9	36	25	7.4	6	1	5	18	**
Total meat	**99**	**134.3**	**65**	**50**	**121**	**256**	**98**	**167.9**	**69**	**76**	**159**	**295**	**99**	**101.6**	**41**	**40**	**98**	**180**	**

Note: SD – standard deviation

† Includes only the meat components of composite foods that contained meat

Differences between men and women using independent t-tests: * p<0.01; **p<0.001; NS, not significant

Source: Cosgrove, Flynn et al. (2005)

Appendix F: Organic certification bodies on IOI

The Department of Agriculture, Fisheries and Food in ROI has approved three organic organisations for certification and inspection services, namely:

- *Bio-dynamic Agricultural Association of Ireland ("Demeter");*
- *Irish Organic Farmers and Growers Association (IOFGA), and*
- *Organic Trust Ltd.*

The Department of Agriculture and Rural Development in NI has approved three organic organisations in addition to the above:

- *Soil Association;*
- *Organic Farmers and Growers, and*
- *Organic Food Federation.*

Glossary

Acceptable daily intake
The amount a particular chemical in food which, based on all facts known at the time, is thought not to present any possibility for adverse health effects if ingested daily over a lifetime.

Average Requirement
This is an estimate of the average requirement for energy or a nutrient - approximately 50% of a group of people will require less, and 50% will require more. It is a value two standards deviations below the average requirement.

Bull
A male.

Carcass Weight Equivalent
The weight of meat cuts and meat products converted to an equivalent weight of a dressed carcass. Includes bone, fat, tendons, ligaments, and inedible trimmings (whereas product weight may or may not).

Cattle
Large farm animals kept for their milk or meat; cows and bulls (beef or dairy cattle).

Cow
A large female farm animal kept to produce meat (beef cow) and milk (dairy cow).

Dam
Breeding female.

Heifer
A young cow, particularly one that has not yet given birth to a calf.

Lower reference intake
The amount of a nutrient that is enough for only the small number of people who have low requirements (2.5%). The majority needs me. It is a value tow standard deviations below the average requirement.

Maximum residue level
The maximum permissible concentration of a residue in a food, agricultural or animal feed commodity as a result of permitted agricultural or veterinary chemical usage. An MRL is not a toxicological limit and a violation is not necessarily a cause of concern for public or animal health.

Prion
An 'infectious protein' associated with degenerative neurological diseases of animals and man, including BSE and CJD.

Pschrotrophic
Term used to describe a microorganism that can survive and grow at low temperatures, but grows optimally between 15 and 20°c.

Ruminant animals
Animals, such as cattle, that have four chambered stomachs which enables cellulose digestion.

Steer
A young male of the cattle family that has had its sex organs removed, and which is usually kept for meat.

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