Consumer Focused Review of the Pork Supply Chain 2008

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Abbreviations

CVD	Cardiovascular disease
CWE	Carcass weight equivalent
DAFF	Department of Agriculture, Fisheries and Food
DDT	Dichloro-diphenyl-trichloroethane
EFSA	European Food Safety Authority
ELISA	Enzyme Linked ImmunoSorbent Assay
EU-15	Belgium, France, Italy, Luxembourg, Netherlands, Denmark, Ireland, UK, Germany, Spain, Portugal, Austria, Finland, Sweden and Greece
EU-25	EU-15 plus Cyprus, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Malta, Poland, Slovakia and Slovenia
EU-27	EU-25 plus Bulgaria and Romania
FSA	Food Standards Agency
FSAI	Food Safety Authority of Ireland
FTE	Full-time equivalent
HACCP	Hazard Analysis and Critical Control Point
HHP	High hydrostatic pressure
IOI	Island of Ireland
JECFA	Joint FAO/WHO Expert Committee on Food Additives
MUFA	Monounsaturated Fatty Acids
NI	Northern Ireland
NRMP	National Residue Monitoring Programme
PCBs	Polychlorinated biphenyls

PBDEs	Polybrominated diphenylethers
PUFA	Polyunsaturated fatty acid
PWE	Product weight equivalent
ROI	Republic of Ireland
SFA	Saturated fatty acid
WHO	World Health Organisation
ZAP	Zoonoses Action Plan

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Executive Summary

In 2005 ***safe*food** initiated a programme which involved 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 stages 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.

In order to ascertain consumer attitudes and behaviour to pork and pork products, ***safe*food** conducted both quantitative and qualitative research. Eighty five percent of consumers interviewed during qualitative research on the island of Ireland (IOI) (n=796) consumed pork and/or pork products such as ham, bacon and sausages. Consumption of pork was found to be marginally higher in Northern Ireland (NI) than in the Republic of Ireland (ROI) at 89 percent versus 83 percent and highest among males (89 percent). Almost one in five females (19 percent) claimed not to eat any pork products. Sausages and sliced ham were the most commonly eaten meats every day, but almost all pork meats and pork products were consumed at least once a week. When those who did not eat pork were asked why not, taste was the most common reason particularly among the under 35 year olds. Fat was of concern to females, while salt was more of an issue for those over 35 years than younger respondents.

One in two respondents had no concerns at all regarding pork products. Of those who had concerns, sausages were the top concern followed by fresh pork products such as pork chops, roast, loin and ribs. When asked of those who expressed concern, fat content was the top concern followed by salt and cholesterol levels. Concerns about fat content increased with age, with respondents in higher socio-economic groups being more concerned about salt, fat and cholesterol than those in lower groups. Antibiotics, the presence of growth hormones and the potential for products to be tampered with were also issues for those with concerns.

Six focus groups were held with consumers in Dublin, Belfast, Ennis and Portadown to further explore some of the issues raised in the quantitative research. The majority of participants felt that overall pork was a relatively healthy meat and considered it to be more nutritious than beef or lamb though not as healthy as fish or chicken. Most were aware that pork was a good source of protein but not as aware that it was also a good source of vitamins and minerals. Participants cited a number of positive attributes of pork, including convenience, taste, versatility, lack of 'scares' and value-for-money. There were a number of negatives however, including fat and salt content, negative effects on cholesterol and blood pressure, and risks associated with undercooking.

There were no major food safety concerns about pork although most participants acknowledged that pork products should be well cooked until there was no pink meat remaining. Respondents were fairly confident of the quality of the products they were buying and there were few concerns about the origin of pork with a general assumption that all pork sold on IOI was produced in IOI. The main concerns surrounding consumption of pork lay in the potential health risks associated with processed products such as rashers and sausages. A common view was that these contributed to high cholesterol and salt intakes and some respondents reported reducing their pork consumption for health related reasons.

As a food commodity, pork makes a valuable contribution to the economies of NI and ROI. In ROI pig meat is the most important agricultural sector after beef and milk.

Pork production systems on IOI are primarily conventional comprised of a small number of specialist producers operating large-scale units. Free range and outdoor production is minimal, while organic pork is very much a niche market. There were approximately two million pigs (410,450 and 1.59 million pigs in NI and ROI, respectively) on IOI in June 2007.

In 2007, 1.3 million pigs were slaughtered in NI. This figure comprises home-produced pigs (789,337) and imported pigs (511,533) the vast majority of which being from ROI. Total pigs slaughtered in ROI in 2007 were 2.6 million.

Over one third of pig meat consumed in ROI is imported, primarily sourced from the UK and continental Europe. A considerable proportion of imports coming into ROI are destined for further processing and eventual re-export as part of a final product.

Approximately half of the pig meat produced in ROI is exported and was valued at €212 (£155) million in 2007. Export sales of pigmeat from NI were valued at £96 (€141) million in 2005.

Infectious intestinal disease arising from the consumption of pork is not a common human illness and in any case is preventable with the adoption of correct hygiene practices. However, the consumption of raw or undercooked pork can pose a risk of infection as does the cross-contamination of ready to eat foods with bacteria from raw pork or its juices.

Salmonella is a major organism of concern with respect to the pork supply chain. Pig meat was implicated in eleven *Salmonella* outbreaks (5.1 percent of total) in the EU in 2004 and these affected 204 people (3.3 percent of total affected). There was a significant outbreak on the island in 1998 in the Dublin region as a result of consumption of ham infected with *Salmonella* Typhimurium.

Salmonella Typhimurium is the serovar most frequently isolated from raw pork and pork meat products. In ROI in 2005 of the 90 raw pork meat samples tested at processing level and found to be positive for *Salmonella*, almost 50 percent were positive for *Salmonella* Typhimurium.

In 2008, a *Salmonella* Agona outbreak, possibly attributed to pork, took place on IOI and in GB. This outbreak was being investigated at the time of this review.

Other pathogens of note along the pork food chain include *Staphylococcus aureus*, *Listeria monocytogenes*, *Yersinia enterocolitica* and *Clostridum botulinum*. There have been no cases or outbreaks associated with any of these organisms on the island in recent years.

Antimicrobial resistance also poses a challenge for those involved in the pork industry. Research and surveillance indicates that pathogens with antimicrobial resistant patterns have been detected in pork-derived products and subsequently in humans. Illness caused by multi-drug resistant species are more difficult to treat than those caused by pan-susceptible species. S. Typhimurium definitive Type 104 (DT104) is a phage type typically characterised by resistance to five or more antimicrobial agents and has been identified in pork and pork products.

The vast majority of pork production on IOI is intensive in nature with the consequent potential of facilitating disease control. However, once biosecurity is breached there can be a rapid spread of microorganisms within a herd. The control of *Salmonella* along the food chain is a challenge for all stakeholders involved and there has been considerable investment placed in this area.

Control schemes to minimise the incidence of *Salmonella* species in pig herds have been in place in NI and ROI for a number of years. While the schemes differ to some extent in the approach taken both are based on a serological testing of pigs at slaughter.

In NI producers take part in the UK Zoonoses Action Plan (ZAP) Programme. The objective of the programme is to ensure that the risk to consumers presented by *Salmonella* species, however small, is minimised. Meat samples are collected at abattoirs and tested for the presence of *Salmonella* antibodies. On the basis of the number of positive samples each herd is assigned a ZAP status. Producers with high prevalence of positive samples are offered advice from the Department of Agriculture and Rural Development (DARD) and are required to draw up and implement an action plan with a veterinarian within the first six months or risk losing their quality assurance status.

In ROI, the statutory National *Salmonella* Control Programme was implemented in August 2002. This programme requires that meat juice from all commercial pig herds be tested at the time of slaughter and categorised according to their *Salmonella* status.

Pigs in the highest category of *Salmonella* positive herds are slaughtered separately from other pigs and in a manner that minimises the risk of contamination. Head meat and selected offal from these pigs must be heat treated before it enters the food chain. At present about 4,000 pigs per week are being restricted and about 50 percent of these are pigs are from herds without a valid certificate.

The importance of an all-island approach to a fully compliant *Salmonella* control scheme is underlined by the fact that almost 40 percent of pigs slaughtered in NI originate in ROI.

At the time of writing both schemes are under review and are likely to be revised in autumn 2008.

A number of quality assurance schemes exist on IOI. The Northern Ireland Pig Quality Assurance Scheme (NIPQAS) is the quality scheme for pig meat in NI and is administered by the Ulster Pork and Bacon Forum. In ROI the Bord Bia Pigmeat Quality Assurance Scheme (PQAS) is an integrated scheme involving the producer and the processing plant to provide the customer with quality assured product. The scheme was developed and is subject to revisions by a Technical Advisory Committee representing Bord Bia; Teagasc; the Food Safety Authority of Ireland; the Department of Agriculture, Fisheries and Food; industry (producers and processors) and technical experts. These schemes seek to provide assurances to buyers and consumers of the quality and safety of pork and pork products on IOI by establishing standards to which participating producers must adhere.

The incidences of chemical contamination or residues in pork are rare and are largely confined to the primary production level. They can include veterinary medicinal products and feed additives, as well as environmental contaminants. There is comprehensive monitoring of potential chemical contaminants entering the pork food chain by the respective competent authorities on IOI. With regard to veterinary medicinal products, residue levels found in pork 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 pork in respective monitoring programmes. Such results highlight the safety and integrity of the pork production systems on IOI.

Per capita consumption of pig meat on IOI is higher than that of other meats including poultry, beef and sheep meat and thus makes a significant contribution to the diet. According to the North South Ireland Food Consumption Survey (NSIFCS) in 2001, men in ROI consume 167 g/d and women consume 101 g/d. Results from the National Children's Survey in ROI in 2004 have indicated that primary school aged children in ROI are consuming almost twice as much processed meats when compared with leaner cuts of fresh meat.

On average pork has a lower total and saturated fat content than other red meats such as beef and lamb. However, on a daily basis more than 50 percent of pork products eaten on IOI are processed e.g. sausages, bacon and ham, which are almost always high in salt and will vary in their fat content.

There is strong evidence to suggest that processed meats can have adverse effects on health and on IOI such meats primarily originate from pork. Dietary saturated fat and salt are two of the major contributors to cardiovascular disease and processed pork products, such as sausages and bacon and ham, are a major source in the diet.

Cured and processed meats are currently estimated to contribute to approximately one fifth of current salt intake. Analysis of the NSIFCS indicated that bacon and ham were the meats which contributed the most to daily salt intakes at 0.925g/day. There is now convincing evidence that sodium intake, mainly through dietary salt, is directly associated with increased blood pressure. A relatively modest reduction in salt intake has important beneficial effects on blood. This would produce substantial falls in stroke and coronary heart disease mortality.

Pork and pork products vary in their fat and saturated fat content. Individuals who consume pork can decrease their total fat and saturated fat intake by choosing leaner cuts more often than fattier processed cuts.

By opting for lower fat and salt varieties of processed pork or by choosing to reduce the amounts of processed pork products in the diet, consumers can reduce their risk of cardiovascular diseases.

Another factor impinging on the risk of cardiovascular disease is the balance of the diet. Diets on IOI high in red meat tend to have higher intakes of processed meat and be lower in fruit and vegetables and fibre thus increasing the risk of cardiovascular disease. In some Mediterranean regions, there is evidence of a lower prevalence of cardiovascular disease in populations that are high consumers of lean red meat but also high consumers of fruit and vegetables.

In 2007 the Expert Panels of the World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) published a comprehensive review of the scientific evidence linking diet, physical activity and weight with 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 included in this review.

The review found convincing evidence of a relationship between processed meats and colorectal cancer. An increased risk of cancers of the oesophagus, lung, stomach and prostate was also found but the evidence was limited and often inconsistent.

In relation to red meat consumption the report also found a positive relationship between colorectal cancer and an increased risk between red meat and cancers of oesophagus, lung, pancreas and endometrium. Again the report suggested the latter evidence was limited and sometimes inconsistent.

The WCRF/AICR recommended that consumers who eat red meat should consume less than 500g (cooked) a week, very little of any to be processed and that the population goals should be for an average consumption of red meat not more than 300g (cooked) a week very little of which to be processed.

In making these recommendations the Expert Panels recognised the valuable contribution that lean red meat, such as pork, can make to the diet particularly in relation to iron, vitamin B12 and protein.

While the dietary advice on IOI supports the recommendations of the WCRF/AICR, currently approximately half the meat consumed on IOI is processed, and therefore a more realistic achievable interim goal for many people would be to slowly reduce their intake of processed meats.

In response to health concerns regarding salt levels in foods and more specifically a negative focus on processed meat products, the industry is moving to respond to some of these concerns. As well as product innovation and the introduction of reduced fat and salt pork products on to the market, since 2003 producers and retailers have been working with regulators in ROI and the UK to reduce the level of salt in pork products. These targets should be met by 2010.

Conclusions

Primary producers, transporters and processors

Pre-slaughter stress is both an animal welfare and a quality issue. Long-term stress, such as that caused by poor on-farm handling, mixing, loading and transport, can lead to meat quality associated with that of dry, firm and dark (DFD) meat. Short-term stress, including that caused by poor lairage conditions and driving to the stunner, can lead to quality associated with pale, soft and exudative (PSE) meat. Legislation ensures that animal welfare is maintained at farm level, during transportation and at slaughter.

Good animal husbandry practices should be adhered to and pigs sourced from microbiologically reliable sources. The implementation of good biosecurity measures and good quality feed and water will ensure a healthy herd. *Salmonella* control schemes are of significant importance to the industry and new developments in this area towards a harmonised all island approach are to be welcomed.

Processors must continue to work with regulators and retailers to reduce the salt content of pork products on the market and meet the targets that have been set for 2010.

Retailers and caterers

At retail level cold ready to eat foods should be stored at chill temperatures; hot foods should be served at temperatures above 63°C; and whole cuts of pork, burgers and sausages should be thoroughly cooked until they are piping hot with no pink or red in the centre. Chopping boards and other utensils used for the preparation on cooked and uncooked foods should be clearly identified and kept separate.

Consumers

Healthy eating

- **Fresh unprocessed cuts of pork, particularly lean cuts, should be chosen and where possible the fat should be trimmed following purchase.**
- **The majority of pork consumed on the island is in processed forms which are high in calories, fat and salt. While these products are convenient and popular with consumers, consumers should be encouraged to reduce their intake and replace with fresh, unprocessed pork. Children in particular should be encouraged to consume less processed pork products, which may also negatively impact on their iron status.**
- **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 pork 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 in appropriate amounts.**
- **Cooking methods, such as grilling, dry frying and stir-frying should be chosen. When roasting, pork cuts should be placed on a rack to allow the juices to drip onto a tray below.**
- **Consumers should be encouraged to read labels on processed pork products and to choose those with lower calorie, fat and salt contents.**

Food safety

Pork and pork products can be considered safe foods when handled and stored correctly. Good hygiene practices in the home should help prevent food poisoning. ***safefood*** advice highlights four key points to ensure safe food preparation in the home.

- **Clean – hand washing after handling raw meat using warm water soap, creating a lather followed by thorough drying. All surfaces and equipment in contact with raw meat also need to be thoroughly cleaned with soap and hot water.**
- **Cook – In the home pork and pork products should be cooked through until the juices run clear, there is no pink meat left and they are piping hot all the way through. The proper cooking of pork will eliminate any food pathogens including *Salmonella* and *Campylobacter*.**
- **Separate – use separate cooking utensils and plates for raw meat and cooked foods and always store separately to avoid cross-contamination.**
- **Chill – keeping cooked and uncooked food at the correct refrigerated temperature of less than 5O°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, cooked 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.

1 Introduction

1.1 Background

The purpose of this series of reviews 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 reviews set 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 sensible steps that can be taken to address both perceived and potential risks. ***safe*food** will use the information gathered in the reviews to provide opportunities to promote good practice amongst all stakeholders along the food chain.

Reviews of the chicken, finfish, fruit and vegetable, beef, and milk supply chains have already been undertaken in this series and are available to download at *www.safefood.eu*.

1.2 Terms of reference

The general terms of reference for each review are 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

1.3.1 Overview

This document collates and considers the information available in the public domain on the health and food safety implications of the pork supply chain. For the purposes of this review, the following products were considered:

- **Raw, unprocessed pork products, e.g. pork loin, pork chops and pork roast;**
- **Raw, processed pork products, e.g. bacon (including sliced bacon or 'rashers'), ham and sausages; and**
- **Processed/heat-treated pork products, e.g. cooked ham.**

On the basis of the evidence, the review draws a number of conclusions for stakeholders in the pork supply chain, including producers, processors and distributors, retailers and caterers, and consumers.

While the primary purpose of these reviews is directly pertaining to food safety and nutrition issues, other relevant issues such as traceability and quality are discussed.

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

1.3.2 Raw, unprocessed pork products

Raw, unprocessed pork products include fresh pork primal cuts, offal and pork ribs. Fresh pork is pork that has not been frozen, cured, smoked, precooked or otherwise processed to a form that changes it from its original meat. Primal cuts can be purchased whole and then cooked whole or they can be cut down into sub-primal and retail cuts. The loin and the leg/ham are commonly purchased as whole primal cuts.

1.3.3 Raw, processed pork products

A raw, processed pork product is a pork product that has been frozen, cured, smoked, precooked or otherwise processed to a form that changes it from its original meat. Such products include sausages to which ingredients have been added to freshly ground pork. They also include cured products such as bacon and ham.

Sausages are made from fresh ground pork, seasonings, fat, preservatives and fillers, such as breadcrumbs, rice, cereal/rusk, soybean flour, and dried milk solids. Some varieties are a mixture of pork and other meats, such as beef, veal and poultry. The casings can be a natural casing made of animal intestines or an artificial casing made of cellulose. The emulsion is then extruded into a case to produce the classic sausage shape.

Bacon is made from pork bellies that have been cured. Bacon is available sliced ('rashers') or as slab bacon, which is sold in un-sliced chunks. Slab bacon is usually left with the skin, or rind, on. Bacon is available unsmoked and smoked.

Ham refers to meat from the hind leg of a pig that has been cured by salting and then cooked. Picnic ham refers to cuts of pork from the collar and shoulder area of the pig. Like bacon, hams can be unsmoked or smoked.

1.3.4 Processed/heat-treated pork products

Processed/heat treated pork products include cooked ham, luncheon meats and puddings. Luncheon meats are ready to slice and serve products that consist of ground meats, which are seasoned and cooked but generally are not smoked. Puddings are available in black and white varieties. Black pudding contains a combination of animal blood, suet, grains, raisins or currants, and spices, which cause the resultant sausage to look either deep purple or black. White pudding does not contain any animal blood products but instead contains sugar, oats or bread, suet and shredded pork. Both types are cooked during processing. Pudding is always served hot, usually cut into thick slices and grilled/fried.

1.3.5 Fermented pork products

Fermented pork products are not included within the scope of this review, however a description of the various types available on the market can be found in Appendix A.

1.4 Consumer focused review of pork

1.4.1 Introduction

Pork (and its related products) is the most commonly consumed meat on the island of Ireland (IOI). It is a rich protein and B vitamin source and has a lower total and saturated fat content than other red meats such as beef and lamb. The majority of pork consumed on the island is in processed forms such as ham, bacon and sausages. As a result, the nutritional attributes of the pork are negatively impacted upon as such processing can increase the salt and fat content of products. This in turn has consequences for conditions such as cardiovascular health and cancer.

From a food safety perspective, pork is not a common source of human infectious intestinal disease. Pork is associated with bacteria such as *Salmonella*, however, good husbandry and hygiene practices along the food chain, including in the home, minimise the risk associated with this product. Although pork meat and processed pork products have been implicated in a number of foodborne diseases in the EU, such as yersiniosis and trichinellosis, these are rare on IOI.

1.4.2 Food safety risks in pork from a consumer perspective

1.4.2.1 Quantitative research

***safe*food** conducts annual quantitative market research ('safetrak') during which consumers' attitudes and behaviour to particular foods and food preparation habits are determined.

Questions relating to pork and pork products were included in quantitative research conducted during September and October 2007. The questions relating to pork centered mainly on consumers' eating habits and their food safety and nutrition concerns.

The research involved face-to-face interviews with 796 participants on IOI; 495 in the Republic of Ireland (ROI) and 301 in Northern Ireland (NI). The sample framework consisted of adults aged 15 to 74 years and was representative of both jurisdictions.

Pork consumption

Eighty five percent of participants consumed pork and/or pork products such as ham, bacon and sausages.

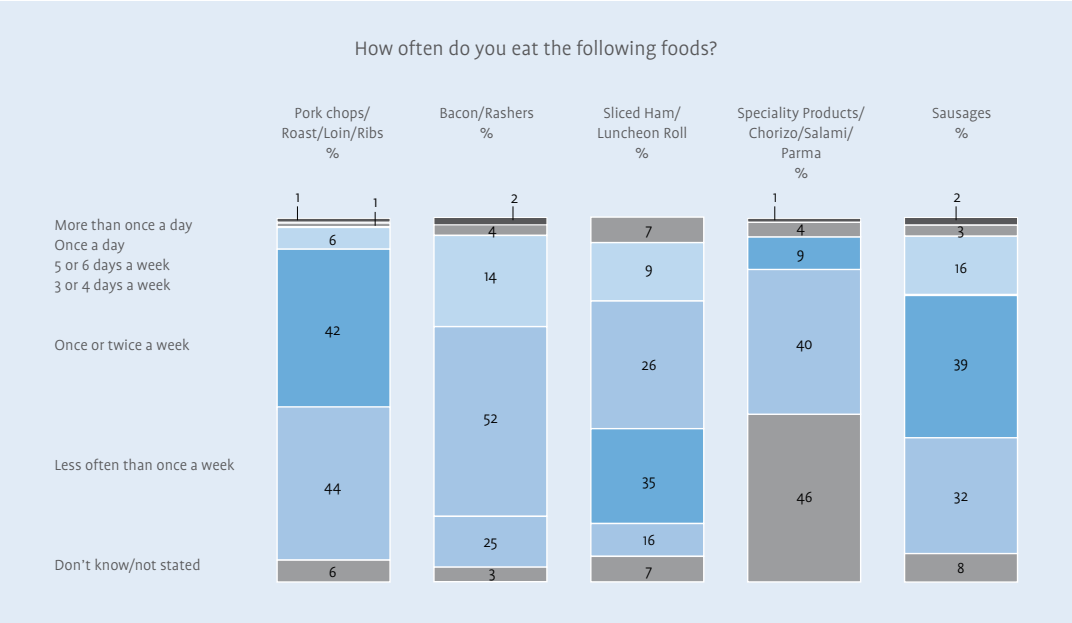
Consumption of pork was found to be marginally higher in NI than in ROI at 89% versus 83% ($p<0.05$).

Consumption was found to be highest among males (89%); those aged 65-74 years (88%); those living in Belfast (97%) and Munster (94%).

Almost one in five females (19%) claimed not to eat any pork products.

Frequency of pork consumption
All categories of pork and pork products were consumed frequently with the exception of speciality products (Figure 1.1).

Figure 1.1: Frequency of eating pork products



Reasons for not eating pork
The main reason cited by those who do not eat pork was taste (Table 1.1).

Table 1.1: Reasons for not eating pork products

Reason	%
I don't like the taste of pork meat	45
I think pork meat is too fatty	17
I am a vegetarian	16
High salt content	15
Preservatives	2
E-numbers	2
Other	12
Don't know	4

Base: all who don't eat pork products (n=119)

Taste was an issue particularly evident among the under-35s, fat was of particular concern to females (22 percent), while salt was more of an issue for the over-35s than the under-35s.

Pork products most concerned about

Almost one in five participants stated that sausages were the main pork product that they had concerns about. Fresh pork products such as pork chops, roast, loin and ribs were the second category of pork products that consumers were concerned about at 15 percent (Table 1.2).

Table 1.2: Pork products most concerned about

Reason	%
Sausages	19
Pork chops/roast/loin/ribs	15
Sliced ham/luncheon roll	8
Bacon/rashers	4
Speciality products – chorizo/salami/Parma ham	4
Other	3
Don't know/can't think of any	11
I am not concerned about pork products	46

Base: all who eat pork products (n=677)

Concerns among pork eaters

In terms of concerns that participants had relating to pork products, fat content was the primary concern with almost 50 percent of participants mentioning this issue. Salt and cholesterol content were also cited by almost one in five participants, with antibiotics, the potential for products to be tampered with easily, and growth hormones being cited by one in ten (Table 1.3).

Table 1.3: Concerns about pork products

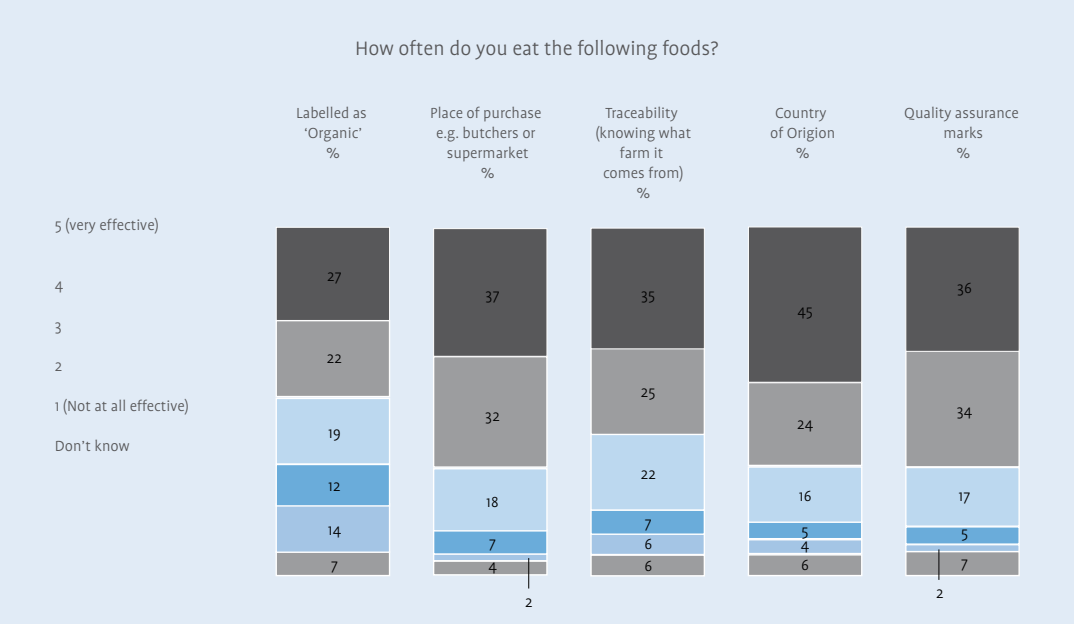
Concern	%
The percentage of fat in the product	46
High salt product	17
Pork meat products are high in cholesterol	17
They contain a lot of antibiotics	13
They can be tampered with easily	11
The pigs are given growth hormones aren't they?	10
They don't go off anymore	3
Not recommended for pregnant women	2
My children might develop allergies from them	1
Other	20
Don't know	3

Note: Pork eaters concerned about pork products (n=302)

Fat was mentioned by one in two females compared with two in five males. Concerns about fat content increased with age with 55 percent of 50 to 64 year olds concerned about the percentage of fat in pork products. This age group was also most likely to be concerned about cholesterol and levels of salt. Respondents in higher socio-economic groups were generally more concerned about salt, fat and cholesterol than those in lower groups.

Safety assurances
Participants felt assured of the safety of pork products at point of purchase by a number of mechanisms, primarily quality assurance marks, place of purchase, country of origin, and traceability information.

Figure 1.2: Safety assurances



Base: Pork eaters concerned about eating pork products (n=302)

1.4.2.2 Qualitative research
In October 2007, ***safefood*** commissioned qualitative research to elicit consumers' perceptions of the pork supply chain.

The objectives were to:

- **Assess the level of knowledge amongst the general public towards pork.**
- **Assess attitudes towards pork consumption including motivations and barriers towards purchase/consumption.**
- **Assess knowledge of the nutritional value and health benefits of pork.**
- **Explore attitudes to associated contamination and microbiological risk of pork.**

Six discussion groups (eight participants per group) were held with pork consumers in ROI and NI. The groups were conducted in both urban (Dublin and Belfast) and rural (Ennis and Portadown) locations to provide a mix and allow for any regional variation. The groups were structured with a gender bias towards females with children in order to provide insight into their own individual attitudes and behaviours and those of their children and other family members. A group of young males and a mixed group of consumers in their mid to late twenties was also included to gain their perspectives of the issues that they may have.

Table 1.4 outlines the make-up of the groups. All participants were pork consumers.

Table 1.4: Focus group matrix

Group	Gender	Life stage	Age	Social class	Location
1	Female	Married with children aged between 5-12; working full or part time	25-40	BC1	Dublin
2	Male	Single; no children; working full time	20-30	C2D	Dublin
3	Mixed	Married with no dependent (under 18) children living at home	50+	C1C2	Ennis
4	Female	Married with children aged between 10-18	35-50	C1C2	Ennis
5	Female	With at least one child aged 5-18; working full or part time	25-40	BC1	Portadown
6	Female	Homemakers with at least one child aged 5-18	30-50	C1C2	Belfast

Note: BC1 = middle and lower middle class; C1C2 = lower middle class and skilled working class; C2D = lower class

Healthy living

The overall view among the group participants was that healthy living has become much more prominent in the last number of years. Most felt they were being constantly faced with a barrage of 'healthy living' messages and were much more aware of the impact of food, diet and exercise on their health and wellbeing. On the one hand, parents felt that their children were also becoming more aware of healthy foods and lifestyles, whereas on the other hand, many felt tired of measures which were seen to be pushing the 'healthy living' agenda too far. Some spoke of stringent rules applied in schools which either limited their children's lunch choices or else proved quite costly for parents to accommodate lunches within these 'rules'.

The majority did admit to making attempts to live healthier lives and most had succeeded in making some positive changes either through dietary changes or increased exercise.

Participants of all age groups spoke of the increased demand for and consumption of convenience foods today. Most were 'time poor' and found it difficult to eat healthily on convenience or 'quick' foods and found themselves trading healthy living for increased convenience.

Sources of information on healthy eating
Most participants could not pinpoint exactly where they got their nutritional information from but all were certain that it was in plentiful supply and messages of nutrition and healthy eating were widespread and far reaching.

Parents of children tended to get a lot of information from schools, doctors and dentists.

Media sources such as television programmes, newspapers and magazines were also highly influential.

Other sources mentioned were supermarkets, leaflets from established food safety agencies or companies promoting their products, and brands using a nutritional angle.

Food safety at home
The majority of participants had a relatively good idea of how to handle food safely within the home but there were still uncertainties and doubts surrounding proper procedures for handling some meats. The majority were strongly guided by expiry dates more so than nutritional content at times. Food safety in the home was something which participants were receptive to knowing more about and were eager to share tips and learnings with one another.

Perceptions of pork
Spontaneous associations with pork were generally centered on sausages, rashers and pork chops. Roast pork, e.g. stuffed loin of pork was also mentioned quite frequently. Some struggled to think of bacon and ham, in particular, as pork products. Further down the list were products like salami, gammon steak and spare ribs.

Most felt that overall pork was a relatively healthy meat and considered it to be more nutritious than beef or lamb though not as healthy as fish or chicken.

Most were aware that pork was a good source of protein but not necessarily that it was a source of vitamins and minerals.

One of the major positives of pork was its versatility at mealtimes, and this perception fed into the different opinions on different cuts and types of pork.

Pork was generally viewed as quite a healthy meat and some felt it was healthier than beef or lamb; however, fried pork meat or 'fries' were considered the major health pitfall.

Roast joints, chops and ham were seen as healthy dinner options which were also fast and convenient. Bacon was seen to be high in salt but was still considered to be relatively healthy.

Participants cited a number of positive attributes of pork, including convenience, taste, versatility, lack of 'scares' and value. There were a number of negatives however, including fat and salt content, negative effects on cholesterol and blood pressure, and risks associated with undercooking (Table 1.5).

Table 1.5: Perceived positives and negatives of pork

Positives	Negatives
Convenient	High fat content
Tasty	A lot of salt
Versatile	Preservatives
Value	Shouldn't eat too much of it
More meat to it	Undercooking can have serious health risks
Wide variety	Too much leads to increased risk of cholesterol and high blood pressure
Inexpensive	
Very little bad press	
Quality Assured meat	

Pork consumption
Pork was consumed at each major eating occasion, for breakfast, lunch and dinner.

Pork varieties consumed mainly at breakfast included rashers, sausages and pudding (particularly prominent among male group). There was some evidence of cutting down on 'fries' and more grilling (or some boiling) of sausages.

Ham sandwiches were extremely popular across the groups as the pork type consumed for lunch. Most participants tended to go for only 'ham' and ate less of what they considered to be 'processed' meats such as luncheon roll, turkey and ham roll.

All varieties of pork were consumed for dinner. Among the most popular were pork chops, roast pork, loin of pork, bacon, gammon steak, and rashers and sausages.

Pork was consumed for a number of reasons, including function (for breakfast, lunch, dinner, snack) and also for emotional reasons. It was perceived to be a comfort food, with participants frequently citing that it was consumed to cure a hangover, and also as a reminder of childhood and homeliness.

In terms of the consumption patterns among participants, males aged 20 to 30 years consumed mostly breakfast sandwiches and rolls. Females aged 20 to 50 years, on the other hand consumed a variety of pork products including pork chops and sausages for dinner and ham for lunches/snacks. The mixed group aged 50 years and over generally consumed more traditional products such as bacon once a week and roast pork on Sundays.

Purchasing patterns
Purchasing locations of pork varied widely between the size and type of household and the type of pork. Many bought some of their sausages in the butchers or markets if time allowed, as they felt it was not an expensive purchase and therefore budget for this purchase was not a major barrier. Rashers were mainly bought in the supermarket with the weekly shop. Purchase of dinner components such as pork chops were mainly bought in the butchers, however, many did opt for the supermarket meat counter as they felt it offered good value for money and were assured by the traceability labels. Roast pork and bacon was mainly bought in butchers. Ham and other lunch meats tended to be bought both in delicatessens and in supermarket packets depending on the number in the household and the frequency of consumption.

There was some awareness of organic pork products, but price was the main purchase barrier.

Out of home eating
Pork was not popular as a meat to have when eating out in a restaurant. Many opted for beef, lamb or fish – generally choosing something they would not typically have at home. Pork was mentioned quite a lot in relation to Chinese food and occasionally people mentioned having dishes such as pork medallions or roast pork in a restaurant.

Cooking pork products
There was general consensus that pork products should be well cooked e.g. pork chops. Pink pork was definitely not appealing to any participants. Quite a few respondents pricked their sausages when cooking them – not necessarily for healthy reasons, but to make sure they did not set the grill on fire or be spattered by burst sausages. A few mentioned using their George Foreman grill for cooking sausages and rashers and felt that it was a lot healthier than frying.

Storage
Consistent with the cooking of pork, the majority of participants were careful about storing and freezing their pork once they brought it home. Many of the females with families bought set amounts of pork each week and froze what they did not need either immediately or the following day. Most were willing to take more risks with other meats such as beef or lamb, but the awareness of the dangers of undercooking pork or storing pork incorrectly was well known.

Quality of pork products on IOI
The general consensus throughout the research was that the quality of pork produced on IOI was extremely high. Most had little or no concerns about the quality of the meat available in the butchers and tended to trust butchers more than supermarkets. Many felt that IOI was a quality pork producing region and the standard of the meats was very high. There were some slight concerns about the percentage of pork meat in supermarket sausages, but this was not enough to deter most from purchasing them. Water content of pork, mainly sausages and chops, was mentioned frequently. Most felt that 'ignorance was bliss' in this instance and that they were better off not being aware of these facts.

Concerns about pork
There were no major food safety concerns about pork. Most respondents were fairly confident in the quality of the products they were buying. There were few concerns about the origin of pork and there was a general assumption that all pork sold on IOI was produced in IOI. All assumed that pork from the butchers was of IOI origin and all were in favour of the supermarket traceability and origin labels on the meats. The main concerns surrounding consumption of pork lay in the potential perceived health risks associated with it. Some of the young males mentioned fat as an issue for them but many loved crispy bacon. A common view was that pork, in particular rashers and sausages, contributed to high cholesterol. Avoidance of 'fat' was one barrier to pork consumption. A number mentioned it not being favoured by Weight Watchers.

Barriers to pork consumption
Many participants reported that they were trying to consume less 'unhealthy' pork such as rashers and sausages because of health risks or even doctor's advice in some cases. The majority had cut down on 'fries' and had them only on a special occasion either on weekends or if they were staying somewhere for the weekend. Cholesterol, blood pressure and the high level of salt in this pork meat were the main reasons some chose to reduce their consumption in recent times.

Fat was another health related reason why many were reducing their pork consumption. Aside from rashers and sausages many felt that roast pork, bacon and some other cuts contained a lot of fat and grizzle and although some did cut off the fat, most ate it if it was there.

Some participants simply did not like the taste of some of the cuts of pork and felt that they lacked flavour and were a very plain cut of meat if served alone with no sauce or accompaniment.

Additives in pork
Generally there was no major concern about the additives in pork products because participants believed they were in everything and thought producers would add them as a matter of course during production. They believed that additives had to be added to food to make it last longer. There was more concern about the shelf life of pork and whether it would be used within the time frame allowed. There was also more concern about how good the food actually tasted rather than the addition of additives and preservatives.

Differences between attitudes and behaviours among ROI and NI participants
There were no major differences in attitudes and behaviours between NI and ROI in terms of pork purchasing patterns. There were some slight differences in terms of habits and consumption. NI participants tended to buy more 'speciality' sausages as opposed to supermarket brands all the time. There was an increased mention of gammon steaks for dinners in NI, but not in ROI. NI participants also seemed to be less inclined to cut out 'fries'.

Pork information needs
There did not appear to be a huge demand for more information on pork products, especially on production methods. Many people prefer a certain level of ignorance, and a head in the sand approach, with regard to knowing where their food comes from. However, there does appear to be a demand for clear labelling with regard to the presence of salt, fat etc.

Summary

IOI pork consumers seemed to be very content with the quality and variety of pork currently available to them. Pork formed part of the staple diet in many households and was held in high regard in terms of its versatility, cost effectiveness and taste. There were no major concerns in terms of origin or quality of the pork meat. Most concerns lay in the perceived health risks which arose from pork consumption. At an overall level it was viewed as quite a healthy meat but sausages, rashers and forms of bacon were considered to have high levels of salt and fat. These health implications concerned most people rather than the quality of the meats (which they assumed was high quality anyway). There was increased evidence of cutting down on fried pork meat and salty pork cuts because of increased awareness of cholesterol levels, weight and blood pressure. Information needs for pork were relatively low although there was an interest expressed in more information on cooking and storing pork, particularly because most participants tended to overcook pork to be on the safe side. Pork was perceived as an IOI meat which can be trusted more than beef or chicken, although this was borne out of the lack of high profile health scares associated with pork.

1.5 Summary

This review collates and considers the information in the public domain on the food safety and nutrition aspects of the pork supply chain on the IOI. For the purposes of this review, the following products were considered: raw, unprocessed pork products, e.g. pork loin, pork chops and pork roast; raw, processed pork products, e.g. bacon, ham and sausages; and processed/heat-treated pork products, e.g. cooked ham.

In order to frame the review, both quantitative and qualitative research was conducted to elicit consumer attitudes, perceptions and behaviours of this particular category. The quantitative research demonstrated that consumers were primarily concerned by the fat content of pork and pork products. Salt and cholesterol content were also a concern to a lesser extent. This was also observed in the qualitative research where participants were also cautious about handling and cooking pork properly.

2 The Pork Supply Chain

2.1 Overview

Pork is the most consumed meat in the world being consumed by more than one in three people, rising to one in two in Europe (EU-25) [1]. It also makes a valuable contribution to the economies of Northern Ireland (NI) and Republic of Ireland (ROI). Pig meat production was valued at €290 (£198[1]) million at farm gate in ROI in 2007, representing five percent of the gross agricultural output [3]. It is the most important sector in agricultural output after beef and milk. In NI in 2006, pig meat was estimated to account for almost seven percent[2] of gross turnover in the food and drinks processing sector[3] at £190 (€280[4]) million [4]. Comparable figures for the value of the pig meat industry on ROI and NI are not available.

Pig production on the IOI has changed from a small-scale enterprise carried out by a large number of mixed farmers to a modern industry comprised of a small number of specialist producers operating large-scale units. There were almost two million pigs on the island in 2007 [5, 6]. The total pig population has decreased by seventeen percent in the ten year period from 1997 to 2007 [5].

In ROI at least 1,200 persons are directly employed at farm level with total employment attributable to the pig sector estimated at about 7,500. This figure includes those employed in the other various sectors within the overall pig industry including haulage, slaughtering, meat processing, feed manufacture, and transport and services [1]. There were an estimated 1,570 full-time equivalents involved in the pig meat sector[5] in NI in 2005 [7].

2.2 Stages in the supply chain

2.2.1 Introduction

The pig is a litter-bearing animal and a typical female will give birth to, on average, ten or more piglets per litter. It is common for sows to give birth to more than two litters of pigs each year, thus one female pig often produces more than 20 pigs each year. The life cycle of the pig is shown in Figure 2.1.

1 Conversion Rate based on average of 2007, €1=£0.68166; 2. Central Bank. Exchange Rates. 2008 [cited 13 March 2008]; Available from: http://www.centralbank.ie/frame_main.asp?pg=sta_exch.asp&nv=sta_nav.asp

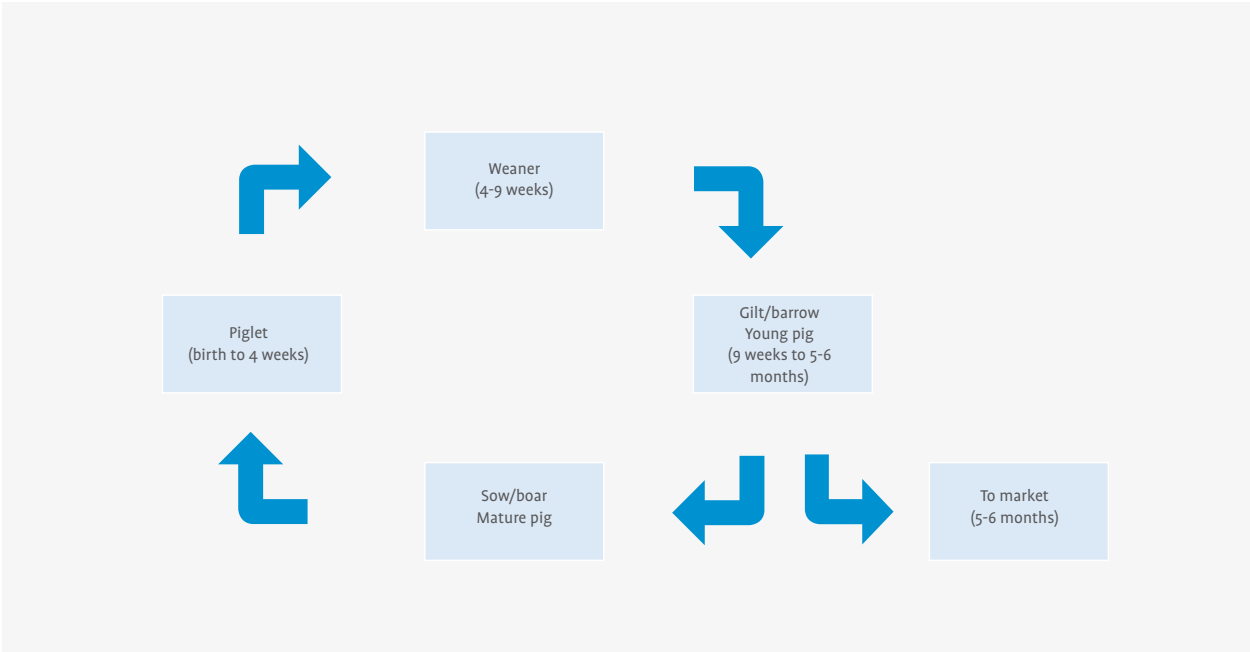
2 Figures do not include an estimate of the turnover of food and drinks processing businesses with turnovers less than £250,000.

3 Businesses involved in processing activities that change the nature of a raw material destined for human consumption.

4 Conversion rate based on average of 2006, £1=€1.47260; 2. Central Bank. Exchange Rates. 2008 [cited 13 March 2008]; Available from: http://www.centralbank.ie/frame_main.asp?pg=sta_exch.asp&nv=sta_nav.asp.

5 All businesses involved in the slaughter and processing of pigs; products include bacon, pork and hams.

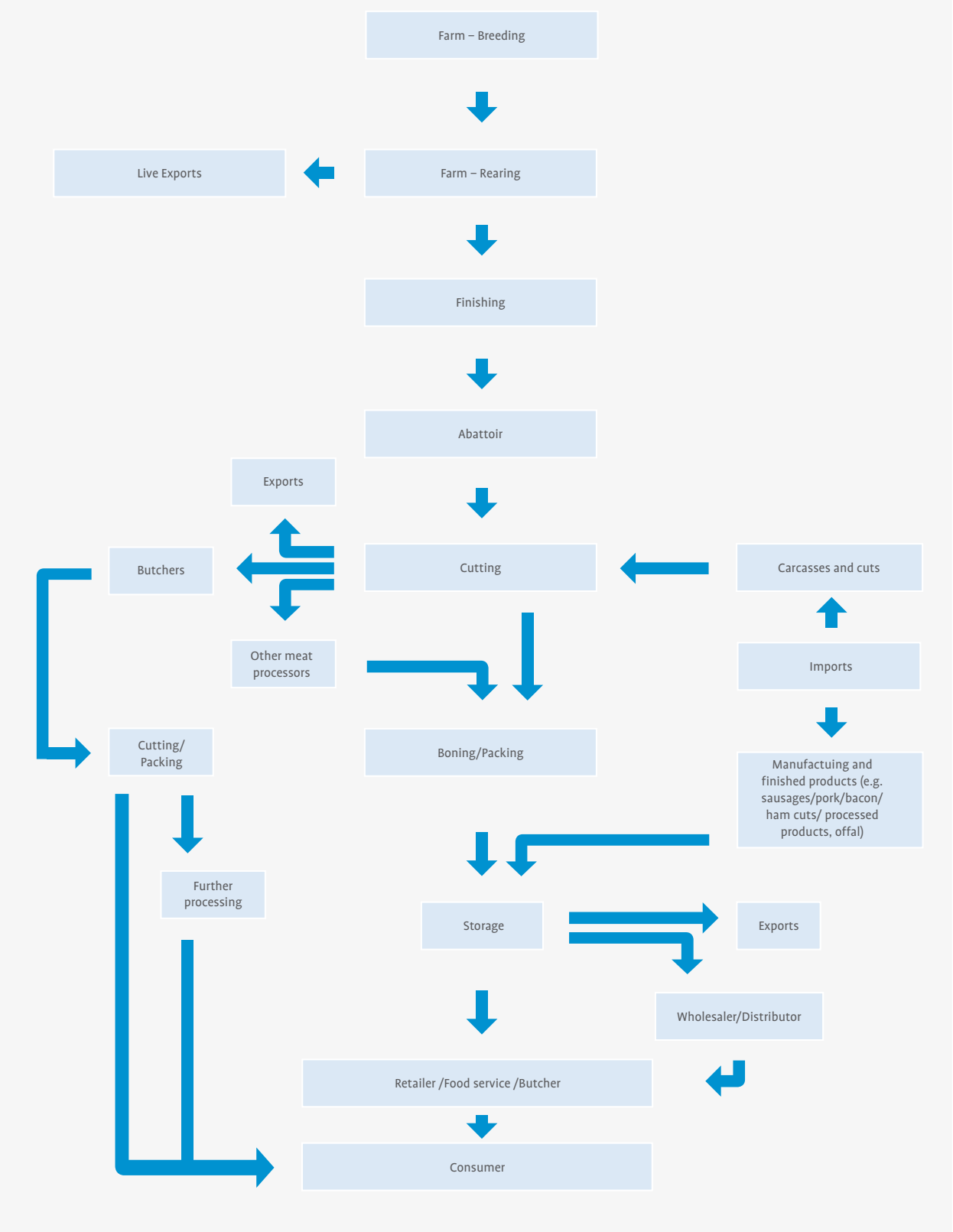
Figure 2.1: Lifecycle of a pig



Pork production systems on the island are primarily conventional. Free range and outdoor production is minimal, while organic pork is still very much a niche market. This section of the report describes the processes associated with conventional pork production, while organic pork production is discussed in chapter five.

See Figure 2.2 for an overview of the pork supply chain on IOI.

Figure 2.2: Overview of the pork supply chain on the island of Ireland



2.2.2 Breeding

The number of breeding animals kept to produce breeding stock on IOI is relatively small; however they determine the genetic composition of all pigs produced in the chain. Genetic selection within breeds and the production of crossbred parents of pork-producing pigs takes place to enhance productivity and quality.

Commercial pig production includes keeping and inseminating commercial crossbred sows for the production of growing and finishing pigs. On integrated units, the pigs are reared from birth to sale in five to six months. On commercial breeding units, the pigs are reared to about 32kg weight/12 weeks old and are then moved to specialised finishing units.

2.2.3 Farrowing and weaning

From birth to three to four weeks of age, piglets are with the sow in the farrowing house. During this time, piglets consume milk from the sow. After weaning, at approximately 28 days, the pigs are moved into the weaner/nursery facilities until they are nine to ten weeks of age. Council Directive 91/630/EEC, as amended, stipulates the minimum weaning age for piglets (28 days). See Section 5.4 for further information on animal welfare requirements.

2.2.4 Growing and finishing

The last stage of production is the grow-finish house. The pigs are in this stage of production until they are approximately five to six months of age. At this point, most pigs are transported to market. Some females (gilts) and males (boars) are selected at five months of age to enter the breeding herd. These animals are maintained for breeding purposes and the production of pigs for market.

The primary components of pigs' diets post-weaning are cereal grains, such as barley and feed wheat, and soybean meal. The soybean meal provides much of the protein, while the cereal grains provide carbohydrates. The diet is supplemented with vitamins and minerals.

Feed accounts for almost eighty percent of the cost of producing a pig. In 2006 the average cost of production in ROI was 123 cents per kg dead weight in herds participating in the Teagasc Pig Recording System (PigSys)[6] and for which costs were available (Table 2.1) [8].

6 The herds that participated in PigSys in 2006 represented 30 percent of the national herd. However, there is a very strong possibility that these are the better performing herds rather than a representative sample of all herds in the country.

Table 2.1: Pig production costs in ROI 2006

Cost category	Cost	Cost per kg (cents)
Feed		79.6
Common	Labour	15.5
	Healthcare	5.1
	Heat, power, light	4.2
	Repairs	3.2
	Manure	2.3
	Others	6.5
	Total	36.8
Herd specific	Building depreciation	4.9
	Interest	1.7
	Total	6.6
Total		123.0

Feed cost per kg dead weight in ROI was the highest in the EU in 2006 at 79.6 cents/kg, compared with 71.8 cents/kg in GB and 64.0 cents/kg in the Netherlands [8]. Figures for NI production costs are not available.

2.2.5 Lairage and slaughter

Finished pigs, which have reached their target weight, are usually transported in special pig transporter trucks to a slaughterhouse.

The slaughtering sector in ROI consists of three medium size plants (10,000 upwards per week) and approximately five smaller plants (up to 5,500 per week) [1]. In NI there is one medium-sized plant (17,000 per week) and two smaller plants (up to 4,000 per week) [1].

On arrival at the slaughterhouse, pigs are usually accommodated and lightly showered for at least two hours in large groups in the lairage area. At this stage, ante-mortem inspection of live animals is undertaken by veterinarians to ensure that only meat from healthy animals will enter the food chain. Veterinarians also assess the welfare of animals to ensure compliance with animal welfare legislation and to ensure that pigs are not and/or do not become stressed as this can have implications for the quality of the meat produced (see Sections 5.2 and 5.4 for further information on quality and animal welfare).

Stunning of pigs on IOI is primarily by means of carbon dioxide, although electrical stunning occurs in some premises. Pigs are then 'stuck', i.e. their throats are cut, and the carcasses are subsequently allowed to bleed out.

Intestines and other organs (including hair and hooves) are removed from the carcass. Post-mortem inspection then occurs whereby carcasses are assessed by veterinarians to ensure that the meat is fit for human consumption. After grading and weighing, the carcasses are stored and cooled for at least 24 hours.

The weight of the pig carcass is defined by the EU as the body of slaughtered pig, either whole or divided down the mid line, which has been bled and eviscerated, excluding flare fat, kidneys and diaphragm without tongue, bristles, hooves and reproductive organs.

Throughout the EU the carcass must be weighed within 45 minutes of slaughter and the weight of the cold carcass is calculated by the application of a conversion coefficient to the "hot" weight to obtain the "cold" carcass weight. This coefficient takes account of the normal weight loss during chilling of the carcass. If a laughterhouse is unable to weigh the carcass within 45 minutes of slaughter, the conversion coefficient should be adjusted accordingly.

Pig carcasses are graded at the time of weighing, according to their estimated lean meat content (Table 2.2).

Table 2.2: The EU Pig Carcass Grading Scheme

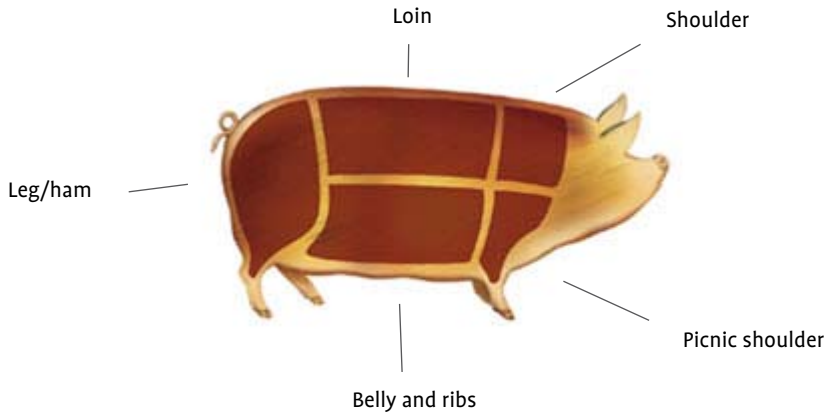
Lean meat as a percentage of the carcass weight	Grade
55 or more	E
50 to 54	U
45 to 49	R
40 to 44	O
less than 40	P

Source: Meat and Livestock Commission, 1999

2.2.6 Boning and processing

Most products for retailers are prepared and packed in specialised cutting and processing units which may or may not be integrated in the slaughter plant. Figure 2.3 outlines the various cuts of pork.

Figure 2.3: Pork cuts



For some pork products, various additives such as salt, herbs and flavour enhancers are added (see Section 1.3). Pork products are then stored and transported, frozen or chilled to wholesale, retail and catering facilities for ultimate sale to consumers.

2.3 Number of pig farms on the island

There were 490 pig holdings in total in NI in 2007, of which 388 were breeding sow holdings [9]. This represents a total decrease of 39 and 44 percent, respectively on figures for 2000 [10]. Pig holdings are concentrated in Tyrone and Down, with Tyrone having the greatest number of pigs (Table 2.3).

Table 2.3: Pig numbers by detailed area NI, June 2007

	Breeding sows	No. of farms	Total pigs	No. of farms
Antrim	3,785	58	41,897	74
Armagh	7,085	66	76,878	87
Down	6,793	100	74,239	122
Fermanagh	*	*	1,937	*
Londonderry	6,731	57	67,913	72
Tyrone	12,583	107	147,586	135
Total	36,977	388	410,450	490

Note: *Figures for Fermanagh and Tyrone have been amalgamated due to data confidentiality constraints

Source: Department of Agriculture and Rural Development 2007 [9]

In ROI there were 440 commercial pig farms in 2007 comprising of 290 integrated breeding-and-finishing units, 50 specialised breeding units and 100 units engaged only in finishing pigs [1]. The three largest pig-producing counties are Cavan (40,000 sows), Cork (38,000 sows) and Tipperary (14,000 sows) representing 52 percent of the national sow herd. The next two largest counties are Waterford (9,000) and Longford (7,700) [1].

2.4 Pig numbers

There were approximately two million pigs on IOI in June 2007. This comprised of 410,450 and 1,587,800 pigs in NI and ROI respectively (Table 2.4).

Table 2.4: Pig numbers on IOI in June 2007

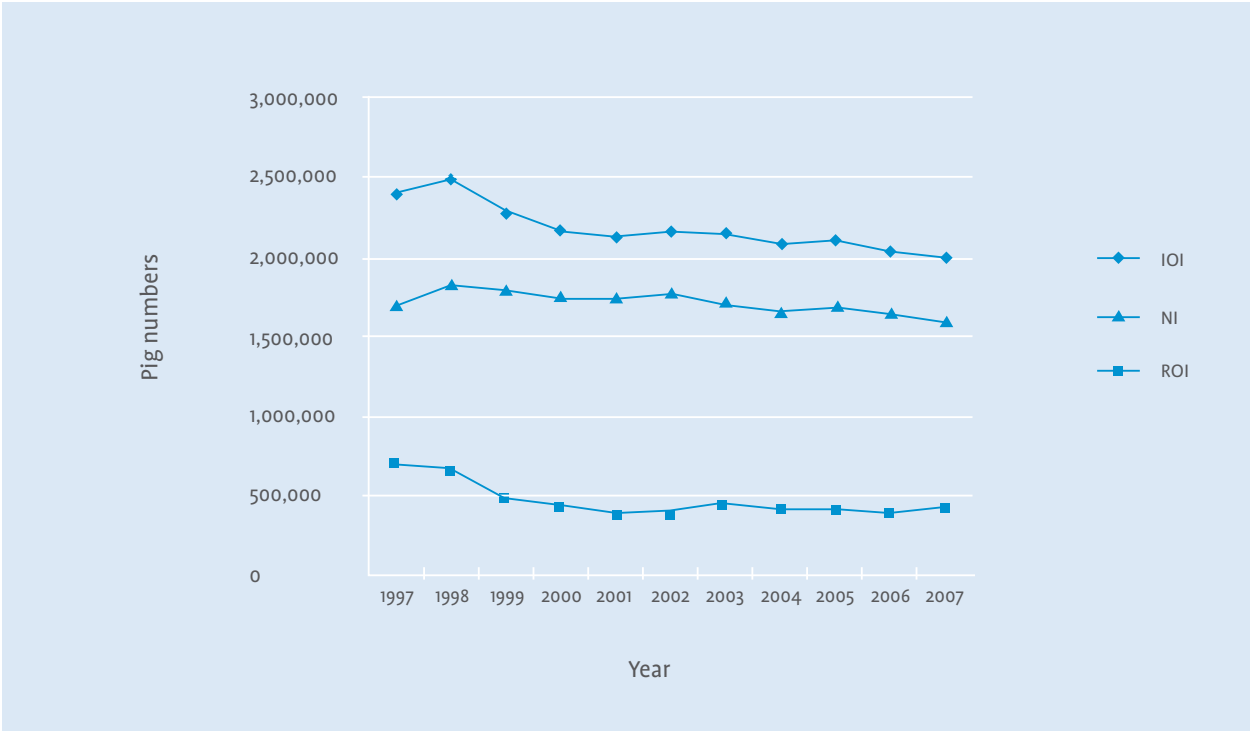
Description	NI[1] June 2007 '000	ROI[2] June 2007 '000
Total pigs	**410.6**	**1,587.8**
Breeding pigs	**41.1**	**165.4**
Gilts in pig	4.3	20.9
Sows in pig	26.0	97.5
Other sows for breeding	6.7	29.6
Gilts not yet served*	3.3	15.6
Boars	0.9	1.8
Other pigs	**369.5**	**1,422.4**
Pigs 80kg and over	65.0	200.1
Pigs 50kg and under 80kg	86.3	330.6
Pigs 20kg and under 50kg	88.7	441.8
Less than 20kg	128.7	449.9
Culled sows being fattened	0.8	-

Note: *Gilts of at least 50kg live weight intended for breeding but not yet served

Source: [1] Department of Agriculture and Rural Development 2008 [6];
[2] Central Statistics Office 2007 [5]

The total number of pigs on IOI has decreased by almost 17 percent in the ten year period since 1997.

Figure 2.4: Pig numbers on the island, 1997 to 2007



Source: Department of Agriculture and Rural Development 2008 [6] and Central Statistics Office 2007 [5]

2.5 Herd size

The average herd size in NI has increased over the years despite a decline in the number of holdings. The average pig herd size in NI in 2007 was 838, a 64 percent increase on the average herd size in 2000 [9].

Ninety percent of farms stocking fattening pigs (20kg and over) and ninety four percent of all pig farms had herd sizes of greater than 400 pigs (Table 2.5).

Table 2.5: Distribution of farms and pigs, June 2007

	Fattening pigs 20kg & over				Total pigs			
	Numbers of		Percentages of		Numbers of		Percentages of	
Number per farm	Farms	Pigs	Farms	Pigs	Farms	Pigs	Farms	Pigs
1-9	50	202	14.2	0.1	115	307	23.5	0.1
10-49	54	1,339	15.3	0.6	91	2,245	18.6	0.5
50-99	26	1,857	7.4	0.8	26	1,929	5.3	0.5
100-199	38	5,494	10.8	2.3	33	4,746	6.7	1.2
200-399	46	14,221	13.1	5.9	49	13,925	10.0	3.4
400-999	84	53,696	23.9	22.3	79	55,374	16.1	13.5
1,000 & over	54	163,888	15.3	68.1	97	331,924	19.8	80.8
Total 2007	352	240,697			490	410,450		
Total 2006	354	219,275			452	386,600		
Average 2007		684				838		
Average 2006		620				855		

Source: Department of Agriculture and Rural Development 2007 [9]

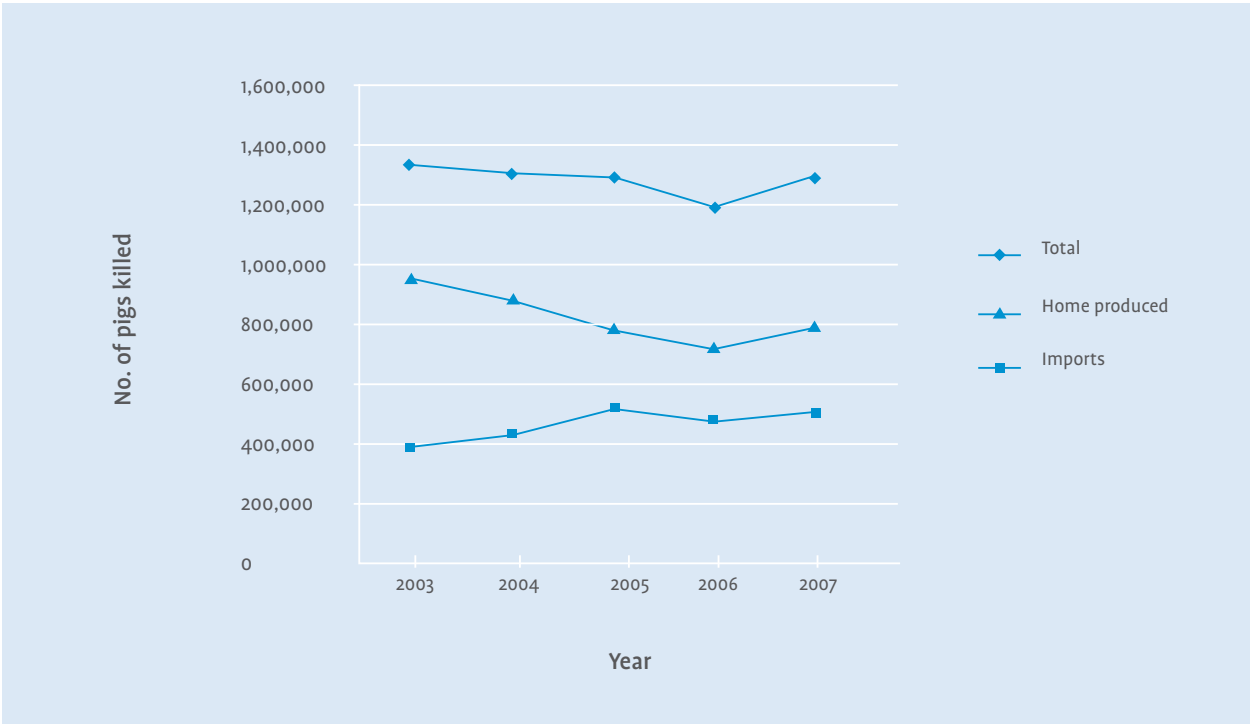
The average size of commercial sow units was 420 in ROI in 2007 [1].

2.6 Production figures

2.6.1 Northern Ireland

In 2007, the total number of pigs slaughtered in NI was 1.3 million. This figure comprises of home-produced pigs (789,337) and imported pigs (511,533[7]) the majority of which are from ROI [11]. This cross-border trade is increasing steadily despite a slight drop off in 2006 (Figure 2.5).

Figure 2.5: Pig kills in NI, 2003 to 2007



The output of finished pigs[8] in NI in 2006 was valued at £68.2 (€100.1[1]) million, while the quantity of the main pig products[9] in output was 71,300 tonnes dead carcass weight[10] (Table 2.6) [12].

7 ROI figures quote 516,000 pigs for 2007 (see Section 2.8.2).

8 Estimated value of home-produced sales, including the value of inter-farm transfers and on-farm use. It includes the value of subsidies on products, the sale value of store animals imported from ROI and GB and finished in NI and the value of produce used in farm households. Stock change estimates are included within the individual output and input items. Includes Foot and Mouth Disease non-capital compensation and Pig Industry Restructuring Scheme (Ongoers) payments. Provisional figure.

9 Estimated home-produced sales, on-farm use and household consumption. Includes pigs slaughtered under the 2000 Pig Welfare Slaughter Scheme and exports of store pigs.

10 These figures cover pigs reared in NI only. They do not include pigs reared in ROI but slaughtered in NI.

Table 2.6: Output of pigs in NI

	1997	2007 (p)
Marketings ('000 head) [1]		
Finished clean pigs	1,286.2	871.1
Culled sows and boars	24.6	12.6
Average price (p per kg deadweight) [2]		
Finished clean pigs	103.48	98.57
Culled sows and boars	75.57	53.20
Average dressed carcass weight (kg)		
Finished clean pigs	71.3	79.7
Quantity of output ('000 tonnes)	95.6	
Finished clean pigs [3]		69.4
Culled sows and boars		1.9
Market value (£m) [4]		69.1
Stock change due to volume (£m)	+0.7	-0.09
Value of output (£m)	**99.1**	**68.2**

Notes: (P) – Provisional

[1] Estimated home-produced marketings, including unrecorded exports and pigs slaughtered under the 1998 and 2000 Pig Welfare Slaughter Schemes. Excludes animals slaughtered under Foot and Mouth Disease control measures.

[2] Average realised return gross of marketing expenses, including receipts from the 1998 and 2000 Pig Welfare Slaughter Schemes.

[3] Clean pig producer prices and carcass weights changed from a UK to an EU carcass dressing specification from 1997. This change increased the average price per kilogram by approximately 1.6 percent and reduced the average carcass weight by a similar amount.

[4] Includes breeding and store pigs exported less all pigs imported. Also includes receipts from 1998 and 2000 Pig Welfare Slaughter Schemes, Foot and Mouth Disease Compensation (non-capital) payments and Pig Industry Restructuring Scheme (Ongoers).

Source: Department of Agriculture and Rural Development, 2008 [12]

2.6.2 Republic of Ireland

The total pig slaughterings in ROI was 2.6 million head in 2007, of which 2.57 million were processed in 14 EU-approved slaughter plants and 25,000 were processed in local authority-approved abattoirs [13].

The volume of ROI pig meat production was 207,000 tonnes cwe in 2007 (Table 2.7) [13].

Table 2.7: ROI pig meat balance sheet ('000 tonnes cwe)

	1997	2002	2007(e)
GIP production	242	245	239
Net production (slaughter)	221	231	206*
+ pigmeat imports	29	46	64
- pigmeat exports	108	127	113
Total availability**	250	285	271
Consumption			
- '000 tonnes cwe	142	150	158
- kg/head	38.8	38.3	37.3

Notes: (e) estimated
*Export meat plants–205,000 tonnes, Local abbatoirs-2,000 tonnes
**Net production plus Imports

Source: Bord Bia, 2007 [15]

Within the 2007 figure, export approved plants accounted for 99 percent of the total at 205,000 tonnes with approximately 2,000 tonnes produced at local abattoirs [14].

2.6.3 Production in a European and global context

Although ROI had the largest average herd size in the EU in 2006 at 355 sows, it only accounted for 1.4 percent of total EU pig meat output. ROI ranked fifteenth (1.62 million) among EU-25 pig numbers with the UK at ninth position (4.731). The top ten EU pig meat producers in 2006 ('000 tonnes cwe) were Germany (4,400), Spain (3,200), France (2,200), Poland (2,100), Denmark (1,800), Netherlands (1,600), Italy (1,500), Belgium (1,000), UK (500) and Austria (400) [16].

Considerably more pig meat is produced within the EU than any other type of meat with 21.4 million tonnes produced in EU-27 countries in 2006 [1]. The EU is a net importer of pig meat (Table 2.8).

Table 2.8: EU-25 pig meat balance sheet 2006

	'000 tonnes
Gross indigenous production	21,400
Consumption	19,868
Imports	18
Exports	1,550

Source: Meat and Livestock Commission 2007, [16]

China is the leading pig meat producer in the world, representing 54 percent of production. The EU is next (21%), followed by the US (10%), Brazil (3%), Canada, Vietnam and Russia (2% each) and others (6%) [14].

2.7 Imports

2.7.1 Northern Ireland

As already discussed in section 2.6.1, in 2007 NI imported 511,533 live pigs for slaughter, the vast majority of these emanating from ROI. This was a reflection of better prices available and a steady demand for pig meat in the UK. Figures for pig meat imports, however, are unavailable separately to overall UK figures.

2.7.2 Republic of Ireland

One third of all pig meat consumed in ROI is imported [17].

ROI pig meat imports were 68,386 tonnes pwe and were valued at over €2 (£1.1[1]) million in 2007 [13]. A considerable proportion of imports coming into ROI are destined for further processing and eventual re-export as part of a final product [13]. The majority of pork products imported are carcasses and backs or loins [1].

In 2007, pig meat was primarily imported into the ROI from the UK (45%, including 4% from NI) and continental Europe (54%). Of the latter, the main countries which provide imports to the ROI market are Germany (21%), Netherlands (13%), France (8%) and Denmark (5%). Third Country imports only represent 1% of all ROI imports and Chile is the principal provider (Table 2.9).

Table 2.9: Overview of ROI imports

Source	Volume (tonnes pwe)	Value (€000's)
UK		
GB	28,090	82,147
NI	2,620	7,431
Total UK	**30,710**	**89,578**
Continental Europe		
Austria	195	301
Belgium	883	3,429
Denmark	3,525	11,602
France	5,768	15,775
Italy	1,313	3,948
Lithuania	510	1,493
Netherlands	8,633	23,177
Germany	14,208	49,842
Poland	1,122	2,536
Spain	585	1,528
Total Continental Europe	**36,756**	**113,697**
International		
Australia	92	273
Brazil	49	123
Chile	679	1,734
Japan	78	34
Total International	**919**	**2,224**
Grand Total	**68,386**	**205,498**

Source: Central Statistics Office, 2007 [18]

Total ROI imports in 2006 comprised, by volume, pork (51.7%), bacon and ham (8.5%), processed products (24.1%), sausages (12.2%) and chilled edible offal (3.5%) [18].

2.8 Exports

2.8.1 Northern Ireland

Total pig meat sales were valued at £170.1 (€250.5[4]) million in 2005[11]. Sales outside of NI (to GB, ROI and other countries) were valued at £96 (€141.4[4]) million, while sales outside of the UK (export sales) were valued at £29.6 (€43.6[4]) million [4]. Sales volumes are not available.

2.8.2 Republic of Ireland

Over half of the pig meat (113,000 tonnes cwe) produced in the ROI in 2007 was exported with a value of €212 (£155[1]) million [13]. Approximately half of this was exported to the UK (56,000 tonnes cwe/€125 (£92[1]) million), over one quarter (32,000 tonnes cwe/€45,000 (£33,000[1]) to continental Europe (Germany, France, Italy and others) and just under one quarter (25,000 tonnes cwe) to international markets such as Japan, Russia, the US and other Third Countries [13].

Total live exports from ROI in 2007 were solely to NI [13].

2.9 Retail sales

2.9.1 Northern Ireland

In NI 2005/6, weekly household expenditure on pork[12] was £0.70 (€1.03[4]), while weekly household expenditure on bacon and ham[13] was £1.10 (€1.62[4]) [19].

2.9.2 Republic of Ireland[14]

In ROI, the total meat market was valued at €1.2 (£0.8[1]) billion year ending 04 November 2007. Each household spent €815 (£556[1]) per annum, or €15.67 (£10.68[1]) per week, on meat [20].

Based on volumes during this period, the meat market on ROI comprised beef (32.2%), lamb (8.2%), sausages (8.5%), pork excluding sausages (12.0%), bacon (13.8%), poultry (23.7%), pudding (1.4%) and other (0.2%) [20]. The total pig meat market comprised 34.3 percent of the overall meat market.

In terms of the overall meat market, pork is showing the strongest growth year on year, followed by puddings. See Appendix C for further information on the pork retail market in ROI.

Distribution channels

Retail sales of pig meat on are primarily via the multiples (Super Valu, Dunnes, Tesco, Superquinn), followed by total symbols, butchers, discounters and independents.

In terms of the type of consumers of the various pork products on ROI, sausages are favoured by families with young children (young families), pork chops and rashers by young couples without children (pre-families), and bacon joints by consumers whose children have grown up and left the family home (empty-nesters) [20].

11 Data more recent than 2005 is not available.
12 Carcass meat only, excludes meat in meals outside the home.
13 Uncooked bacon and ham only, excludes meat in meals outside the home.
14 All figures are based on year ending 15 July 2007.

2.10 Summary

The pig sector makes a valuable contribution to the economies of NI and ROI. Pig meat production was valued at €290 (£198) million at farm gate in ROI in 2007, representing five percent of gross agricultural output [3]. In 2006 in NI, pigmeat was estimated to account for almost seven percent of gross turnover in the food and drinks processing sector at £190 (€280) million [4]. Comparable figures for the value of the pig meat industry on ROI and NI are not available.

There are approximately 930 pig holdings on the island stocking 2.0 million pigs. In 2007, 1.3 million pigs were slaughtered in NI and 3.12 million in ROI. There is significant cross-border trade in live pigs with approximately 40 percent of pigs slaughtered in NI reared in ROI.

Over one third of pig meat consumed in ROI is imported. The volume of pig meat imported into ROI was approximately 64,000 tonnes cwe, valued at over €1.5 (£1.1) million in 2007. Imports were primarily sourced from the UK and continental Europe.

Approximately half of the pig meat produced in ROI is exported (113,000 tonnes cwe) and was valued at €212 (£155) million in 2007. Export sales of pig meat from NI were valued at £96 (€141) million in 2005.

3 Food Safety

3.1 Overview

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). Pork production systems on the island strive to control both microbiological and chemical hazards and minimise the risk to consumers.

Table 3.1: Types of food contaminants

Hazard	Example
Microbiology	Bacteria, viruses, yeasts, moulds
Biological	Parasites, bone, hair, insects, faeces
Chemical	Pesticides, toxins, cleaning liquids, veterinary drug residues
Physical	Glass, metal, wood, string, dirt etc.

This chapter will look at the microbiological and chemical aspects of the pork supply chain. This includes the hazards and risks associated, and the controls in place to minimise such risk.

3.2 Microbiology

3.2.1 Foodborne human infections associated with pork and pork products[15]

3.2.1.1 Introduction

The consumption of raw or undercooked pork poses a risk of infection as does the cross-contamination of ready to eat foods with bacteria from raw pork or its juices. However, infectious intestinal disease associated with pork is not a common source of human infection and in any case is totally preventable with the adoption of correct hygiene practices.

A study of the estimated annual impact of foodborne disease from pork in England and Wales for the years 1996 to 2000 was reported as three percent of cases with four percent of attributable deaths [21]. *Salmonella* is one of the principal organisms of concern with respect to the pork supply chain. Pig meat was implicated in 11 *Salmonella* outbreaks (5.1 percent of total) in the EU in 2004 and these affected 204 people (3.3 percent of total affected) [22].

Pork meat and processed pork products have been associated with a number of foodborne diseases such as yersiniosis and trichinellosis that are rare on the island of Ireland (IOI) but more common in other areas of the world. In recognition of the global economy and multi-culturalisation on IOI, these infections may become more frequent in the future.

Antimicrobial resistance also poses a challenge for those involved in the pork industry. Epidemiologic research and surveillance indicates that pathogens with antimicrobial resistance patterns have been detected in pork-derived products and subsequently in humans.

15 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.

3.2.2.2 Human outbreaks associated with pork

Data from population-based studies and surveillance systems have been analysed to estimate the burden of infectious disease associated with pork.

Outbreak data from IOI

Table 3.2 details five outbreaks associated with pork meat notified in ROI in the past decade. The most notable is the major outbreak of *Salmonella* Typhimurium in the Dublin region in 1998 as a result of consumption of infected ham.

Table 3.2: Outbreaks associated with pork meat on ROI

Year	Month	Extent	No. ill	No. hospitalised	Pathogen	Location	HSE region	Vehicle
1998	March	General	173	n/a	S. Typhimurium DT104b	Retail outlet	E	Ham
1998	July	General	20	n/a	*Salmonella* spp.	Hotel	W	Ham
1998	August	General	26	n/a	S. Typhimurium	Hotel	W	Ham
2000	February	General	78	27	S. Typhimurium DT104	Community	NE	Ham
2005	December	Family	3	1	*Salmonella* spp.	Private House	MW	Hot dog

Source: Personal Communication, Health Protection Surveillance Centre, December 2007

There have been no recent outbreaks associated with pork meat in NI (Personal Communication, CDSC, December 2007).

Outbreak data from England and Wales

A major study conducted on data from England and Wales during the period 1996 to 2000 demonstrated that only three percent of cases of indigenous foodborne diseases (over 1.7 million total cases) were attributed to pork meat consumption (Table 3.3) [21]. However, it is noteworthy that the associated fatality rate is high.

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
Pork	**46,539 (3)**	**24 (4)**	**53**
Beef	115,929 (7)	67 (10)	58
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

*Deaths/100,000 cases

Source: Adak et al. 2005, [21]

In spite of the high fatality rate, the actual estimated disease risk associated with pork meat ingestion is relatively low (Table 3.4). At 20 cases/one million servings, the disease risk is almost half that of the other red meats (beef and lamb).

Table 3.4: 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
Pork	**20**	**180**	**93**	**208**
Beef	41	375	153	339
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	n/a	8	NA

Note: * Cases/1 million servings
† Hospitalisations/1 billion servings

Source: Adak et al. 2005, [21]

The health care impact arising from pork associated infection for the surveillance period in the study was also low (Table 3.5) in terms of GP visits and hospitalisation.

Table 3.5: 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)
Pork	**11,923 (3)**	**219 (1)**	**1,685 (2)**
Beef	34,981 (8)	429 (2)	4,284 (4)
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)

Note: * Totals given are calculated on the basis of rounding to whole numbers.

Source: Adak et al. 2005, [21]

In England and Wales between 1992 and 1996, 1,423 foodborne general outbreaks of infectious intestinal disease were reported. Sixteen percent of these (218 outbreaks) were linked with the consumption of red meat with over 5,000 people affected, 186 hospital admissions and nine deaths. Pig meat accounted for (32 percent) or 71 outbreaks. Most outbreaks occurred as a result of food cooked in commercial catering premises (46 percent).

Outbreak data from the EU
The 2004 EU Zoonoses Report, published in 2006 by the European Food Safety Authority (EFSA) provides, for the first time ever, extensive data on foodborne disease outbreaks [22]. However, the data differed somewhat between the Member States and details of outbreak settings and sources were not available on the majority of outbreaks.

The most common cause of outbreaks in the EU in 2004 was *Salmonella*, causing 215 (73.9 percent) of reported outbreaks and 68 percent of individual cases. Pig meat was implicated in 5.1 percent of these *Salmonella* outbreaks, accounting for three percent of people hospitalised [22].

In the same year there were 15 outbreaks of trichinellosis affecting 196 people of which 145 people were hospitalised. Lithuania reported four outbreaks with 20 cases associated with eating undercooked wild boar and pig meat. Poland reported four outbreaks with 157 cases and 131 hospitalisations. The Czech Republic and Latvia also reported outbreaks. Pig meat and wild boar meat sausages were the foods identified [22].

The Danish Institute of Food and Veterinary Research used a mathematical model to quantify the contribution of animal–food sources to human salmonellosis based on surveillance data from 1999 [23]. Pork meat accounted for nine percent of domestic and sporadic cases.

3.2.2.3 Pathogens associated with pork meat
Salmonella
S. enterica was detected in a retail survey of raw pork sausages in the Republic of Ireland (ROI) at a level of 4.4 percent and 1.7 percent in samples collected in 2001 and 2002, respectively [24]. In a large study that collated microbiological test data from the Department of Agriculture, Fisheries and Food (DAFF) approved private laboratories, *Salmonella* was detected in 2.1 percent of raw pork and raw pork products (454 out of 21,144 samples) tested over the years 2003–2004 in ROI [25]. The predominant serovar isolated was *Salmonella* Typhimurium, followed by *Salmonella* Derby [26].

Salmonella was not found in any of the pork meat products sampled at retail level in ROI in 2005 (n=1,853), but it was identified in 1.8 percent of raw pork (51 out of 2,843 samples) and 0.5 percent of pork products (39 out of 7,976 samples) sampled at processing level in 2005 [27]. *S.* Typhimurium was the serovar identified in 43 of the samples (48 percent). Similarly *Salmonella* was found in 1.7 percent (n=2927) of raw pork and 0.5 percent (n=9,053) of pork products sampled at processing level in ROI in 2006. The serovar *S.* Typhimurium was identified in 20 samples of raw pork (40 percent) and 26 samples of pork products (57 percent) at processing level. *S.* Bredeney was identified in one pork product sample (0.1 percent, n=943) at retail level [28].

Salmonella was identified in 15 out of 310 pigs ante-mortem (4.8 percent) sampled in 2006. The species identified were Typhimurium (33 percent), Derby (20 percent), Braenderup (7 percent) and Unspecified (40 percent) [28].

In June 2008 the Report of the Task Force on Zoonoses Data Collection on the analysis of the baseline survey on the prevalence of *Salmonella* in slaughter pigs, in the EU, 2006-2007, was published [29]. The purpose of this study was to establish baseline levels of *Salmonella* in pigs at slaughter in the EU-25 and Norway in advance of proposed Community legislation setting *Salmonella* reduction targets for food-animal populations including pigs.

A review of five large salmonellosis outbreaks from 2001 to 2005 in Germany, for which pork was the probable vehicle of infection, identified pork as an increasingly recognised source of human infection [30].

In summer 2004, a multi-state outbreak caused by a relatively rare serovar, *Salmonella* Give, was detected in Germany. In total 115 cases caused by *S.* Give were identified. There was strong epidemiologic and microbiological evidence of an association with consumption of raw minced pork.

A large outbreak of *Salmonella* Typhimurium DT193 affecting 206 persons in 1989 in Northern England was thoroughly investigated [31]. There was epidemiologic and microbiological evidence pointing to cold roast pork supplied by a local butcher. Inadequate processing and cross-contamination played a part in transmission.

An unusual outbreak reported in France between August 2005 and March 2006, was caused by *Salmonella* Manhattan [32]. Sixty nine cases were reported, 74 percent of them from South-Eastern France. A case control study identified an association with pork sausages. Microbiological evidence confirmed the link. A trace-back revealed one wholesaler in South-Eastern France whose pork products had tested positive on routine testing in August 2005.

An economic analysis of annual societal costs caused by human salmonellosis cases in the Netherlands in 2001 estimated that they accounted for between €32 (£23.5[1]) and €90 (£66[1]) million [33]. Approximately 25 percent of all human salmonellosis cases in the Netherlands are caused by serotypes originating from pigs.

In order to better detect outbreaks of salmonellosis across Europe the Enter-Net data co-ordination project was created in 1998 and initially produced reports on human salmonellosis involving the then 15 countries of the EU, plus Australia, Canada, Japan, South Africa, Switzerland and Norway [34]. The network is currently being extended to include the newly associated eastern European countries.

Staphylococcus aureus

Staphylococus aureus is transmitted from the skin of animals and food handlers and is associated with illness (vomiting) as a result of toxins produced at temperatures above 10°C. This organism is commonly associated with unhygienic handling and contact with food workers who carry the bacteria but it can be controlled by good hygienic practices.

Staphylococci are salt tolerant and can grow in salty foods such as ham. The salt content of precooked, packaged hams is often as high as 3.5 percent, which provides an ideal growth medium for this bacterium [35]. Furthermore, this processing, which reduces the normal flora of a meat product, can favour the growth of *S. aureus* which is otherwise a poor competitor.

In many countries *S. aureus* is the second or third most common known pathogen causing outbreaks of food poisoning. Often the consumption of ham is identified as the cause of illness [36]. In a German study of 135 pork meat samples, 25.9 percent of the samples were culture positive for *S. aureus*. Over a third (35 percent) of these strains were enterotoxigenic and therefore capable of causing food poisoning.

Listeria monocytogenes

Listeriosis is mostly a mild and self-limiting flu-like illness, but in certain instances it can cause meningitis and meningoencephalitis. In pregnant women it can also be associated with transplacental foetal infection which can result in abortion, stillbirth, or premature labour. *In utero* infection can cause pneumonia, septicaemia and widely disseminated granulomas.

L. monocytogenes was identified in six percent of pork meat products (n=175) sampled at processing level in ROI in 2005 [27]. In the same year it was identified in 0.1 percent of pork products (n=1,840) sampled at retail level [27].

L. monocytogenes was not identified in any pork meat products (n=130) sampled at processing level in ROI in 2006 [28], however, it was detected in 5.8 percent of pork products (n=602) sampled at retail level in the same year [28].

Listeria spp. was not identified in any of the 312 ante-mortem pigs sampled in 2006 [28].

Pork meat and processed pork producers, such as deli meats, have been implicated in a few *Listeria* outbreaks in France and in other European countries over the past decade [37].

A major pork-associated outbreak of listeriosis was identified in France in 1992 [38]. In all, 272 cases were identified (92 pregnancy-related). The epidemic strain identified was phenotypically and genotypically closely related to strains responsible for major outbreaks of listeriosis previously observed in Europe and North America. Pork tongue in jelly was the identified vehicle of this outbreak.

Yersinia enterocolitica
Yersiniosis is an acute enteric bacterial disease manifested by acute diarrhoea (especially in young children), enterocolitis, abdominal pain, fever, headache and vomiting. It can cause appendicitis-like symptoms in humans.

In the last ten years, the incidence rate of reported cases in Europe has been relatively stable, but clear peaks were seen in 1998 and 2002 [39]. In 2005, 23 European countries notified a total of 9,564 cases of human yersiniosis with Lithuania followed by Finland reporting the highest incidence rates.

EFSA identified 51 outbreaks of yersiniosis in Europe in 2004 representing 0.8 percent of all foodborne outbreaks for that year [22].

An outbreak of an unusual serotype (serotype O:9) occurred in Norway in 2006 [40]. Eleven cases were notified and a case control study identified brawn (jellied pig heads) as the probable source based on both epidemiological and microbiological findings.

Yersiniosis has been notifiable in ROI since 2004 and the number of cases in recent years were six in 2004, three in 2005 and one in 2006 [41]. Yersiniosis is not a notifiable disease in Northern Ireland (NI), however, laboratories report it in any instance and there were three cases in 2006 (Personal Communication, Communicable Disease Surveillance Centre, December 2007).

Yersinia spp. was not identified in any of the 310 ante-mortem pigs sampled in ROI in 2006 [28].

Clostridium botulinum
Botulism is a rare but serious paralytic illness caused by the bacterium *Clostridium botulinum*. Foodborne botulism is a serious problem in only a few countries in Europe and the trend has been stable over the years [39]. Over the past 10 years Poland reported the most cases with a total of 152 cases being reported in 2005.

There is no common pattern of implicated foods in countries where botulism occurs frequently, but rather a large range of products [42]. Home-made preparations are most commonly implicated. A review of reports from Italy indicate that vegetable preserves are responsible for most cases while home-made ham and sausages were associated with seven percent of cases from 1994 to 1998.

Antimicrobial resistance and cross-resistance
Illnesses caused by multi-drug resistant species are more difficult to treat than those caused by pan-susceptible species. Although many patients recover without antimicrobial therapy, those with severe infections may require treatment and multi-drug resistant organisms limit effective medication choices.

Resistance to antimicrobials has been reported in all of the bacterial pathogens discussed in the previous sections.

A review of 110 *Salmonella* Derby isolates notified during a three year period (2000 to 2002) in Spain showed a major clone of *S.* Derby in 62 percent of swine, 52 percent of pork products and 19 percent of strains from humans [43]. Anti-microbial resistance was a feature of this clone.

In Luxembourg, locally produced pork meat was associated with two major outbreaks of *Salmonella* Enterica serovar, four in a day care centre in 2006. This strain had a distinct antibiotic resistance profile [44].

Salmonella Typhimurium is the *Salmonella* serovar most frequently associated with pork meat [39]. *S.* Typhimurium definitive Type 104 (DT104) is a phage type typically characterised by resistance to five or more antimicrobial agents. In NI, the number of isolates of DT104 associated with human illness have declined considerably over the past decade from 142 in 1998 to 11 in 2006 (Personal Communication, CDSC NI, December 2007). In ROI in 2006 12 isolates of DT104 were notified.

Other non-bacterial pathogenic microorganisms

Toxoplasmosis

Toxoplasmosis is caused by the protozoan parasite, *Toxoplasma gondii*. The infection is asymptomatic in most human cases but can cause serious illness in immuno-compromised individuals and can cause foetal damage if contracted in pregnancy. The definitive host is cats but ingestion of undercooked meat can be a source.

In 2005, 1,519 cases were reported from 14 European countries with Lithuania and Slovakia reporting the highest incidence [39]. The European Centre for Disease Control concluded that very few conclusions could be made from currently available data [39].

Trichinellosis

Trichinellosis is a parasitic disease caused by roundworms with variable clinical manifestations from mild to occasionally fatal.

In the last ten years, the incidence of Trichinellosis in Europe has shown an overall decreasing trend despite peaks in Slovakia, France and Italy in 1998, Poland 1999, Latvia 2000 and Lithuania 2001 [39]. In 2005, 153 cases were reported Europe-wide with cases in Latvia and Lithuania being the most frequent.

In the EFSA Zoonoses Report for 2004, 15 outbreaks (0.2 percent total foodborne) were documented, affecting 196 people of which 145 were hospitalised. Undercooked wild boar and pig meat were the linked foods [22].

While trichinellosis is a notifiable disease in ROI, it is not notifiable in NI, although laboratories report it. There were no laboratory reports of trichinellosis in NI in 2006 (Personal Communication, Communicable Disease Surveillance Centre, December 2007). The last confirmed case of trichinellosis in NI was in 1979 in pig meat from a farm. This case was linked to suspected illegally imported meat [45]. Available data from ROI report no cases for the years 2004 to 2006 [41]. However, two cases in Polish nationals living in ROI were notified in 2007, infection was associated with consumption of lightly smoked pork sausages produced in Poland and brought into ROI [46].

Pigs are routinely monitored for the presence of Trichinella at the slaughterhouse. Trichinella was not detected in any of the 3,598 pigs tested in ROI in 2005 [27] or in any of the 3,743 pigs tested in 2007 [28]. In NI 838,822 pigs were tested during 2006. All samples were negative [45].

Commission Regulation (EC) 2075/2005, lays down specific rules on official controls for *Trichinella* in meat. It requires all domestic pigs to be tested for *Trichinella* at slaughter. However, Article 3 allows for the competent authority of a Member State to seek the agreement of the Commission and other Member States not to test fattening pigs for *Trichinella* in regions where the risk in domestic pigs is officially recognised as negligible. All pigs slaughtered for human consumption on IOI have to be tested and shown to be free from this worm.

3.2.4 Microbiological risks along the food chain

The vast majority of pork production on IOI is intensive in nature with the consequent benefits of facilitating disease control. However, once biosecurity is breached there can be a rapid spread of microorganisms within a herd. Pigs are prone to several illnesses which are zoonotic in nature with *Salmonella* being the principal organism of interest.

3.2.4.1 At Farm Level

The large numbers of animals in close proximity facilitates the spread of infections and in cases of illness, contaminated faeces are produced. The persistence of pathogens in such material is well documented. One study conducted in ROI [47], showed that when pig slurry was inoculated with $\log_{10}$ 5.0 CFU ml^{-1} *Salmonella* Typhimurium and *Salmonella* Derby, that the serovars survived for 34 and 23 days, respectively in summer, and 58 and 46 days, respectively in winter. Thus a two month holding time of pig slurry, prior to land spreading may be inadequate. Application to land can lead to the spread of contamination unless carefully managed [48] [49].

Control of *Salmonella* on pig farms has been investigated with studies such as a Canadian determination of potential risk factors for the presence of *Salmonella* on finishing farms [50]. This study found that three factors remained significant at the five percent level in a multivariable analysis: farm type; ration type; and precautions taken when entering or leaving the farm. Thus biosecurity-related factors were significant. The use of antibiotics in feed is permissible in Canada and during the study this was found to reduce the prevalence of *Salmonella*. However, the use of antibiotics for non-therapeutic reasons is illegal in Europe and alternative methods would need to be employed.

Acidification of feed with lactic and formic acids has been shown to reduce *Salmonella* sero-prevalence in pigs [51], and the use of lactic acid bacteria as probiotics has also shown promise for the control of *Salmonella* [52].

A study in ROI noted that improvements in the application of hygiene programmes could be expected to reduce the potential for spreading infection and cross-contamination of other animals, and help to reduce the number of *Salmonella* positive pigs entering abattoirs [47].

3.2.4.2 Transport from farm to slaughterhouse

The effects of transport and time spent in the lairage are known to increase levels of *Salmonella* in pigs. Recovery of additional serovars at the abattoir to those noted on farms suggests that pigs are receiving *S. enterica* from extra-farm sources. Rapid infection during transport, and particularly during holding, is cited as a major reason for increased *S. enterica* prevalence in pigs.

The holding pen (lairage) has also been identified as an important *S. enterica* control point in the pork production chain [53]. The *Salmonella* status of market-age pigs assessed on the farm, either by serological or bacteriological examinations and the time spent in lairage before slaughtering, can play a crucial role in caecal contamination [54]. Indeed the need to develop effective intervention measures to control the spread of *Salmonella* in the preslaughter environment was highlighted [55]. When *Salmonella* free pigs were placed in a contaminated environment they rapidly (within 3 hours) became infected with the challenge *Salmonella* Typhimurium strain [24].

The incidence of *Salmonella* on pigs presented at processing plants in ROI in 2002 was up to 60 percent [56]. One study found that up to 100 percent of Belgian lairage samples could contain *Salmonella* [57], thus the opportunities for cross contamination in the lairage are very high.

These findings highlight that it is essential that clean pigs are appropriately transported and held prior to slaughter to ensure cross contamination does not occur.

3.2.4.3 Primary Processing

Examination of pigs for the presence of *Salmonella* can be undertaken by a number of methods. One Dutch study of 1,114 pigs noted that the prevalence determined will vary according to the sample type taken [58]. The highest prevalence of *Salmonella* was observed in rectal content samples (25.6 percent), whereas the lowest prevalence of *Salmonella* was observed on the carcasses (1.4 percent). Overall, 43 percent of pigs yielded a positive sample of some type which, given the much lower incidence of positive carcasses, illustrates that interventions in the abattoir can be successful.

The consequences of failing to control cross-contamination can be gauged from the fact that 61 percent of drain water samples from two abattoirs in the Dutch study were positive for *Salmonella*, as were 33 percent of samples from the carcass splitter in one abattoir. Thus there is considerable potential for cross contamination in abattoirs and this must be controlled.

In contrast to the low prevalence in the Dutch study, a Belgian review of 370 carcasses before chilling found a much higher prevalence of *Salmonella* on carcasses (37 percent); however, this figure fell markedly after chilling overnight [57]. It should be noted that a different set of carcasses were sampled before and after chilling making comparison of the results difficult. Nevertheless, studies conducted by DARD in NI showed that chilling pig carcasses overnight to United States Department of Agriculture standards reduced the prevalence of salmonellae on carcasses by about 85 percent.

A ***safe*food**/FIRM project 04-RESR-08 "Occurrence of *Salmonella* in pork on IOI and an assessment of the risk factors contributing to its transmission" is currently in progress. The study investigated oyster cuts from pig carcasses and found 3.3 percent were positive in ROI and 8.3 percent in NI.

Overall, contamination rates vary across countries and different sampling regimes make direct comparisons difficult. The results of the EU baseline study conducted at abattoir level in each Member State allows ready comparison of *Salmonella* prevalence throughout the EU [29].

Control of Salmonella in the pork food chain

Control schemes to minimise the incidence of *Salmonella* species in pigs have been in place in NI and ROI for a number of years. While the schemes differ to some extent in the approach taken, both are based on a serological testing of pigs at slaughter. At the time of writing both schemes are under review and are likely to be revised in autumn 2008.

As noted in Chapter Two, 40 percent of pigs slaughtered in NI originate in ROI thus a fully compliant *Salmonella* control scheme on the island is critical.

Northern Ireland
The UK Zoonoses Action Plan (ZAP) Programme was introduced in order to help ensure that the risk to consumers presented by *Salmonella* species, however small, was minimised. A *Salmonella* Control Scheme was introduced in NI in January 2003. This is based on meat samples being collected at abattoirs and being sent for testing for the presence of *Salmonella* antibodies, based on the VetSignä VP020 *Salmonella* ELISA (Enzyme-Linked ImmunoSorbent Assay) test. In the year ending June 2006, 160,019 samples were collected and submitted by participating abattoirs.

Each herd is assigned a ZAP status based on the herd prevalence of *Salmonella* as given by the *Salmonella* ELISA antibody test.

Producers with high prevalence of positive samples are offered advice from DARD and are required to draw up and implement an action plan with a veterinarian within the first six months or risk losing their quality assurance status (see Chapter Five).

Republic of Ireland
In ROI, the statutory National *Salmonella* Control Programme was implemented in August 2002. This programme requires that all commercial pig herds be tested and categorised according to their *Salmonella* status. Herds are categorised on the results of a meat juice ELISA test carried out on finishing pigs submitted for slaughter.

There is a dedicated slaughter regime for pigs in the highest category of *Salmonella* positive herds. These are slaughtered separately from other pigs and in a manner that minimises the risk of contamination (separate days or times). Head meat and selected offal from these pigs may not enter the food chain unless heat treated. The extra cost is at present borne by meat plants at an estimated cost of €4 per pig. Herds with incomplete data are treated in the same way. At present about 4,000 pigs per week are being restricted and about 50 percent of these pigs are from herds without a valid certificate [1].

When the *Salmonella* control scheme was introduced a penalty system was also envisaged as is the case in Denmark. However, mainly for trade issues this was never implemented in ROI. The Danish pig industry is often cited as having one of the best *Salmonella* control programmes in the world. The basis of the system is regular sampling of animals to maintain a *Salmonella*-free status (Appendix C) [23]. The UK and ROI have adopted simpler systems to suit local conditions by concentrating sampling on meat juice taken from abattoir samples. On farm sampling is only undertaken when a high prevalence of *Salmonella* is detected and remedial action is required, rather than as a routine measure. Hence significantly less sampling is undertaken in UK and ROI than in Denmark, reducing the scheme costs.

Since 1 January 2008, all slaughterhouse operators in NI must 'request, receive, check and act upon' food chain information (FCI) for all pigs sent to the slaughterhouse. This consists of a range of facts about the farm and the pigs destined for the food chain, including the history of rearing, their exposure to veterinary medicines and their health status. This requirement forms part of the whole chain, farm-to-fork, approach to food safety introduced by the Hygiene Regulations from the beginning of 2006 [59].

Antimicrobial treatment (decontamination) of pork
EU restrictions on treating fresh meats mean that limited interventions in the abattoir are in force. The chilling process has been seen to reduce the prevalence of *Salmonella* but little quantitative data is available. The outputs of ***safefood***/FIRM project 04-RESR-08 are expected to establish levels in order to provide data for a risk assessment model.

Current interventions, meanwhile, are based around limiting cross-contamination during carcass preparation with hot water being used as a final intervention [60].

3.2.4.4 Secondary processing
The process of preparing the pork carcass into a suitable product for sale to retailers, caterers and the final consumer is known as secondary processing. There are four main areas of secondary processing: catering and butchery (supplying meat packs of a specific meat type for hotels, restaurants *etc.*); retail packing (the Modified Atmosphere Packaging (MAP) and labelling of specific meat products for supply to retailers, such as supermarkets and shops); prepared meats and recipe products (the production of uncooked meats such as burgers, sausages and ready to eat convenience foods); and manufacturing (supply of pork for the production of cured meats).

In the UK it is estimated that 78 percent of pig meat (pork and bacon) is handled by a secondary processor in order to produce a "value added" product [61].

The cutting of the pork carcass into smaller portions can result in the transfer of *Salmonella* from the outer surface of the meat and inedible tissues to freshly cut pork [62]. Research has shown that *Salmonella* can be spread by inadequately cleaned knives and this can lead to cross contamination of different pork carcasses [62].

Cold cooked meats are considered a source of listeriosis in the US and an incidence of 0.89 percent in sliced luncheon meats has been demonstrated [63]. Indeed, the WHO Risk assessment of *Listeria monocytogenes* in ready-to-eat foods showed a link with a range of foods including processed meats, pates, salami and other processed pork products [64]. In the American study [63] it was shown that *L. monocytogenes* could grow readily in retail packs of commercial cured ham, however, lactate-diacetate (a natural anti-microbial) was an effective inhibitor of this pathogen. As an alternative, novel food processing technologies such as high hydrostatic pressure (HPP) may offer advances in the control of *Listeria* since HPP has enhanced the effects of combination treatments using enterocins and lactate-diacetate [65].

Given that *L. monocytogenes* isolates vary widely in their susceptibility to HPP a combination treatment would afford an additional margin of safety.

3.2.4.5 Storage and Distribution
Post slaughter pig carcasses are chilled to between 2°C to 4°C overnight [66]. This results in the short term preservation of the food. The pork products can then be distributed to wholesalers, supermarkets, butchers and grocers.

3.2.4.6 Retail and Catering
Research into the prevalence of foodborne pathogens in raw and cooked meats, including pork, in ROI between the years 2002 to 2004 found that 2.1 percent of retail pork in ROI tested positive for *Salmonella* [25]. A retail study of 200 pork products in NI concluded that 5.5 percent of pork (raw) tested positive for *Salmonella* [67].

In a small survey of butcher shops in Dublin, the incidences of *Salmonella*, *Yersinia* and *Listeria* on retail pork products was found to be 9.9 percent [68], 70 percent [69] and 45 percent [70], respectively.

Guidelines for retailers and caterers to produce a food safety management plan based on Hazard Analysis Critical Control Point (HACCP) principles were compiled by the FSA [71].

Guidance has been issued by the National Standards Authority in Ireland in relation to hygiene requirements in both the catering and retail and wholesale sectors in ROI [72, 73].

3.2.5 Food safety controls along the food chain

3.2.5.1 Overview
The legislation in place to ensure the safety of pork throughout the food chain in both NI and ROI is the new hygiene legislation, commonly referred to as the 'Hygiene Package'. As EU regulations, the legislation is directly applicable. The regulations are:

- **Regulation (EC) 852/2004 on the hygiene of foodstuffs;**
- **Regulation (EC) 853/2004 laying down specific hygiene rules for food of animal origin; and**
- **Regulation (EC) 854/2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption.**

The general hygiene requirements for all food business operators are laid down in Regulation 852/2004. Regulation 853/2004 supplements Regulation 852/2004 in that it lays down specific requirements for food businesses dealing with foods of animal origin. Regulation 854/2004 relates to the organisation of official controls on products of animal origin intended for human consumption. The legislation introduces a 'farm to fork' approach to food safety by including primary production (that is, farmers and growers) in food hygiene legislation, for the first time in the majority of cases. Also included in the package is Directive 2004/41 which repeals the previous EU legislation and in relation to fresh meat, in particular it repeals Directive 64/433/EEC.

In addition to the regulations included in the 'hygiene package' there are a number of implementing regulations that support the application of the regulations. One such regulation that has specific relevance to the safety of pork is Commission Regulation (EC) No 2073/2005 of 15 November 2005 on the microbiological criteria for foodstuffs. As this is an EU regulation, it applies directly in both NI and ROI and lays down the food safety and process hygiene criteria for certain microorganisms in respect of a range of foodstuffs.

3.2.5.2 Implementing legislation
The Hygiene Package is implemented in NI under the Food Hygiene Regulations (NI) 2006 and in ROI by the European Communities (Food and Feed Hygiene) Regulations 2005 (S.I. No. 910/2005), as amended. In respect of the implementation of the regulations in NI, pig farms are registered and inspected by the DARD Quality Assurance Branch (QAB) on behalf of the FSA.

With respect to the implementation of the hygiene legislation in ROI, the Department of Agriculture, Fisheries and Food (DAFF) and Local Authorities, carry out the work on behalf of the FSAI. This includes the approval of premises and the conduction of inspections and audits.

3.2.5.3 The implementation of microbiological testing and HACCP within abattoirs and cutting plants
In addition to implementing HACCP principles, proprietors 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 pig 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.

Guidance has been issued by the FSA and the FSAI in relation to the requirements [74-76].

The Veterinary Inspector (VI) and Official Veterinarian (OV) in ROI and NI, respectively, have responsibility for inspecting all documentation and monitoring compliance with such legal requirements. Any deviation from the requirements must only be with the approval of the VI/OV.

3.2.5.4 Supervision of hygiene practices in abattoirs
The OV/VI has overall responsibility for overseeing checks on hygiene rules and plant operation. Meat inspection 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; health marking[16]; and animal identification checks.

3.2.5.5 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 [77]. In ROI, the FSAI provides advice and guidance in relation to butchers' shops and meat counters [78].

16 The OV/VI is responsible for the application of the Health Mark. 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.

3.2.6 Potential food safety implications of sodium reduction in pork products

The practice of using salt to preserve foods and prevent the growth of pathogens dates back many thousands of years. The development of other preservation techniques, however, such as refrigeration, means salting is no longer necessary as the primary preserving mechanism. The use of salt for partial preservation nonetheless is commonplace because of its functional and sensory properties [79].

As will be discussed in the following chapter, intakes of salt on IOI are approximately 50 percent higher than recommended safe intake levels. Thus, initiatives are underway on the island to decrease current intake levels by decreasing the salt content of processed foods led by regulators in collaboration with industry. Food business operators must validate the safety of their product if a change has been made in its formulation.

The effect of changing salt concentrations on the potential for growth by food pathogens was modelled for hypothetical foods at the Institute for Food Safety Research in the UK based on the pH, moisture contents and salt concentrations of a variety of products including bacon and ham [79]. In all cases the rate of growth of foodborne pathogens was much greater in the reduced salt products, with the greatest changes noticed in salt sensitive organisms. The researchers concluded that when salt levels are reduced it may be necessary to include other preservative factors or decrease the shelf life of a food to ensure that an adequate safety margin is maintained. They also stated that the safety of each reformulated food should be evaluated on a case by case basis and consistent with a HACCP based approach due to the inherent difficulties in issuing blanket recommendations on appropriate salt levels [79].

3.3 Chemical contamination

3.3.1 Introduction

Chemical hazards arise either from the deliberate use of chemicals during the production process or from unintentional environmental contamination. Monitoring and surveillance systems are in place in both jurisdictions to ensure that pork products in the market place do not contain unacceptable levels of chemical residues or contaminants. Residues in pork can occur from the use of veterinary medicines or from the addition of approved additives such as nitrites to pork products. Contamination can also occur from environmental exposure to compounds such as dioxin or from natural sources such as fungal toxins.

3.3.2 Potential residues in pork and pork products

3.3.2.1 Veterinary Medicinal Products

Veterinary drug residues pose a potential chemical hazard if their use is not in accordance with good veterinary practice guidelines. To ensure these have been followed, residue levels in pig meat at the time of slaughter are monitored to check for compliance with the legislation. If residues of antibiotics occur at unacceptable levels in the meat this may give rise to the potential for toxic effects in susceptible individuals.

The definition, licensing and marketing of veterinary medicinal products (VMPs) in both ROI and NI is specified in several pieces of transposed EU legislation[17],[18]. These do not include medicated feedingstuffs or any additives for use in the formulation of feedingstuffs, which are governed by separate legislation[19],[20]. The Irish Medicines Board (IMB) is the designated competent authority for the licensing of VMPs in ROI although the Department of Agriculture, Fisheries and Food (DAFF) can authorise the use of certain medicines in exceptional circumstances[21].

In NI, the licensing of VMPs is the responsibility of the UK Veterinary Medicines Directorate (VMD). VMPs are not for sale to the general public and require a prescription for use by authorised personnel.

All pharmacologically active substances in VMPs marketed in the EU for administration to food-producing animals must have a specified Maximum Residue Level (MRL)[22]. This is the highest level of drug residue that is allowable in food derived from the animal to which the drug was administered. To ensure that MRLs are not breached and that good veterinary practice is adhered to, an annual residue surveillance plan for food produced in the EU is carried out[23]. 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. Currently, the IMB lists over 280 preparations for use in pig production. These include not only antibacterial preparations, but also parasiticides, hormones and vaccines, as well as vitamin, mineral and electrolyte supplements. The UK VMD operates a similar inventory of permitted VMPs.

17 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)

18 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)

19 Council Directive 90/167/EEC of 26 March 1990 laying down the conditions governing the preparation, placing on the market and use of medicated feeding stuffs in the Community (OJ L 092 , 07.04.1990, P. 42 – 48)

20 Council Directive of 23 November 1970 concerning additives in feeding-stuffs (70/524/EEC) (OJ L 270, 14.12.1970, p. 1)

21 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

22 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)

23 Commission Decision of 12 August 2002 implementing Council Directive 96/23/EC concerning the performance of analytical methods and the interpretation of results. (2002/657/EC). L 221/8 Official Journal of the European Communities, 17.8.2002

The National Residue Monitoring Programme (NRMP) in the ROI is carried out by DAFF. Table 3.6 shows the results of the ROI Monitoring Programme for pigs over a four-year period from 2003 to 2006. Samples were taken on a routine targeted basis and also on suspicion, including follow-up investigations. A significant number of animals were tested for the presence of antibacterial substances including sulphonomides and quinolones each year. The total number of animals sampled decreased by approximately 80 percent between 2003 and 2006, while over the same period, the frequency of positive animals decreased from 0.4 to 0.1 percent. No positive animals were returned for class B2 drugs ('other veterinary drugs') tested during this period.

Table 3.6: Group B – Veterinary drugs and contaminants: results of the National Residue Monitoring Programme in pigs in ROI 2003 to 2006

Substance	2006		2005		2004		2003	
	Total no. of pigs tested	No. of pigs tested positive	Total no. of pigs tested	No. of pigs tested positive	Total no. of pigs tested	No. of pigs tested positive	Total no. of pigs tested	No. of pigs tested positive
B1 Antibacterial substances including sulphonomides & quinolones	9,024	11 (0.12%)	24,924	26 (0.10%)	31,499	91 (0.29%)	48,200	186 (0.39%)
B2 Other veterinary drugs	538	0	569	0	498	0	354	0
Anthelminitics	155	0	147	0	128	0	129	0
Anticoccidials, including nitroimidazoles	34	0	32	0	22	0	32	0
Carbamates and pyrethroids	42	0	40	0	50	0	37	0
Sedatives	65	0	65	0	57	0	26	0
Non-steroidal anti-inflammatory drugs	56	0	110	0	121	0	27	0
Other pharmacologically active substances	186	0	175	0	120	0	103	0

Source: Department of Agriculture, Fisheries and Food, 2004-7 [80-83]

In NI DARD collects and analyses samples for the National Surveillance Scheme (NSS) on behalf of the VMD. DARD also carries out follow-up investigations. The results of the NSS are published quarterly in the Medicines Act Veterinary Information Service (MAVIS) and in the Veterinary Medicines Directorate (VMD) 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 2005 was that in the UK (including NI) authorised uses of VMPs did not result in residues of human health concern (Table 3.7).

Table 3.7: Results of the National Residue Monitoring Programme for the UK from 2003 to 2006 for pigs and pork meat tested for different compounds

	Source	Matrix	Compound	No of samples	Reporting limit (mg/kg)	Positives
2006	Independent retailer	Pork	ß-agonists	2	-	0
			Levamisole	2	-	0
			Tranquillisers	2	-	0
			Trenbolone	2	-	0
			Zeranol	2	-	0
		Ground pork	tetracyclines	1	50	0
			ß-lactams		10	0
			sulphonamides		50	0
	NRSP	Pig kidney	Chlortetracycline	796	600 (MRL)	3 (0.4%)
			Sulphadiazine	799	100 (MRL)	2 (0.3%)
2005	NRSP	Pig Kidney	Chlortetracycline	772	600 (MRL)	3
			Oxytetracycline		600 (MRL)	1
			Salinomycin	100	10 (LOQ)	2 (2.0%)
			Sulphadiazine	773	100 (MRL)	3 (0.4%)

2004	NRSP	Pig kidney	Chlortetracycline	839	600 (MRL)	2 (0.2%)
			Sulphadiazine	819	100 (MRL)	2 (0.2%)
2003	NRSP	Pig kidney	Chlortetracycline	908	600 (MRL)	1 (0.1%)
		Pig liver	Salinomycin	9	-	1 (11.1%)

Note: The Reporting Limit refers to the MRL or, where not specified, the MRPL (Minimum Required Performance Limit) which is the minimum analytical detection standard.

Source: Veterinary Residues Committee, 2003-6 [84-87]

Hormones and prohibited substances

The National Residue Monitoring Programmes for ROI and NI also include monitoring for prohibited substances including those with growth promoting properties. No positive samples were detected over the period 2003 to 2006. Results from ROI are shown in Table 3.8 results from NI are not available separately from the UK results.

Table 3.8: Number of pigs tested and tested positive for prohibited substances having anabolic effect and unauthorised substances (Group A) under the National Residue Monitoring Programme for ROI 2003 to 2006

Substance	2006		2005		2004		2003	
	Total no. of pigs tested	No. of pigs tested positive	Total no. of pigs tested	No. of pigs tested positive	Total no. of pigs tested	No. of pigs tested positive	Total no. of pigs tested	No. of pigs tested positive
A1 Stilbenes, stilbene derivatives, and their salts and esters	57	0	85	0	90	0	77	0
A2 Antithyroid agents	42	0	61	0	52	0	60	0
A3 Steroids	219	0	287	0	242	0	208	0
A4 Resorcylic acid lactones including zeranol	51	0	86	0	73	0	75	0
A5 Beta-agonists	105	0	129	0	148	0	135	0
A6 Compounds in Annex IV to Council Regulation (EEC) no. 2377/90 for which no MRL could be set	268	0	303	0	270	0	200	0
Total	**742**	**0**	**951**	**0**	**875**	**0**	**755**	**0**

Source: Department of Agriculture, Fisheries and Food, 2004-7 [80-83]

Certain hormonal substances are permitted in pig production. In ROI and NI, a total of 18 and five hormonal substances, respectively, are currently registered for use in pig production (Personal Communication, Irish Medicines Board, December 2007). These hormones do not have growth promoting properties, rather they are used to facilitate pig breeding or to enhance lactation. Like all VMPs, they are sold with instructions for dosing, administration and handling, as well as recommendations for suitable withdrawal periods prior to slaughter.

3.3.2.2 Nitrite

Potassium nitrite (E249), sodium nitrite (E250) and sodium nitrate (E251) are permitted as curing agents for meat products. Nitrite functions as an antimicrobial and anti-oxidant in cured meats. However, residual nitrite may potentially give rise to health hazards.

Nitrites can react with amines in the meat to form N-nitrosamines which may be carcinogenic [88]. Studies have associated cured ham with a risk of certain types of cancer (see also Section 4.4) [89-91]. Nitrites can be toxic to young children and infants. Exposure to excess levels of nitrite in the environment can cause methaemoglobinaemia or "blue baby" syndrome. EFSA issued an opinion on the anti-microbial efficacy of nitrite/nitrate use in cured meats in 2003 but did not discuss the issue of the health risk of nitrosamines in these products [92].

Routine sampling for nitrate and nitrite in meat products carried out between 2000 and 2002 by DAFF and Public Analysts Laboratories in conjunction with the FSAI revealed that a significant proportion of meat and meat products (including those derived from pig production) exceeded the EU maximum limits set for these additives. While the majority of samples contained concentrations of nitrate and nitrite at less than half of the maximum permitted levels, 15 percent of bacon and ham samples exceeded the EU maximum permitted levels for nitrate. Approximately seven percent of bacon, three percent of ham and three percent of salami samples exceeded the EU limits for nitrite. However, the estimated exposure to nitrite and nitrate via these products was determined to be below the ADI. Nevertheless, given that vegetables are the main source of nitrate in the diet and the contribution from drinking water is also significant, there is a potential increased risk of exposure in high consumers of bacon and ham products. This study highlighted the need for continued surveillance and monitoring of nitrites and nitrates in meat products in order to protect consumer health and welfare [93].

3.3.2.3 Red 2G

Approximately ten colours are permitted in the production of pork products under Council Directive 94/36/EC. Recently, Red 2G (E128) was removed from the list of permitted colours on foot of an evaluation by EFSA [94][24]. On IOI, this dye was used in very small quantities as a colour in some sausages and burger meat. The reason for this prohibition was the discovery that Red 2G is converted in the body to aniline which may have both carcinogenic and DNA-damaging potential. The ADI (0.1 mg/kg body weight) established in 1981 for Red 2G has been withdrawn.

For many producers, cochineal is the colour that replaced Red 2G in formulations.

24 Commission Regulation (EC) No 884/2007 of 26 July 2007 on emergency measures suspending the use of E 128 Red 2G as food colour Retrieved from http://www.fsai.ie/legislation/legislation_update/2007/0707_euupdate/Reg884_2007.pdf

3.3.3 Potential environmental contaminants in pork and pork products

The ROI NRMP for the years 2003 to 2005 also targeted contaminants such as pesticide residues (organochlorine and organophosphorus compounds), chemical elements (e.g. heavy metals) and mycotoxins such as Ochratoxin A, which could potentially contaminate raw pork.

3.3.3.1 Mycotoxins

Mycotoxins are chemicals produced by moulds and fungi which may contaminate foods or animal feeds. Most are toxic to humans and show a range of different toxic effects. Mycotoxins are also toxic to farm animals which may serve as a vector for transferring mycotoxins between plant-based animal feed and the human food chain. For example, Ochratoxin A causes kidney disease in pigs and may be passed to meat products.

Zearalenone is an oestrogenic mycotoxin that is common in cereals such as maize, wheat and barley. It is known to have adverse side effects on fertility in pigs. This mycotoxin has an anabolic or growth-promoting activity and is banned in some countries. Pig meat can become contaminated through consumption of contaminated feed. However, the EFSA Opinion published in 2004 concluded that, "due to the rapid biotransformation and excretion of zearalenone in animals, secondary human exposure resulting from residues in meat, milk and eggs is expected to be low, contributing only marginally to the daily intake" [95]. However, due to concerns over this compound's broad toxicity spectrum, which includes pronounced oestrogenic activity, the Joint FAO/WHO Expert Committee on Food Additives (JECFA) has established a provisional maximum tolerable daily intake for zearalenone of 0.5 mg/kg of body weight [96].

Mycotoxins were not detected in samples taken from pigs during the ROI NRMPs for 2003 to 2005 (Table 3.10). In addition, samples analysed for the presence of zeranol (which is a derivative of the mycotoxin zearalenone) were found to be negative over the same period (Table 3.9).

Table 3.9: Number of pigs tested and tested positive for prohibited 'other substances and environmental contaminants' (B3) substances. National Residue Monitoring Programme for ROI 2003 to 2006

Substance	2006		2005		2004		2003	
	Total no. of pigs tested	No. of pigs tested positive	Total no. of pigs tested	No. of pigs tested positive	Total no. of pigs tested	No. of pigs tested positive	Total no. of pigs tested	No. of pigs tested positive
B3a Organo-chlorine compounds	41	1 (2.4%)	37	0	32	0	46	0
B3b Organo-phosphorus compound	33	0	33	0	25	0	23	0
B3c Chemical elements	29	0	38	0	34	0	45	0
B3d Mycotoxins	20	0	13	0	18	0	11	0
B3e Others	0	0	0	0	0	0	0	0
Total	**123**	**1 (0.8%)**	**121**	**0**	**109**	**0**	**125**	**0**

Source: Department of Agriculture, Fisheries and Food 2004-7 [80-83]

The UK Statutory Surveillance Results for red meat, obtained during the UK sampling programmes, returned a total of 9, 48, 41 and 63 samples of pig liver tested for aflatoxin during 2003 to 2006, respectively, which were found to be compliant [97-100]. In addition, 123, 182, 162 and 175 samples, respectively, of pig urine were analysed for zeranol and found to be compliant. No testing for ochratoxin A was carried out in either the ROI or UK NRMPs.

3.3.3.2 Pesticides

Porcine food products can contain pesticide residues resulting from direct application of a pesticide to the animal, for instance a parasiticide, or pesticide contaminants resulting from unintentional exposure in the environment or via feedstuffs containing pesticide residues. The two main classes of pesticides are organochlorine (OC) and organophosphorus (OP) pesticides.

In ROI, 69 samples of pork fat were analysed by DAFF as part of the NRMP for 2005 (Table 3.10). Three of those samples (4.3 percent) were found to contain a detectable pesticide residue. Residues of two different pesticides, dichloro-diphenyl-trichloroethane (DDT) and dicofol, were detected along with a residue of one polychlorinated biphenyl (PCB) congener. However, none exceeded 0.01 mg/kg pig fat and thus the MRL thresholds were not exceeded [101]. DDT was banned across the EU in the 1980s and is banned or heavily restricted in many other countries. However, it is a persistent organic pollutant and can accumulate in the fatty tissue of animals.

Table 3.10: Results of the National Residue Monitoring Programme for ROI regarding pesticide residues in pig meat 2002 to 2005

Year	No. of samples analysed	No. of pesticides tested	Results determined			No. of pesticides Detected
			No. ND (%)	No. <MRL (%)	No. >MRL	
2002	52	55	50 (96.2)	2 (3.8)	0	2
2003	71	55	71 (100)	0	0	0
2004	59	55	59 (100)	0	0	0
2005	69	55*	66 (96)	3 (4.3)	0	3

Note: *Samples in 2005 were analysed for 55 pesticides and pesticide metabolites as well as 7 PCB congeners.

Source: Department of Agriculture, Fisheries and Food, 2004-6 [102-104]

Under the UK monitoring programme, no non-compliances for organophosphate and organochlorine compounds were detected between 2003 and 2006. Organochlorines were detected in just two samples (four percent) in 2004. Quarter One results from the 2007 UK National Residue Monitoring Programme showed that 69 out of 70 pork samples analysed contained no residues of the pesticides [105]. One sample contained DDT at a level below the MRL (0.1 mg/kg). This environmental contamination was considered to be the source of the positive sample.

In the UK in 2006, a total of 1,007 animal products were analysed for up to 13 pesticides, resulting in over 12,000 pesticide/sample combinations [106]. Bacon was among the products analysed and no residues were found in any of the samples. Out of 120 samples of cooked or cured pork, one sample of salami contained residues of DDT at low levels, another sample of salami contained residues of lindane, and a sample of chorizo also contained lindane. Lindane is an organochlorine insecticide that is classified by WHO as 'moderately hazardous'. In the EU, lindane is almost completely banned for use as an agricultural pesticide or as a home and garden product.

3.3.3.3 Dioxins and polychlorinated biphenyls (PCBs)

Dioxins and PCBs are reproductive and carcinogenic toxins that are produced during inefficient combustion processes. PCBs have been shown to be present at high levels in smoked ham [107]. The European Commission has set a maximum permissible level for dioxin in pork of 1 pg TEQ/g fat.

In ROI, analyses carried out by DAFF under the NRMP for 2002 to 2004, and an investigation into levels of dioxins, furans, PCBs and PBDEs (Polybrominated diphenylethers) in foods in 2004 carried out by the FSAI, recorded no breaches of current EU maximum permissible levels for dioxin or several PCB congeners [102-104, 108].

Under the UK monitoring programme, no non-compliances for PCBs were recorded in pig kidney samples taken between 2003 and 2006.

3.3.3.4 Heavy metals

Heavy metals can occur as essential nutrients and natural constituents of meat (e.g. zinc, copper, selenium) or as toxic contaminants from industrial or environmental sources (e.g. lead, cadmium, mercury and arsenic). The DAFF NRMP for 2003 to 2005 did not record any positive samples of pig meat for cadmium, lead, arsenic or mercury. Under the UK sampling programme for 2003 to 2006, no non-compliances were recorded with regard to levels of lead or cadmium in pig kidney samples. However, cadmium was detected in most samples in 2003, 2004 and 2005 and in eight percent of samples in 2006 albeit below the limit.

3.3.3.5 Polycyclic aromatic hydrocarbons

Polycyclic aromatic hydrocarbons (PAH) are contaminants that may occur as a result of industrial processes such as heating or smoking. Many PAHs are known carcinogens. Previous studies of cured or smoked ham in ROI have yielded results well below EU permissible levels [109]. Data for NI is unavailable.

3.4 Summary

On the IOI, there are controls, legislation and systems in place which aim to control both microbiological and chemical hazards in the pork supply chain and thereby minimise the risk to consumers.

Pork is not a common source of human infectious intestinal disease. Although pork meat and processed pork products have been implicated in a number of foodborne diseases abroad such as yersiniosis and trichinellosis, these are rare on IOI. There have been no recent pork meat associated outbreaks in NI. The last significant outbreak of *Salmonella* Typhimurium in ROI occurred in 1998 in the Dublin region as a result of contaminated ham.

Monitoring programmes in ROI and NI routinely test for all chemical residues such as dioxins, furans and dioxin-like PCBs, as well as veterinary residues and growth hormones. On the basis of the results of these ongoing tests there are currently no causes for concern from the chemical contamination of pork and pork products.

4 Nutrition

4.1 Introduction

Pork is nutritionally classed as a red meat because it contains more myoglobin (the protein responsible for transporting oxygen to muscles) than chicken or fish. The iron content of pork is similar to that of chicken and turkey, nevertheless pork is still considered a good source of iron (Table 4.1). When fresh pork is cooked the myoglobin molecule is denatured and the meat becomes lighter in colour.

Table 4.1 The nutritional value of different raw meats per 100g

Type of Raw Meat	Energy (kcal)	Protein (g)	Fat (g)	Saturated Fat (g)	Iron (mg)	Sodium (mg)
Beef, average, trimmed, lean raw	136	22.5	5.1	2.2	1.8	63
Lamb, average trimmed, lean raw	156	20.2	8.3	3.8	1.4	70
Pork, trimmed lean, raw	123	21.8	4	1.4	0.7	63
Chicken meat, average, raw	108	22.3	2.1	0.6	0.7	77
Turkey meat,average,raw	105	22.6	1.6	0.5	0.6	68

Source: Foods Standards Agency, 2002 [110]

Dietary guidelines do not give specific advice on the consumption of pork. The dietary guidelines in the Republic of Ireland, in the form of the Food Pyramid, classify meat, fish, eggs and the alternative protein sources (such as beans and nuts) as a food group. Recommendations indicate that individuals should strive to consume any two portions of meat, fish, eggs or alternatives per day in order to plan healthy choices. A portion of lean cooked meat is 2oz (56g).

In Northern Ireland (NI) , the guidelines known as the eatwell plate, recommend that one eighth of the average individual's diet (i.e. of all food consumed daily) consists of meat, fish or alternatives. It also highlights the importance of making an effort to limit the consumption of processed meats e.g. sausages and other processed pork products. Given the fact that there are many processed pork products this advice is particularly relevant when reviewing and making recommendations on the consumption of pork.

4.2 Nutritional composition of pork

4.2.1 General

Pork and other meats are termed 'high biological value protein' foods due to their content of essential amino acids, which can only be obtained through the diet. These meats contain 'essential' amino acids in similar proportions when compared to the theoretically optimal protein for humans.

The nutrient composition of meat is dependent on the fat to muscle (lean) ratio (Table 4.2).

Table 4.2: Typical values for the composition of pork per 100g edible material

	Water (g)	Protein (g)	Fat (g)	Energy (Kcal) (kJ)	
Lean	74	21.8	4.0	123	519
Fat	33.6	10.1	56.4	548	2259

Source: Chen et al., 1995 [111]

The fat content of different cuts of pork (separated by domestic methods as opposed to careful dissection) has decreased since the 1970s (Table 4.3).

Table 4.3: Changes in the fat content of some retail joints of pork (lean and fat included)

	Fat Content g/100g	
	1970s[a]	1990s[b]
Belly	35.5	20.2
Leg	22.5	15.2
Loin chop	29.5	21.7

Source: a Paul and Southgate, 1973 [112], b Chen et al., 1995 [111]

On average pork has a lower total and saturated fat content than other red meats such as beef and lamb (Table 4.1). The total fat content of pork depends on the anatomical position that the cut originated from on the animal (Table 4.3). On some cuts of pork, such as those from the leg or loin, the visible fat can be easily removed. Other cuts, especially those from the shoulder, 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 pork cuts over the last couple of decades (Table 4.3). The fat content will also depend on the extent to which the cut has been trimmed at the retail level.

Over a third of the fat content of pork is monounsaturated fat. Pork also contains significant amounts of essential n-3 polyunsaturated fatty acids (PUFAs) (Table 4.4).

Table 4.4: The fatty acid profile of selected lean cuts of pork

Cut of Beef	Fat (g/100g)	Saturates (g/100g)	Mono-unsaturates (g/100g)	Polyunsaturates (g/100g)
Pork, trimmed	4	1.4	1.5	0.7
Pork Belly joint	20.2	7.3	8.4	3.1
Chump Chops	12.6	4.5	5	2.1
Pork Fillet	6.5	2.3	2.3	1.3

Source: Food Standards Agency, 2002 [110]

Another nutritional characteristic of pork is its rich content of inorganic constituents such as phosphorous, zinc, potassium, iron and magnesium. Iron from meat such as pork 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. As mentioned previously, although pork is classed as a red meat its iron content is more similar to white meats. Nonetheless the iron contained in pork is still highly bioavailable.

Pork is also a good source of B vitamins such as B_{12}, B_6, thiamin, niacin, riboflavin. The content of fat-soluble vitamins such as vitamins A and D in pork is dependent on the fat content. Therefore leaner cuts of pork will have lower, albeit high levels of fat-soluble vitamins compared to pork cuts with more fat.

4.2.2 Effect of pork processing on nutritional composition of pork products

In this section discussions will focus on the most popular types of processed pork products, i.e. cured pork products such as bacon and ham, and sausages. Processed pork products are almost always high in salt and will vary in their fat content and these will have implications on health. However, innovations in the industry have led to the introduction of new pork products with reduced salt and fat. Pork producers and retailers are also currently working with regulatory agencies to reduce the levels of salt in products (Section 4.4.6).

4.2.2.1 Curing

Unprocessed pork is naturally low in sodium. Curing with salt (sodium chloride, NaCl) was traditionally used as a preservation method to produce hams and bacons. Further addition of sodium nitrite and sodium nitrate during curing intensifies the sodium content of these pork products.

Hams and gammons are made from the leaner part of the pig, usually from around the leg areas. There is a range of different types of products described as bacon. Boiling bacon is from the side of the pig and is generally lean once the visible fat is removed. With respect to rashers, back bacon is leaner than streaky bacon due to fact that fat is not marbled throughout the meat. Back bacon is from the loin of the pig whereas streaky bacon is produced from the belly. A comparison between the nutrition content of these products is given in Tables 4.5 and 4.6.

Table 4.5: Nutritional content per 100g of fresh and processed pork products

Type of meat	Energy (kcal)	Protein (g)	Fat (g)	Saturated Fat (g)	Iron (mg)	Sodium (mg)
Pork, trimmed, lean raw	123	21.8	4	1.4	0.7	63
Bacon rashers, back, raw	215	16.5	16.5	6.2	0.4	1,540
Ham	107	18.4	3.3	1.1	0.7	1,200
Pork pie individual	363	10.8	25.7	9.7	1.1	650
Sausage roll, puff pastry	383	9.9	27.6	11.2	-	600
Pork sausages, chilled, raw	286	11.8	22.7	8.6	0.9	880
Pork spare ribs, barbecue style, chilled/frozen	281	26.3	17.1	6.2	1.6	440

Source: Food Standards Agency, 2002 [110]

Table 4.6: Typical values for the composition of pork per 100g edible material

Pork per 100g	Energy (Kcal)	Energy (KJ)	Protein (g)	Fat (g)	Sodium (mg)	Iron (mg)	Vitamin B_{12} (ug)
Leg joint raw, lean	107	450	21.7	2.2	65	0.8	1
Leg joint raw, lean & fat	213	885	19	15.2	60	0.7	1
Loin joint, raw, lean & fat	246	1,024	19.3	18.8	55	0.5	1
Loin chops, raw, lean & fat	270	1,119	18.6	21.7	53	0.5	1
Loin Steaks, raw, lean & fat	225	934	19.9	16.1	56	0.5	1
Spare ribs, raw, lean & fat	195	814	18.7	13.4	98	0.8	1
Chump Chops, raw, lean & fat	194	808	20.1	12.6	54	0.6	1
Chump Steaks, raw, lean & fat	151	632	21.3	7.3	56	0.7	1
Diced, raw, lean	122	512	21.4	4	70	0.8	1
Fillet, raw, lean, & fat	147	615	22	6.5	53	0.7	1
Mince, raw	164	685	19.2	9.7	66	0.9	1
Liver	113	447	21.3	3.1	82	13.9	23
Kidney	86	363	15.5	2.7	200	6.4	40

Source: Meatmatters.com, 2007 [113]

In some instances hams and bacon can also be cured with other ingredients such as sugar, which will further affect the nutritional composition. Other ingredients added can include spices and binders e.g. cereals. Pork-based luncheon meats and canned hams are common examples of such products and these can vary in the proportions of meat and other ingredients they contain. In general these meats are higher in fat when compared to those such as hams that have only gone through the curing process. Luncheon meat for example contains 13g protein and 24g fat per 100g compared to smoked honey roast ham which contains 18g protein and 3g fat.

4.2.2.2 Sausages

Pork sausages are either fresh or cured. The majority of sausages consumed on the island of Ireland are fresh. Fresh sausages generally contain trimmings from pork which are most likely to be from a fatty cut of meat (see Section 1.3.2).

Sausages are high in salt and fat. Two pork sausages (80g) provide on average nearly 1g sodium or 2.4g salt. This is high given the recommendation that adults consume no more than 6g salt per day.

Frankfurter or hot dog style sausages have a similar nutritional composition to fresh sausages. Other sausages like salami and pepperoni are higher in fat, saturated fat and salt compared to fresh sausages. The addition of ingredients and/or use of particular cooking methods to such processed pork products can further impact negatively on the nutritional content. For example, sausage rolls and battered sausages are sausages encased in puff pastry and batter, respectively. Both products are high in fat and salt.

4.2.2.3 Butchering

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 will reduce the energy and fat content of the cut of meat (Table 4.6). This trend for the removal of visible fat has 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 and sauces. These additional ingredients can increase the salt and fat content of the original pork products.

When choosing pork products consumers should opt for fresh lean cuts of pork over processed pork products that are high in salt and in some instances high in fat. As previously discussed there is a huge variation in the nutritional content of processed pork products and consumers can opt for lower fat and salt options if they choose to purchase them.

4.2.2.4 Preparation and Cooking

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

- **Removing the visible fat. The removal of visible fat from a raw piece of pork can reduce the fat content by more than a third [110];**
- **Avoiding the use of additional fat during preparation, for example, rashers contains some fat and will cook very well without the addition of fats or oils (grilling or 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 [110].**

Cooking methods which involve water, stock or wine, e.g. boiling, can impact both positively and negatively on the nutritional content of pork. The B vitamins are water-soluble and will therefore leech into the liquid thereby reducing the vitamin content of pork. On the other hand, boiling results in the leeching of salt into the liquid. Traditionally this salty water may have been used to make sauces but due to the high salt content of liquid this practice is not advisable. Soaking of hams and bacon in water prior to boiling will also help remove some of the salt from the joint.

4.3 Current consumption patterns

4.3.1 Consumption based on market data

Per capita consumption of pig meat on IOI is higher than that of other meats including poultry, beef and sheep meat (Table 4.7). Pig meat represents about 40 percent of total meat consumption on ROI.

Table 4.7: Meat consumption on ROI ('000 tonnes cwe)

Meat Type	2003	2004	2005	2006(e)
Beef	84	86	86	86
Pigmeat	146	149	150	150
Sheepmeat	21.5	20	20	20.5
Poultry	-	119	125	

Source: Bord Bia 2007, [14]

Consumption of pig meat is predominantly in the form of bacon and ham. Pork consumption in ROI (approximately 37kg per capita per year) is close to the EU average (44kg).

Per capita consumption in NI during 2004/5 was 2.9kg (carcass meat only, excludes meat in meals outside the home) [19]. Per capita bacon and ham consumption in NI 2004/5 was 4.7kg (uncooked bacon and ham only, excludes meat in meals outside the home) [19].

There continues to be a shift in sales toward more value added and convenience options in ROI. When foodservice and sales of processed pig meat are taken into account, total ROI pig meat consumption for 2006 was estimated at almost 150,000 tonnes cwe [14].

4.3.2 Consumption based on dietary surveys

4.3.2.1 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 [114]. Among this population, 35% consumed pork, 80% consumed bacon and ham, 59% consumed sausages, 70% consumed meat products and 28% consumed burgers (both beef and pork) [114].

A detailed analysis of meat consumption on the ROI cohort of the NSIFCS was carried out and the intakes of the various pork and pork products are detailed in Table 4.8.

Table 4.8: Mean daily intakes (g/day) of pork, pork products in male and female consumers in ROI by age group and by social class occupations and education level

	Total Meat	Bacon and ham	Pork	Burger	Sausage	Meat products
Total population	99	33.0	26.9	12.7	16.1	10.0
Men						
18-35 years	171	39.8	28.7	15	22.2	12.4
36-50 years	172	43.8	32.4	13.4	18.8	11.2
51-64 years	159	42.8	30.5	11.3	16.7	12.5
Women						
18-35 years	97	18.3	25.4	11.8	11.9	6.6
36-50 years	107	26.1	21.7	9.7	12.5	8
51-64 years	100	26.5	20.7	11.5	9.8	7
Education Level Attained						
Primary	139	37.8	28.3	10.8	14.6	10.8
Intermediate	145	35.5	28.5	15.4	17.6	9.4
Secondary	130	29.9	25	12.4	16.5	10
Tertiary	128	29.7	26.3	12.1	15.3	10
Social Class/Occupation						
Professional, Managerial and Technical	128	30.7	28.1	11.4	13.8	9
Non-Manual	122	29.7	25.2	12	15	9.2
Skilled Manual	159	39.6	28.3	14.7	17.9	12.5
Semi-Skilled and Unskilled	123	34.9	25	13.9	18.9	8.9

Source: Cosgrove et al., 2005 [115]

Men consumed higher amounts of pork, bacon and ham, and sausages compared to women ($p<0.01$). Individuals with manual skilled occupations, consumed more bacon, ham, sausage and meat products compared with individuals from professional, managerial or technical type occupations ($p<0.01$). Individuals with no formal education were also eating more bacon and ham compared ($p<0.01$) to those with a formal education [115]. The older age groups consumed pork less frequently than the younger age categories; however, there was no difference in the amounts consumed on those occasions when eaten (Table 4.8).

The mean serving size of pork among the ROI population of the NSIFCS was 127g, bacon and ham 52g and processed type meats 37g. Men consumed significantly larger portions of pork and processed pork meats than women. Bacon, ham and sausages were nearly always consumed as an individual portion, i.e. not as a part of a composite dish (Table 4.9). Pork, on the other hand was often consumed as part a composite meal.

Table 4.9: Comparison of meat intakes between individual portions and as a composite food

	% Individual Portion	% Composite Food
Bacon and Ham	97	3
Beef	59	41
Lamb	83	17
Pork	84	16
Poultry	61	39
Offal	62	38
Burger	37	63
Sausage	92	8
Meat Products	91	9
Total Meat	75	25

Source: Cosgrove et al., 2005 [115]

The majority of pork eating occasions in the NSIFCS were identified as being in the home. Furthermore, pork consumed in the home was greater in quantity than that in the workplace and was significantly greater when compared with the commercial food service sector [116].

Within ROI, the SLAN study found that more females (40.5 percent) than males (38 percent) consumed the actual recommended two servings of meat, fish, egg and alternatives per day [117]. The analysis of dietary intakes did not provide details on the intakes of specific meats but did show that 39 percent of respondents were reported to be consuming the recommended two servings daily of meat, fish and poultry.

In NI the 'Eating for Health' survey found that 69 percent of adults surveyed reported eating red meat once or twice a week or less often [118]. 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. Forty-five percent of individuals reported consuming meat products (including sausages, bacon, meat pies, pastries and chicken nuggets) once or twice per week. Adults from households with children reported eating meat products more often than other adults.

No data exists on the intake of pork and pork products among those aged over 65 years on IOI. The National Diet and Nutrition Survey which survey individuals from Britain, Scotland and Wales also found that most pork consumed was in the form of processed pork [119].

4.3.2.2 Children and Adolescents

The National Children's Survey of 293 boys and 301 girls aged 5-12 years found intakes of fresh meat, processed meat and meat dishes was 25, 44 and 37g/day, respectively [120]. This highlights that primary school aged children in ROI are consuming almost twice as much processed meats when compared with leaner cuts of fresh meat. The average intake by this group of processed meats, burgers (beef and pork), sausages, meat pies/pastries, was 19, 7, 10 and 2 g/day, respectively (see Table 4.10).

Table 4.10: Consumption of pork and pork products (g/d) by boys and girls aged between 5 to 12 years

Pork and Pork Products	Boys			Girls		
	All	5-8y	9-12y	All	5-8	9-12
Bacon and ham	8	6	9	7	6	8
Pork	3	3	3	3	3	3
Lamb, pork and bacon dishes	3	2	4	4	3	5
Burgers (beef and pork)	8	6	9	7	4	10
Sausages	11	12	11	10	11	8
Meat pies and pastries	2	2	2	2	2	3
Meat products	22	22	21	17	18	16

Source: Irish Universities Nutrition Alliance, 2005 [120]

The NI 'Eating For Health' survey, of eating habits among children and young people, revealed that a quarter of children surveyed ate red meat including pork on most days [118]. Around 18 percent of children ate meat products on most days or daily. Girls were most likely to eat meat products less than once a week (30 percent) compared to boys (19 percent).

4.3.3 Contribution of meat, pork and pork products to nutrient intakes

In the NSIFCS meat and meat products were found to account for 12 percent of energy intake and to contribute to over 10 percent of the intake of many other nutrients (Table 4.9). Meat and meat products contributed in particular to protein, vitamin B12, zinc, niacin, vitamin D, vitamin B6, thiamin and iron.

Table 4.11: 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
Thiamin	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
Panthathenic acid	20.1	17.2

Source: Cosgrove et al., 2005 [115]

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 is indicative of the fact that a large proportion of processed meat was consumed by the population. No breakdown was given in this study on the contribution of pork alone to nutrient intakes.

The ROI cohort of the NSIFCS was classified into non-consumers, low (<41g/d), medium (41 to 72 g/d) and high (>72 g/d) red meat consumers (Cosgrove et al. 2005b). 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 zinc, iron, vitamin A, riboflavin, vitamins B_6, B_{12} and C. However, high consumers were found to have a lower compliance with carbohydrate recommendations and had a less fibre dense diet compared to non consumers of red meat. This provides evidence for the need to promote a balance of food groups to consumers.

Further analysis of the NSIFCS data conducted on behalf of the FSAI estimated the mean daily intake of salt in adults from a variety of meat-based foods. Bacon and ham were the meats which contributed the most to daily salt intakes at 0.925g/day (Table 4.12).

Table 4.12: 2006 modelling estimates of the specific meat based food groups affecting average daily sodium intake in the adult population 18-64 years of age

	Mean daily intake from foods	
Food group	**g/day sodium**	**g/day salt**
Bacon and ham	0.37	0.925
Sausages	0.11	0.275
Beef products	0.05	0.125
Meat pies, pastries and sausage rolls	0.03	0.075
Ready meals	0.05	0.125
Other meat dishes	0.20	0.500
Total intake all foods	3.38	8.45

Source: FSAI, 2007 [121].

Meat and meat products contributed to 13 percent of total energy intakes of primary school aged children in the National Children's Survey in ROI [120]. Meat also contributed on average to 24 percent of salt intake and 19 percent of total fat intake.

4.4 Health

4.4.1 Introduction

Pork and pork products are the most popular types of meat eaten on IOI. As discussed in Section 4.3.2, a large proportion of pork is eaten in processed form and includes products such as bacon, ham and sausages. Pork products tend to be higher in salt and saturated fat than fresh lean cuts of pork. There is mounting evidence for the adverse effects of processed meats on health and on IOI these primarily originate from pork.

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

4.4.2 Pork and cardiovascular health

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

Pork and other meats contain nutrients that are known to exert cardio-protective properties such as B vitamins, selenium and n-3 fatty acids. However, these may be negated by other nutrients in pork and processed pork products such as salt and fat content.

Approximately half the meat consumed on IOI is processed meat which is high in salt. Intakes of salt on IOI are approximately 50 percent higher than recommended safe intake levels [122, 123]. Cured and processed meats are currently estimated to contribute to approximately one fifth of current salt intake. There is now convincing evidence that sodium intake, mainly through dietary salt (sodium chloride), is directly associated with increased blood pressure [124]. A relatively modest reduction in salt intake has important beneficial effects on blood pressure in hypertensive and normotensive individuals. This would produce substantial falls in stroke and coronary heart disease mortality [125]. Based on this evidence it can be estimated that on IOI an average reduction of systolic blood pressure of 5 mmHg, achieved by a reduction in salt consumption of 3 grams per day, would reduce the incidence of stroke by 13 percent and the incidence of coronary heart disease by ten percent. As previously outlined, over half the meat consumed on IOI is processed meat, which is a major contributor to salt intake. Therefore, a reduction in the consumption of processed meat on the island would have a major impact on CVD health.

A high fat and saturated fat intake increases blood cholesterol and triglyceride levels and is associated with an increased risk of CVD [126]. Meat is a major source of fat and saturated fat in the western diet and on IOI this is no exception (see Section 4.2.1). In Section 4.2.1 it was highlighted that different types of pork and pork products vary in their fat and saturated fat content. Individuals who consume pork can decrease their total fat and saturated fat intake by choosing leaner cuts more often than fattier processed cuts.

Meat and meat products contain moderate amounts of cholesterol. However, it is well established that dietary cholesterol has a very small effect on blood cholesterol [127]. Other dietary factors such as fat, saturated fat, wholegrains and fruits and vegetables have a greater influence on blood cholesterol.

Many prospective studies have shown a positive association between red meat intake and CVD [128-130]. 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.

Consumers who have diets high in red meat tend to consume less fruit and vegetables and fibre and have higher intakes of processed meat, thus increasing their CVD risk. 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 [131]. 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. This supports the inclusion of unprocessed, lean red meat in a healthy balanced diet.

As well as the saturated fat content of red meat, which is known to raise blood cholesterol, unprocessed pork is an equally good source of mono unsaturated fatty acids (MUFA) and contains small amounts of n-5 Polyunsaturated Fatty Acids (PUFA). 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.

4.4.3 Pork and cancer

In 2007 the reports of the Expert Panels of the World Cancer Research Fund/American Institute for Cancer Research were published [91]. These reports contained a comprehensive review of the scientific evidence linking diet, physical activity and weight with cancer. On 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 included 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 increased risk per 50g processed meat consumed per day.**
- **That there is suggestive increased 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 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 N-nitroso compounds formation as well as 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 evidence from cohort and case-control studies, showing a dose response relationship. Meta-analysis of the data demonstrated that there was a 15 percent increased risk per 50g red meat consumed per day.**
- **That there is 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 iron.

The WCRF/AICR made both individual and public health recommendations in relation to meat [91]:

- **People who eat red meat to consume less than 500g (18 oz; cooked) a week, very little of 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 there 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 wholegrains, and avoiding foods that promote weight gain are equally as important for cancer risk as the quantity and type of meat consumed.

4.4.4 Pork and iron status

As mentioned at the outset of this chapter, pork is a good source of iron. Dietary intake is the single most important factor determining the risk of developing iron deficiency anaemia. Iron-deficiency anaemia is associated with an increase in the proportion of maternal deaths; higher incidence of low birth weight; and intrauterine malnutrition [132]. In children it is associated with impaired psychomotor development; impaired intellectual performance; and changes in children's behaviour. At an individual level it is associated with increased infections and increased fatigue and thus reduced work capacity.

Dietary iron intakes on IOI have been found to be low among a significant proportion of the population, especially children and women of child bearing age [114, 133]. The richest source of bioavailable haem iron in the diet is meat, particularly liver and red meat.

4.4.5 Type II diabetes and weight status

There is a positive association between total meat and processed meat intake and Type II diabetes and weight [115, 126]. Processed meat contains more total and saturated fat and hence more energy dense (contains more energy per gram) 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 [115, 126].

4.4.6 Salt reduction in processed pork products

As well as product innovation and the introduction of reduced fat and salt pork products on to the market, since 2003 producers and retailers have been working with regulators in ROI and the UK to reduce the level of salt in pork products.

In 2003 the Food Standards Agency (FSA) in the UK introduced salt reduction targets for the industry although these were initially considered to be unachievable and subsequently revised in 2005 [134]. The new targets set figures for pork and other meat products to be achieved by 2010. These were a maximum of 3.0g salt/1.4g sodium for bacon; 2.5g salt/1 g sodium for sausages; 1.8g salt/700 mg sodium for cooked uncured meats; and 1.0g salt/400mg sodium for burgers/patties and grill steaks [135]. Furthermore, all the major retail multiples in the UK have committed themselves to reducing salt levels in their products and are working with the FSA through the British Retail Consortium (BRC). The British Meat Processors Association (BMPA) and the Food and Drink Federation Meat Group have made a commitment to 1.1g salt/100g in burgers; 2g salt/100 g in uncured cooked meats; and 1.1 g salt/100 g in coated meats.

In 2005 the FSAI set out new targets for salt levels, which should be adopted by the meat producers in ROI by 2010. These targets are as follows:

- **0.75g sodium/100g in raw sausages.**
- **0.4g sodium/100g for raw burgers.**
- **0.6g sodium/100g for puddings.**
- **1g sodium/100g for ham/cured meats.**

The FSAI would like to see a further decrease in salt levels for raw sausages to 0.55g sodium/100 [135].

Table 4.13 below shows the sodium and salt equivalent content (per 100 g) of typical "reduced salt or sodium" meat products against typical processed pork products. It is evident from the table that the reduced salt and fat levels still exceed the targets set out by the FSAI. However, the reduction in salt is an ongoing process and must be done gradually so as not to affect taste and consumer acceptability of food products [136].

Table 4.13: Comparison of sodium and salt equivalent content (per 100g) of typical "reduced-salt or sodium" meat products against typical processed pork products on market in ROI and UK

Product	Sodium (mg)		Salt equivalent (g)	
	Typical	Reduced/low	Typical	Reduced/low
Sausages	433-1080	1.1-2.7	520-750	1.3-1.9
Rashers/bacon	1000-1540	2.5-3.9	900	2.3
Cooked ham	900-1200	2.3-3.0	670-790	1.7-2.0

Source: Adapted from Desmond (2006) [134].

4.5 Summary

Pork and its related products are the most commonly consumed meats on IOI. Pork is a rich protein and B vitamin source and has a lower total and saturated fat content than other red meats such as beef and lamb. The majority of pork consumed on the island is in processed forms such as ham, bacon and sausages. As a result, the nutritional attributes of the pork are negatively impacted upon as processing can increase the salt and fat content of products. This in turn has consequences for health such as cardiovascular disease and certain cancers.

5 General

5.1 Overview

This chapter covers additional aspects of the pork supply chain, which have not been discussed in earlier sections including quality issues associated with pork production, quality assurance schemes, animal welfare, traceability, labelling and organic pork production.

5.2 Quality

5.2.1 Stress-related quality problems in pork

Stress has a profound detrimental effect on the pig's immune system, reducing the animal's ability to cope with disease and other potential health and welfare insults. A stressed animal is more susceptible to diseases already present on the farm as well any other diseases that are circulating in the locality.

Stress can be caused by a wide range of management and husbandry practices [137]. Examples of stressors include: mixing pigs; moving pigs; change of housing; rough handling; transport; overstocking; dirty conditions; extremes of temperature; discomfort (e.g. wet conditions, draughts); change of feed; inadequate access to water/feed; and barren environment.

A classic example of how stress increases disease susceptibility was seen with the explosion of post-weaning multi-systemic wasting disease (PMWS) in many pig units during the foot and mouth disease (FMD) outbreak in 2001. In this case, stress caused by overstocking due to FMD movement restrictions was the trigger for the pig wasting disease [137].

Pre-slaughter stress can also have implications for pork quality [138]. Pre-slaughter stress can roughly be divided into long-term stress, such as on-farm handling, mixing, loading and transport; and short-term stress, including lairage conditions and driving to the stunner [138]. The two types of stress should not be considered as two separate things, although long-term stress mainly leads to poor meat quality associated with that of dry, firm and dark (DFD) meat, while short-term stress mainly leads to reduced quality associated with pale, soft and exudative (PSE) meat.

Addressing stress and its causes in turn can markedly reduce the effects of diseases present on the pig unit and improve and enhance pork quality [137].

5.2.1.1 Pale soft exudative (PSE) meat

PSE meat is characterized by its pale colour, lack of firmness, and fluid (exudate) dripping from its cut surfaces. When cooked, this meat lacks the juiciness of normal meat. PSE meat is also unsuitable for processed meats as it results in products which have an undesirable pale colour and are swimming in extra fluid.

PSE condition results from an abnormally rapid drop in the pH of the carcass after slaughter. This condition is most often noted in carcasses of pigs suffering from Porcine Stress Syndrome (PSS) but can also affect carcasses of normal pigs which have experienced pre-slaughter stress.

5.2.1.2 Dry firm and dark (DFD) meat

DFD meat is less appealing to consumers due to its unappealing dark colour, dry or sticky texture and less pronounced taste. An additional problem with this type of meat is that it is more susceptible to spoiling since it has a higher than normal pH which is favourable for the growth of microorganisms. This condition occurs in animals which have survived stress before slaughter but have not had a chance to replenish their glycogen reserves.

5.2.2 Quality Assurance Schemes

5.2.2.1 Northern Ireland Quality Assured Pigs

The Northern Ireland Pig Quality Assurance Scheme (NIPQAS) is the quality scheme for pig meat in Northern Ireland (NI) and is administered by the Ulster Pork and Bacon Forum. It is based on and affiliated to the Assured British Pigs Standard[25].

The NIPQAS is one link in an integrated assurance chain which has the objective of providing effective assurance to internationally recognised standards throughout the whole pigmeat production chain from animal feed manufacture to meat processing and distribution. Certification to the Scheme allows producers to demonstrate that their standards of husbandry and welfare meet nationally agreed levels of best commercial practice and give an assurance to the consumer that the product is safe.

The scheme is accredited by the United Kingdom Accreditation Service to the European Product Certification Standard EN45011. Scheme members are inspected and assessed against the Standard by the certification bodies CMi Certification26 and PMi27 on several occasions annually.

A manual for the Assured British Pigs Scheme is available for participants in the scheme which summarises the procedures for application, inspection, certification, complaints and appeals [139]. It also contains the technical standards to which participants must conform to at all times to be entitled to certification [140].

Participants must renew registration with the scheme annually. Certification is assessed by a combination of quarterly reports from private veterinary surgeons and independent inspections.

Assured British Pigs has integrated the British Pig Executive's (BPEX) ZAP *Salmonella* scheme into the requirements of Assured British Pigs standards and this also includes the Northern Ireland *Salmonella* Scheme (NISS). ZAP results are reported by BPEX/NISS to participating abattoirs, to producer groups, to the relevant veterinarian and to the Certification Body but are not to be distributed for any other purpose other than in relation to the ZAP scheme.

There are approximately 200 producers registered under the scheme (Personal Communication, Ulster Pork and Bacon Forum, April 2008).

5.2.2.2 Bord Bia Pig meat Quality Assurance Scheme

The Bord Bia Pig meat Quality Assurance Scheme (PQAS) is an integrated scheme involving the producer and the processing plant working in partnership to provide the customer with quality assured product. The scheme was first introduced in 1989 and was revised in 2002. It was developed and is subject to revisions by a Technical Advisory Committee representing Bord Bia; Teagasc; the Food Safety Authority of Ireland (FSAI); the Department of Agriculture, Fisheries and Food (DAFF); industry (producers and processors) and technical experts.

The scheme describes the essential quality assurance requirements from primary production through factory processing to final despatch. In addition to meeting regulatory requirements, the scheme lays down additional standards to be complied with at each step of the production chain. The processor standard sets out compositional product parameters such as maximum added water and salt for various pork cuts.

25 The Assured British Pigs scheme (ABP) is a wholly owned subsidiary of Assured Food Standards (AFS) for the production of assured pig meat. Assured Food Standards (AFS) is the independent organisation set up to manage the Red Tractor mark.

26 *http://www.cmi-plc.com/en/index.php*

27 *http://www.assuredpigs.co.uk/pigs/about.asp*

The scheme consists of a producer standard and a processor standard [141, 142]. The PQAS is voluntary and application for membership is open to all producers (excluding outdoor production) who have a valid herd number and who wish to participate and all processors (abattoirs, boning halls, value added processors) that are approved and/or licensed in accordance with relevant national and/or EU regulations.

Certification to the standard is only granted to producers/processors who meet the relevant requirements. Monitoring of compliance with the requirements of the standard is carried out by Bord Bia or its nominated agents through audit of farms and processing plants. Each producer/processor is independently audited at determined intervals, the maximum interval between which is 18 months, and audits or spot checks can be carried out on an unannounced basis. Bord Bia reserves the right to remove samples of pig meat for the purpose of testing by an independent laboratory to determine compliance with the requirements of the Standard.

Overall control of the scheme is exercised by the Bord Bia Quality Assurance Board. This Board is representative of the relevant sectors of the food industry and collaborates with the Technical Advisory Committee.

Only pigs and pig meat sourced from producers and processors, respectively, that have been certified under the Bord Bia PQAS are eligible for inclusion in the Scheme. Imported product may also be eligible for inclusion provided that it is sourced from a quality assurance scheme that has been deemed equivalent by the Technical Advisory Committee. In this case, the origin of the meat must be clearly identified on the label.

The following products are eligible for inclusion in the scheme: pork carcasses and cuts; Wiltshire bacon and bone-in primals; bone-in and boneless bacon products; cooked hams; pork mince; and pork trimmings. Other value-added pig meat products that have been produced using quality assured pig meat as its only meat source may also be marketed under the scheme, however, a specific application must be made in this regard. The Technical Advisory Committee, who will advise on the specific conditions that may apply prior to approval, will consider the application.

When certified, the producer/processor will be issued with a Membership Certificate and will be listed on the Bord Bia register/database. The Member is thereafter permitted to use the Quality Assured Logo on approved specified grades/packaging and/or related documentation.

There were 31 plants registered under the scheme in December 2007, all for cutting and 11 for slaughter [143].

There were approximately 250 producers registered under the scheme in April 2008. Eighty to ninety percent of pigs slaughtered in ROI are from PQAS farms (Personal Communication, Bord Bia, April 2008).

Since February 1, 2008 sausages are eligible for inclusion in the scheme based on certain compositional requirements. These include the following: only quality assured pork meat as defined in the regulations and added pork fat can be used; minimum pork meat content: 80 percent by weight; only pork fat from leg, shoulder, neck and or back is permitted; maximum fat in the final product: 24 percent (by analysis); maximum added water: 10 percent (by weight); and maximum added sodium in the final product: 0.75g/100g (by analysis).

5.3 Animal welfare

5.3.1 Introduction

Animal welfare legislation protects all animals that interact with humans. EU Welfare Regulations are based on 'five freedoms' – freedom from hunger and thirst; discomfort; pain, injury or disease; fear and distress; and express most normal behaviour. Animal welfare requirements apply on-farm, during transport and related operations and at slaughter.

Guidance has been issued by DAFF in ROI in relation to the welfare of pigs on farm and in transit [144]. The Department of Agriculture and Rural Development (DARD) also issued a code of practice in relation to pig welfare [145].

5.3.2 On-farm

In 1998, Council Directive 98/58/EC on the protection of animals kept for farming purposes gave general rules for the protection of animals of all species kept for the production of food, wool, skin or fur or for other farming purposes, including fish, reptiles or amphibians.

Specific rules continue to apply to certain animals, including pigs. Council Directive 2001/88/EC amends Council Directive 91/630/EC laying down minimum standards for the protection of pigs and aims in particular to:

- **Ban the use of individual stalls for pregnant sows and gilts and the use of tethers[28].**
- **Improve the quality of the flooring surfaces.**
- **Increase the living space available for sows and gilts.**
- **Allow the sows and gilts to have permanent access to materials for rooting.**
- **Introduce higher level of training and competence on welfare issues for the stockmen and the personnel in charge of the animals.**
- **Request new scientific advice in relation to certain issues of pig farming.**

From January 1, 2003 these requirements were applicable to all holdings newly built or rebuilt; however, from January 1, 2013 these provisions shall apply to all holdings.

In parallel, the Commission has adopted Directive 2001/93/EC amending the Annex to Council Directive 91/630/EEC on the welfare of pigs. Supplementary improvements have been set for various categories of pigs and introduced specific requirements concerning the following issues: light requirements and maximum noise levels; permanent access to materials for rooting and playing; permanent access to fresh water; additional restrictive conditions to carry out mutilations (for example castration, tail docking and tooth clipping) on pigs; and minimum weaning age of four weeks. Member States were obliged to apply the new requirements from 2003 on. The two Directives were initially proposed by the Commission on the basis of the Veterinary Scientific Committee's report on the Welfare of Intensively Kept Pigs [146].

28 The use of tethers has been banned in the UK since 1999 and in ROI, and the rest of the EU, since 2006.

This legislation is implemented in ROI by the European Communities (Welfare of Calves and Pigs) Regulations 2003 (S.I. No. 48 of 2003) and in NI by the Welfare of Farmed Animals (NI) Regulations 2000, as amended.

Staff from the Veterinary Public Health Service of DAFF and the Veterinary Service of DARD monitor and enforce welfare of animals' regulations during their regular visits to farms.

5.3.3 During Transport

Regulation (EC) No. 1/2005 stipulates welfare conditions for the transport of animals and related operations.

The Regulation introduces new, more efficient monitoring tools such as checks on vehicles via a compulsory satellite navigation system from 2007. It also introduces much stricter rules for journeys of more than eight hours, including a substantial upgrading of vehicle standards. For newly built vehicles, the Regulation became obligatory from January 2007 and will become obligatory for all vehicles from January 2009.

This legislation is implemented in NI under the Welfare of Animals (Transport) Regulations (NI) 2006, as amended and in ROI by the European Communities (Animal Transport and Control Post) Regulations 2006 (S.I. No. 675 of 2006). Guidance has been issued in both jurisdiction on these regulations [147-149].

DAFF and DARD monitor compliance with this Directive through non-discriminatory roadside checks.

5.3.4 At slaughter

EU legislation on slaughtering practices aims to minimise the pain and suffering of animals through the use of properly approved stunning and killing methods, based on scientific knowledge and practical experience.

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. This Directive is 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 DARD (through Official Veterinary Surgeons (OVSs)) in NI and DAFF (through Veterinary Inspectors (VIs)) in ROI.

5.3.5 Food safety implications of animal welfare

The EFSA Panel on Biological Hazards issued a scientific opinion on the food safety aspects of different pig housing and husbandry systems in 2007 following a request from the European Commission [150].

The Panel stated that the use of pig production systems based on good/hygienic farming practices, including provision of optimal animal welfare, increases the pigs' resistance to infections and leads to a reduction of the food safety risks associated with the resulting carcasses. Therefore, in principle, they concluded that on-farm pig welfare assurance contributes to the resulting carcass meat safety assurance. However, some on-farm practices that are considered beneficial for pig welfare such as holding in groups, use of bedding, use of non-slippery floors (that are difficult to sanitise) and access to outdoor spaces, were seen to have the potential to increase risks of a greater survival rate of, and/or exposure to, and/or spread of, food-borne pathogens in slaughter pigs. They advised that the closer to slaughter that a factor relevant for food safety occurs on farm, the greater the carcass safety risk it poses.

5.4 Product Traceability and Recall

5.4.1 Introduction

In recent years, high profile 'scares' such as BSE, have focused attention on how the 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 serious 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.

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

The EU recently published a document outlining traceability requirements [151].

5.4.2.1 Pig identification and tracing

All pig holdings on the island of Ireland (IOI) must be registered with the respective departments of agriculture – DARD in NI and DAFF in ROI.

Republic of Ireland

In July 2002, DAFF developed a National Pig Identification and Tracing System (NPITS) in accordance with legal requirements. The system involves the identification of all pigs that are moved off farm by either an ear tag or a slap mark and the identification of breeding stock with an individual number. All pig movements are recorded on a central movement database. Veterinary staff from local District Veterinary Offices inspect premises for suitability.

Northern Ireland

DARD allocates herd keepers a holding number and serial numbered movement documents in triplicate for the sole use of that holding. All pigs on the specified holding must be identified with the allocated holding number before leaving the farm or when they attain six months of age, whichever is sooner [152]. All pigs moving off a holding must be identified and be accompanied by the original movement document which should be retained by the buying herd keeper for one year. The first copy should be sent to the holding's local district veterinary office (DVO). The selling herd keeper should retain the second copy for one year [152].

Pigs over six months of age must be identified by an ear tag, an ear tattoo or a slap mark bearing the holding code and an individual number. Alternatively they can be slap marked with holding code and tagged with an individual number.

Pigs under six months of age moving off a holding must be identified by an ear tag, an ear tattoo or a slap mark bearing the holding number.

Finishing pigs moving directly from their holding of origin to an abattoir in NI are usually identified by a slap mark. This may be a holding code or curer number, which has been notified to the Department. The slap mark must be applied to the pigs before they leave the holding.

5.4.2.2 Health/Identification Marks

Health marks and identification marks contain similar information and have an important function in traceability systems; however, they differ in their legal significance.

The health mark is applied to carcasses, sides and quarters of pigs which have passed ante-mortem and post-mortem inspection. The official veterinarian is responsible for the application and control of the health mark which is oval in shape and must be of a minimum size.

Council Directive 853/2004/EC states that food business operators must ensure that 'products of animal origin', have a health 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.**
- **The following 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, are allocated a code number which is part of the health mark along with the code of the particular country. The competent authority in each country is obliged to maintain a list of approved premises.

Where Regulation (EC) 854/2004 does not provide for the application of a health mark, an identification mark must be applied to products of animal origin in accordance with Annex II, Section I of Regulation (EC) 853/2004. The same information is required on the identification mark as the health mark; however, there is no specified size requirement. The mark is applied directly to the product, to wrapping, to packaging or to a label or tag before the product leaves the Food Business Operator's establishment.

Health marks and identification marks are important elements of any traceability system. However, they 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 health/identification mark of the factory in which the latter activities took place.

5.4.3 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.**

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, also established the Rapid Alert System for Food and Feed (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 FSA NI and the FSAI in ROI are the primary contact points on IOI.

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 [135] relating to Product Recall and Traceability (applicable only to food) and also a Code of Practice on Food Incidents and Food Alerts [135]. A similar guidance document has been issued by FSA NI, Guidance Note on EC Directive 178/2002 [153], and includes guidance on product recall and traceability.

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 where the event arises. The FSA has set up an Incidents Taskforce in the UK to strengthen existing controls in the food chain so that the possibility of future food incidents occurring may be reduced. It also aims to improve the management of such incidents when they do occur [154].

5.5 Labelling

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.

5.5.1 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. Sale of loose (over the counter) non-prepackaged food (when it is packaged on the premises from which it is to be sold), is governed by Article 14 of Directive 2000/13/EC. This legislation permits individual Member States to decide what labelling information needs to be shown, and how it should be displayed, subject to the condition that the consumer still receives sufficient information. The only requirement for foods sold loose specified on IOI is that the name of the product and the presence of allergens must be given.

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 lies with the FSAI[29] in ROI and the 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, regardless of their quantity.

5.5.1.1 Specific meat labelling requirements

Specific rules regarding the labelling of meat came into force on July 1, 2003 and are laid down in Commission Directive 2001/101/EC, an amendment to the General Labelling Directive. This Directive only applies to the labelling of products which contain meat as an ingredient (e.g. sausages) and does not apply to the labelling of meat cuts (e.g. pork loin) and anatomical parts which are sold without further processing. The latter, such as offal, including the heart, intestine and liver, have to be labelled as such and not as 'meat'. In addition, sandwiches, rolls, soups, pizza and similar products containing meat ingredients are also excluded from these labelling requirements.

The new definition of meat defines 'meat' as the skeletal attached muscles i.e. muscle meat only and other parts of the animals such as fat and offal, e.g. the heart, liver and kidneys, are excluded and must be declared separately in the list of ingredients. There are limits to the amount of fat and connective tissue (collagen/protein percentage), which can be included in the meat content declaration (Table 5.1).

Table 5.1: Limits applied to fat and connective tissue

Meat	Fat (%)	Collagen/Protein % (Connective tissue)
Pork	30	25
Avian meat and rabbits	15	10
All other red meats and mixtures	25	25

The Directive also requires that the species from which the meat comes from must be indicated in the list of ingredients, for example, 'porcine meat' or 'pork meat' or simply 'pork'.

A further requirement is that the pork content is 'quided', (QUID: Quantitative Ingredient Declaration), meaning that the percentage of pork in the product is stated in the ingredient listing if mentioned in the name of the product (only muscle meat counts). For example, sausages must have the percentage meat declared.

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 in the definition.

29 The FSAI have overall responsibility for the enforcement of the general labelling legislation in collaboration with its official enforcement officers – the environmental health officers of the Health Service Executive.

The meat labelling requirements have been transposed into legislation in ROI under the European Communities (Labelling, Presentation and Advertising of Foodstuffs) (Amendment) Regulations, 2003 (S.I. No. 257 of 2003), and in NI under the Meat Products Regulations (NI) 2004, as amended. These requirements are enforced in ROI by the FSAI in collaboration with its official enforcement officers.

Minced meat and meat preparations
Council Directive 94/65/EC regulates the production and placing on the market of minced meat and meat preparations.

Under Directive 94/65/EC minced meat is defined as meat which has been minced into fragments or passed through a spiral screw mincer. Meat preparations are defined as meat which has had foodstuffs, seasonings or additives added to it or which has undergone a treatment insufficient to modify the internal cellular structure of the meat and thus to cause the characteristics of fresh meat to disappear. Meat preparations include burgers, sausages, sausage meat and kebabs.

This legislation details additional marking, labelling, wrapping and packaging requirements for meat preparations including the declaration of the species from which the meat was obtained in certain circumstances; the percentage meat from each species where the meat is obtained from a mixture of species; and date of preparation.

This Directive is implemented in ROI by European Communities (Minced Meat and Meat Preparations) Regulations, 1996 (S.I. No. 243 of 1996).

Guidance notes on Directive 2001/101/EC have been issued on IOI [135, 155]. The FSAI has also issued a guidance note on general meat labelling [156].

5.5.2 Nutrition labelling

5.5.2.1 General nutrition labelling requirements
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.

5.5.2.2 Nutrition and health claims

Over the past number of years, there has been a substantial increase in the number and type of nutrition and health claims appearing on food labels within the EU. As a result, in July 2003, the European Commission adopted a proposal to harmonise national legislations regulating the use of nutrition and health claims made on foods marketed within the EU. Regulation (EC) No 1924/2006, on nutrition and health claims made on foods[30] marketed within the EU, was introduced on January 19, 2007 and has been applicable since July 1, 2007.

The main aim of this new Regulation is to allow consumers to make informed food choices, by ensuring that they receive accurate information and are not misled. Claims made on foods must be clear and understandable by the average consumer. Claims that exaggerate a food's expected health benefits and/or are not adequately substantiated by scientific evidence will no longer be permitted.

This Regulation is wide in scope and covers the use of all wording and symbols which imply that a food provides a particular nutritional or health benefit. It also applies to nutrition and health claims made in commercial communications whether in the labelling, presentation or advertising of foods to be delivered to the final consumer.

The Regulation does not apply to claims made in non-commercial communications, such as dietary guidelines or advice issued by public health authorities and bodies, or non-commercial communications and information in the press and in scientific publications.

It is the responsibility of all food business operators to ensure claims they make on foods are authorised. Claims that are not authorised under this Regulation will not be permitted.

In order to be used, nutrition and health claims must not be false, ambiguous or misleading; give rise to doubt about the safety and/or the nutritional adequacy of other foods; encourage or condone excess consumption of a food; state, suggest or imply that a balanced and varied diet cannot provide appropriate quantities of nutrients in general – subject to derogation; or refer to changes in bodily functions which could give rise to or exploit fear in the consumer, either textually or through pictorial, graphic or symbolic representations.

Foods or certain categories of foods must comply with specific nutrient profiles in order to bear nutrition or health claims. These nutrient profiles are to be established by the Commission by January 19, 2009 at the latest.

Nutrient profiles will particularly take account of the fat, saturated fat, trans fat, sugar and salt/sodium content of foods bearing claims; the role and importance of the food and the contribution to the diet of the general population or certain risk groups; and the overall composition of the food and the presence of nutrients that have been scientifically recognised as having an effect on health.

When a nutrition or health claim is made, nutrition labelling is required, but must appear in group two format as set out in Article 4(1) of Directive 90/496/EEC. In addition, the amounts of substances to which a nutrition or health claim relates, that do not appear in the nutrition labelling, must also be stated in the same field of vision as the nutrition information and expressed according to Article 6 of Directive 90/496/EEC.

30 The Regulation also covers claims made on food supplements, foods for particular nutritional uses (PARNUTS), natural mineral waters and water intended for human consumption.

Salt claims

Nutrition claims for salt are permitted, but the amounts mentioned shall be those of the food as sold. Where appropriate, this information may relate to the foodstuff after preparation, provided that sufficiently detailed preparation instructions are given e.g. salt claims for dried soups should be made about the product in its re-hydrated ready-to-eat form.

Article 8 of Regulation (EC) No 1924/2006 restricts salt claims to those listed in the Annex to the Regulation (Table 5.2).

Table 5.2: Salt claims permitted under Regulation (EC) No 1924/2006

Claim	May only be made where
Low salt/sodium	Product contains no more than 0.12g of sodium, or the equivalent value for salt [0.3g] per 100g or per 100ml.
Very low sodium/salt	Product contains no more than 0.04g of sodium, or the equivalent value for salt [0.1g] per 100g or per 100ml.
Sodium-free or salt-free	Product contains no more than 0.005g of sodium, or the equivalent value for salt [0.0125g], per 100g.
Reduced sodium/salt	The reduction in content is at least 25% compared to a similar product. However, note that article 9 restricts comparative claims like 'reduced salt' – "…. a comparison may only be made between foods of the same category, taking into consideration a range of foods of the same category. The difference in the quantity of a nutrient and/or the energy value shall be stated and the comparison shall relate to the same quantity of food". Therefore, to make a comparative claim for salt e.g. 'reduced salt rashers', the product in question must be reduced in comparison with a range of similar non-salt reduced products from different brands.
Naturally/Natural	Where a food naturally meets the conditions laid down in the Annex to the Regulation for the use of a nutritional claim, the term 'naturally/natural' may be used as a prefix for the claim. E.g. if a food naturally has a salt content less than 0.3g then it could bear the claim 'Naturally Low Salt'.

Where a nutrition claim is made for sodium, the information layout required is referred to as group two in the Regulation. In addition if the claim is for salt rather than sodium then the amount of salt to which the nutrition claim relates shall also be stated in the same field of vision as the nutrition information and be expressed in accordance with Article 6 of Directive 90/496/EEC.

5.6 Organic Pork

5.6.1 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 Member State. The certifying bodies are the Irish Organic Farmer's and Grower's Association (IOFGA) and the Organic Trust in ROI. These are also certification bodies in NI along with Bio-dynamic Agricultural Association of Ireland ('Demeter'), the Soil Association, Organic Farmers and Growers, and Organic Food Federation.

There are 30 organic pork producers certified with IOFGA – 25 fully certified and five in conversion (Personal Communication, IOFGA, March 2008). Only ten producers are registered with the Organic Trust. These are what would be considered 'non-commercial' producers – the numbers are very small (1-3 pigs each mostly) and they are mostly kept for domestic supply of pork (Personal Communication, Organic Trust, April 2008). Organic pork production in NI is also limited.

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.

The organic sector on IOI is regulated by DAFF in ROI and DARD in NI. Farmers, 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".

The market for organic food in ROI is worth approximately €25 million per year, representing less than 0.5 percent of the total food market. Approximately 70 percent of the organic food on the market in ROI is imported [135].

The question of whether organic food is significantly different to conventional food with respect to nutritional content or quality is still a matter of public and scientific debate, with published literature supporting both sides of the argument [157]. 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 [135].

5.7 Summary

Pre-slaughter stress is an animal welfare and a quality issue. Long-term stress, such as on-farm handling, mixing, loading and transport, mainly results in dry, firm and dark (DFD) meat. Short-term stress, including lairage conditions and driving to the stunner, mainly leads to pale, soft and exudative (PSE) meat. There is legislation in place to ensure that animal welfare is maintained at farm level, during transportation and at slaughter.

Two quality assurance schemes for pig meat operate on the island, the NI Pig Quality Assurance Scheme and the Bord Bia Pig meat Quality Assurance Scheme in ROI. Such schemes allow producers to demonstrate that their standards of husbandry and welfare meet nationally agreed levels of best commercial practice and give an assurance to the consumer that the product is safe.

Labelling allows consumers to make informed decisions about the food they eat and also builds confidence in products. There are legal requirements in place, which govern the labelling of meat and meat products. Legislation has recently come into force on the use of nutrition and health claims on products. This has particular relevance for pork products in terms of nutrition claims relating to salt and fat content.

6 Conclusions

6.1 Introduction

Pork, including its related products, is the most commonly consumed meat on the island of Ireland (IOI). Indeed the pig sector makes a valuable contribution to the economies of Northern Ireland (NI) and the Republic of Ireland (ROI), valued at £170.9 million and, €312 million respectively in 2006.

Pork is a rich protein and B vitamin source and has a lower total and saturated fat content than other red meats such as beef and lamb. The majority of pork consumed on the island is in processed forms such as ham, bacon and sausages. Such processing can increase the salt and fat content of products. This in turn has consequences for cardiovascular health and cancer, among others. Research conducted to inform the review found that consumers were primarily concerned about the fat content of pork and pork products. Salt and cholesterol content were also cited as concerns, but to a lesser extent.

From a food safety perspective, pork is not a common source of human infectious intestinal disease. Although pork meat and processed pork products have been implicated in a number of foodborne diseases such as yersiniosis and trichinellosis, these are rare on IOI. The last reported significant outbreak associated with a pork product on the island occurred in 1998 and was the result of *Salmonella* contamination of ham. The handling and cooking of pork and pork products was an area met with caution by consumers during the qualitative research conducted. Nevertheless, the presence of *Salmonella* in pig herds is a major issue for the industry and there are programmes in place on the island to ensure its control and prevent further contamination along the food chain.

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

6.2 Conclusions

6.2.1 Primary producers, transporters and processors

Pre-slaughter stress is both an animal welfare and a quality issue. Long-term stress, such as that caused by poor on-farm handling, mixing, loading and transport, can lead to meat quality associated with that of dry, firm and dark (DFD) meat. Short-term stress, including that caused by poor lairage conditions and driving to the stunner, can lead to quality associated with pale, soft and exudative (PSE) meat. There is legislation in place to ensure that animal welfare is maintained at farm level, during transportation and at slaughter.

Good animal husbandry practices should be adhered to and pigs sources from microbiology reliable sources. The implementation of good biosecurity measures and good quality feed and water will ensure a healthy herd. *Salmonella* control schemes are of significant importance to the industry and new developments in this area towards a harmonised all island approach are to be welcomed.

Processors must continue to work with regulators and retailers to reduce the salt content of pork products on the market and meet the targets that have been set for 2010.

6.2.2 Retailers and Caterers

At retail level cold ready to eat foods should be stored below 8 (NI) and 5 (ROI)°C; hot foods delivered at a temperature above 63°C; and whole cuts of pork, burgers and sausages should be thoroughly cooked and piping hot in the middle with no pink or red in the centre. Chopping boards and other utensils used for the preparation on cooked and uncooked foods should be clearly identified and kept separate.

6.2.3 Consumers

6.2.4.1 Healthy eating

- **Fresh unprocessed cuts of pork, particularly lean cuts, should be chosen and where possible the fat should be trimmed following purchase.**

- **The majority of pork consumed on the island is in processed forms which are high in calories, fat and salt. While these products are convenient and popular with consumers, consumers should be encouraged to reduce their intake and replace with fresh, unprocessed pork. Children in particular should be encouraged to consume less processed pork products, which may also negatively impact on their iron status.**

- **The consumption of lean red meat in association with fruit and vegetables and whole grains, has been shown to have a positive effect on cardiovascular health. The addition of vegetables to a pork 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 in appropriate amounts.**

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

- **Consumers should be encouraged to read labels on processed pork products and to choose those with lower calorie, fat and salt contents.**

6.2.4.2 Food safety

Pork and pork products can be considered safe foods when handled and stored correctly. Good hygiene practices in the home should help prevent food poisoning. ***safe*food** advice highlights four keys points to ensure safe food preparation in the home.

- **Clean – hand washing after handling raw meat using warm water soap, creating a lather followed by thorough drying. All surfaces and equipment in contact with raw meat also need to be thoroughly cleaned with soap and hot water.**
- **Cook – In the home pork and pork products should be cooked through until the juices run clear, there is no pink meat left and they are piping hot all the way through. The proper cooking of pork will eliminate any food pathogens including Salmonella and *Campylobacter*.**
- **Separate – use separate cooking utensils and plates for raw meat and cooked foods and always store separately to avoid cross-contamination.**
- **Chill – keeping cooked and uncooked food at the correct refrigerated temperature of less than 5O°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, cooked 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.

Appendices

Appendix A: Fermented pork products

Product	Description
Chorizo	Sold fresh or cured, occasionally smoked. Of Spanish origin, widely used in Mexico and gaining popularity in Canada. A highly seasoned, coarsely ground pork sausage flavored with garlic, chili powder and other spices. Mexican Chorizo is made with fresh pork; in this version the casing should be removed and the sausage crumbled before cooking. The Spanish version is smoked and can be served uncooked and sliced for tapas.
Salami	A family of sausages that often varies in size, shape, ingredients, seasoning, and curing methods. In general a salami sausage is made from a pork and beef blend, is strongly seasoned with garlic and peppercorns, coarsely-grained, dry, and is not smoked, but there are exceptions. All salamis have a characteristic fermented flavour and are eaten uncooked. The white mould crust found on most salamis is due to the fermentation process, and is not a sign of deterioration. Pepperoni is a popular salami variety. It is thin and highly-seasoned.
Pepperoni	Dried – Sausage that has been cured and dried under a controlled process using bacterial fermentation to create a distinctive flavor. They are wrapped in a casing and are generally hard and dry in texture and can be stored indefinitely without refrigeration as long as they are sealed in their original package. Dried sausages are ready to slice and serve.
Prosciutto	Skin on, bone in and cured. The most famous of raw hams, Prosciutto hams are dry salted with sea salt for up to one month, then dried without smoking for at least eight months. Generally available pre-sliced. Prosciutto is generally eaten uncooked.
Frankfurters	Sold cured, cooked and smoked. Wieners are made from a finely-ground blend of pork and beef, but are occasionally made with veal, chicken or turkey. Seasonings may include paprika, mustard, pepper, celery seeds, mace, coriander, garlic, nutmeg, salt, and sugar. Wieners may contain up to 30 percent fat and 10 percent added water. They may be skinless or with natural casings. They range in size from the tiny “cocktail frank” to the famous foot-long giants. The most common size is about 6 inches long. Wieners are always served hot, either grilled or poached. Smoked and cooked – Made from fresh chopped or ground pork that is cured, smoked and cooked fully.
Cervelat	Cured, dried, and smoked. A large, mild sausage of German origin, made from a blend of beef and pork, which can be used for spreading, but is best sliced. Cervelat is fully cooked before consumption.
Pancetta	An Italian specialty is also made from pork bellies. It is cured, dried and flavoured with pepper and cloves, but is neither cooked nor smoked.

Appendix B: EU-25 pig numbers ('000)

Country	Dec 2006	Ranking
EU	**153,699****	
Germany	26,602**	1
Spain	26,034	2
Poland	18,813**	3
France	15,009	4
Denmark	13,613	5
Netherlands	11,220	6
Italy	9,281	7
Belgium	6,304	8
UK	4,731	9
Hungary	3,987	10
Austria	3,139	11
Czech Republic	2,741	12
Portugal	2,295	13
Sweden	1,662	14
Ireland	1,620	15
Finland	1,435	16
Lithuania	1,127	17
Greece	1,033**	18
Slovak Republic	1,105	19
Slovenia	575	20
Cyprus	453	21

Latvia	417	22
Estonia	341	23
Luxembourg	87	24
Malta	74	25

**Provisional

Source: Central Statistics Office 2007 [5]

Appendix C: Retail pork market statistics year ending 15 November 2007

Market	Value (millions)†	Volume ('000 tonnes)	Composition by volume	Further information
Pork	€137.8 (£93.9)	19,319	Pork chops (43.3%), pork joints (27.3%), pork steak (14.4%), pork mince/ casserole (4.1%) and pork offal (0.9%).	Over three quarters of pork was sold pre-packed, with the remainder sold loose.
Bacon (including rashers)	€186.7 (£127.3)	22,256	Joints (41.7%), steaks (4.4%), chops (0.3%) and rashers (53.6%).	Nearly 85 percent was sold pre-packed, with the remainder sold loose. Discounters sell more bacon than other retailer types.
Sliced ham[1]	€130.24 (£88.78)	8,695.7	N/A	Pre-packed ham was represented by private label (38.5%) and branded (61.5%) products.
Sausages	€75.4 (£51.4)	13,712	N/A	Only ten percent were sold loose, with the remainder pre-packed.
Pre-packed rashers	€98.27 (£66.99)	8,940.8	Unsmoked (60.3%), speciality (7.3%), smoked (16.2%), flavoured (6.4%) and economy rashers (9.7%).	There was an approximate fifty-fifty split between branded (46.2%) and private label (53.8%) products by volume.

Source: Bord Bia, 2007 [20]

† Figures period ending 15 July 2007 as of year ending 15 November 2007 were not available.

* Conversion rate based on average of 2007 €1=£0.681

Appendix D: Salmonella surveillance of Danish pig production, 2005.

Breeding and multiplier herds		
Time	**Sample taken**	**Purpose**
Every month.	10 blood samples per epidemiological unit. Herds with *Salmonella* -index 5 or above: Pen-faecal samples, max twice per year.	Calculation of *Salmonella* – index. Clarify distribution and type of infection in the herd.
Sow-herds		
Time	Sample taken.	Purpose
When purchaser of piglets is assigned to level 2 or 3, max. twice per year.	Pen-faecal samples.	Clarify distribution and type of infection in the herd, and clarify possible transmission from sow herds to slaughter-pig herds.

Slaughter-pig herds		
Time	**Sample taken**	**Purpose**
At slaughter.	Meat juice, 60-100 samples per herd per year. Herds in RBOV: one meat juice sample per month. Pen-faecal samples.	Calculation of slaughter-pig index. Assigning herds to level 1-3 and assigning herds to risk-based surveillance (RBOV) Clarify distribution and type of infection in the herd.

Pork carcasses at the slaughterhouse		
No. of samples	**Sample taken**	**Time and no. of animals slaughtered**
5 samples daily pooled into one analysis	Swabsamples from 3 designated areas	> 200 pigs slaughter/day
5 samples pr 200 slaughtered pig, pooled into one analysis	Swabsamples from 3 designated areas	200 pigs pr. months, < = 200 pigs pr. day
5 samples every 3 month, pooled into one analysis	Swabsamples from 3 designated areas	> 50 pigs pr. month, < 200 pigs pr. month
1 sample every 3 month	Swabsamples from 3 designated areas	< 50 pigs pr. month

Source: Danish Veterinary and Food Association.

Appendix E: Nutritional composition of pork products when different cooking methods are used

Name	kcals	KJ	Protein (g)	Fat (g)	Saturated Fat (g)	Iron (mg)	Vit B12 (ug)	Vit B6 (mg)	Vit D (ug)	Vit E (mg)	Sodium (mg)
Bacon rashers, back, grilled	287	1,194	23.2	22	8.1	0.6	1	0.52	0.6	0.07	1,880
Bacon rashers, back, grilled crispy	313	1,308	36	19	7.1	1.1	1	0.71	1	0.1	(2,700)
Bacon rashers, back, fat trimmed, grilled	214	892	25.7	12	4.6	0.7	1	0.5	0.7	0.07	(1,930)
Bacon rashers, streaky, fried	335	1,389	23.8	27	9.1	0.7	1	0.47	0.6	N	(1,880)
Bacon rashers, streaky, grilled	337	1,400	23.8	27	9.8	0.8	1	0.4	0.7	0.07	1,680
Ham, canned	107	449	16.5	4.5	1.6	1.2	Tr	0.21	N	0.08	1,470
Ham, gammon joint, boiled	204	851	23.3	12	4.1	0.8	Tr	0.42	0.8	0.08	1,180
Ham, Honey roast and smoked	107	451	18.4	3.3	1.1	0.7	1	0.61	N	0.04	1,200
Pork pie, individual	363	1,514	10.8	26	9.7	1.1	Tr	0.15	N	0.21	650
Sausage rolls, puff pastry	383	1,596	9.9	28	11.2	N	N	N	N	N	600
Pork sausages, chilled, fried	308	1,279	13.9	24	8.5	1.1	1	0.09	(1.1)	0.86	1,070

Pork sausages, chilled, grilled	294	1,221	14.5	22	8	1.1	1	0.12	(1.1)	0.92	1,080
Frankfurter/ hot dog sausage	287	1,189	13.6	25.4	9.2	1.1	1	0.12	N	0.63	920
Salami	438	1,814	20.9	39.2	14.6	1.3	2	0.36	N	0.23	1,800
Pepperami	551	2,279	22.3	51.1	19.5	2.2	2	0.27	N	2.05	1,790
Black pudding, dry fried	1236	297	10.3	21.5	(8.5)	(12.3)	1	0.04	(0.7)	0.24	(940)
White pudding	1876	450	7.0	31.8	N	2.1	1	0.06	N	1.00	370
Pate, liver	348	1,437	12.6	33	9.5	5.9	8	0.25	1.2	N	750
Luncheon meat, canned	1158	279	12.9	23.8	8.7	1.0	1	0.10	N	0.11	920
Pork casserole, made with canned cook-in sauce	153	640	17.1	7.8	2.6	0.7	1	0.35	0.5	0.03	650
Pork chops in mustard and cream	261	1,084	14.5	22	8.3	0.8	1	0.38	0.7	N	310
Pork pare ribs, 'barbecue style'	318	1, 322	20.6	24	6.4	1.7	1	0.34	0.8	(0.1)	1,160
Pork, stir-fried with vegetables	105	442	12.1	4.7	1.3	1.3	Tr	0.26	0.3	N	330
Sweet and sour pork	177	741	12.7	8.6	2	0.9	1	0.3	0.4	(0.3)	494
Pork, chump chops, fried, lean and fat	293	1,217	24.6	21.6	7	0.8	Tr	0.38	0.9	N	60

Pork, diced, kebabs, grilled, lean and fat	189	797	33.6	6.1	2.2	1.2	1	0.18	0.9	0.02	81
Pork, fillet slices, grilled, lean and fat	178	749	33.2	5	1.9	1.3	1	0.65	0.8	61.1	67
Pork, fillet strips, stir-fried, lean	182	764	32.1	5.0	1.3	1.4	1	0.78	0.8	59.6	71
Pork, leg joint, roasted medium, lean	765	182	33.0	5.5	1.9	1.1	1	0.50	0.7	0.02	69
Pork, loin chops, grilled, lean and fat	257	1,074	29	15.7	5.6	0.7	1	0.49	1.1	54.6	70
Pork, loin chops, roasted, lean and fat	301	1,256	31.9	19.3	7.0	0.8	1	0.42	1.1	0.03	68
Pork, loin joint, roasted, lean and fat	253	1,054	26.3	16.4	5.9	0.7	1	0.32	1	0.03	18,263
Pork, mince, stewed	191	800	24.4	10.4	3.9	1.4	1	0.23	0.9	0.02	18,268
Pork, steaks, grilled, lean and fat	198	832	32.4	7.6	2.7	1.1	1	0.68	0.9	0.02	76

Note: N=the nutrient is present in significant quantities but there is no reliable information on the amount; ( )=estimated values; Tr=trace amounts

Source: Food Standards Agency, 2002 [110]

Glossary

Barrow a pig that has been castrated before sexual maturity.

Boar a mature breeding male pig.

Farrow a litter of pigs.

Gilt a young female pig, being prepared for, or in her first parity.

Piglet a young pig from birth to weaning.

Sow a mature breeding female pig.

Weaner a young pig that has recently been weaned, usually at four to nine weeks.

Zoonose a disease or infection which is naturally transmissible directly or indirectly between animals and humans.

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