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Contents

Informed Decisions on Grain Quality

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Wheat and barley are the predominant cereals used in pig diets in Ireland. The quality of these home grown cereals (i.e. their nutritive value) is largely influenced by weather conditions at and before harvesting. Difficult growing and harvesting conditions can result in low hectolitre weight, sprout damage, heat damage and increased potential for mould, and consequently, mycotoxin contamination. Further to this, the way in which these cereals are dried, stored and the degree to which they are milled prior to incorporation in pig diets can also influence their feeding value. The loss in nutritive value associated with each of these is discussed below.

1. Hectolitre weight

Hectolitre weight is the standard measure of cereal quality in Ireland. It is the standard European Community mass per storage volume (density) measurement and is expressed in kilograms per hectolitre (100 litres). Measurements obtained in pounds per bushel can be converted into Hectolitre weight by multiplying by a factor of 1.25.

Low hectolitre weight grains are generally associated with reduced feeding value because they contain less starch, more fibre, and to more foreign material being present in a sample. If fed, grain of low hectolitre weights will result in poorer feed conversion efficiencies (FCE) compared with normal test weight grain. Average daily gain (ADG) may not be adversely affected unless the reduced energy and increased fibre level physically limits feed intake.

A general rule, when buying wheat for inclusion in pig diets, is to choose wheat with a hectolitre weight in excess of 72. Table 1 shows the relative performances of grower-finisher pigs fed 74, 64 and 56 hectolitre weight wheat. ADG was only marginally affected by the hectolitre weight of the grain as daily feed intake was found to increase on the low hectolitre wheat in order to maintain a constant energy intake level. This increased intake resulted in a deterioration in FCE as hectolitre weight fell.

Table 1: Effect of wheat Hectolitre weight on the relative performance of finishing pigs.

Hectolitre weight kg /hl	74	64	56
ADG	100	101	102
Daily Intake	100	107	110
FCE	100	107	108

(Parker 1991)

From this information a good rule of thumb when pricing low hectolitre weight wheat for use in pig diets might be as follows.

Wheat with a hectolitre weight range of 63 - 68 should be priced at 93% of the value of wheat with a hectolitre weight in excess of 72.

Wheat with a hectolitre weight range of 56 - 62 should be priced at 90% of the value of wheat with a hectolitre weight in excess of 72.

As a rule, it is assumed that grain of very low hectolitre weight is inferior in energy content but small differences of 2 - 4 kg / hl are unreliable indicators of a difference

A similar rule of thumb can be devised for barley. Barley with a hectolitre weight of 50 - 56 could be discounted to 90% of the value of barley with a hectolitre weight in excess of 60.

American research has found that when hectolitre weights fall below 56 and 50 for wheat and barley respectively the fibre content is so high that it becomes physically limiting for a pig to consume enough to maintain an energy intake level for acceptable growth. This causes a reduction in ADG.

2. Better predictors of feeding value

Many studies show that hectolitre weight is a poor predictor of the digestible energy (DE) value of the cereal (Zijlstra, *et al.* 1999; O'Doherty and Dore 2001) or pig performance (HGCA, 2001). Zijlstra, *et al.* (1999) concluded that the prediction of the nutritive value of wheat is more accurately based on chemical characteristics than on hectolitre weight. They found that hectolitre weight was only a poor predictor of the DE of wheat. Of a range of chemical analysis, the single best predictor of DE in wheat was xylose (R^2 = 0.61) followed by total non-starch polysaccharides (NSP) (R^2 = 0.54). Using two chemical characteristics, Crude Protein (CP) and Neutral Detergent Fibre (NDF) together resulted in the best prediction of DE content (R^2 = 0.75). From the more routine analysis measures CP and Crude Fibre together accounted for 67% of the variation in the DE of wheat (R^2 = 0.67). According to work by Fairbairn *et al.* (1999) acid detergent fibre (ADF) can be used to predict the DE content of barley with an accuracy of 85%.

AusScan a commercial arm of the Austrailan Pork Cooperative Research Centre is currently commercialising NIRS calibrations that predict the energy value as well as other chemical and physical characteristics of whole cereal grains for different types of livestock including pigs. Such a rapid test could result in huge feed cost savings for producers by enabling them to discriminate between grain batches of differing digestible energy content.

An experiment conducted in Moorepark looked at wheats differing in hectolitre weight and origin. In brief, 3 diets formulated with (1) high quality wheat (HQ), (2) good quality wheat (GQ), and (3) poor quality wheat (PQ) (Table 2). Diets were formulated to 11.2 g/kg lysine and 13.6 MJ/kg DE and contained 744 g/kg wheat and 222 g/kg soya-bean meal.

Table 2: Analysis of wheats fed to finishing pigs (Lawlor and Lynch, 1999)

	HQ	GQ	PQ
Origin[1]	Britain	Ireland	Ireland
Hectolitre weights (Kg/hl)	74.2	73.3	67.0
Yeast and mold count (10^4/g)	4.5	38	65
Crude protein (%)	11.6	10.3	10.6
Fibre (%)	2.15	2.52	3.09
Fat (%)	1.70	1.85	1.85
Ash (%)	1.53	1.54	1.51
Digestible Energy (MJ / Kg) [2]	14.2	13.7	13.5

[1]Wheats were harvested in 1997 when harvesting conditions were difficult in Ireland, [2]Calculated using prediction equation (Zijlstra, *et al.* 1999)

As expected the HQ wheat resulted in the best animal performance. However, unexpectedly the GQ wheat resulted in poorer growth rate than the PQ (Table 2). On examination of the data the yeast and mould counts for GQ and PQ wheats were 10 fold higher than for HQ. This might indicate a presence of mycotoxins in the GQ and PQ wheat. However presence or absence of moulds does not confirm that a mycotoxin is present and, unfortunately, mycotoxin analysis was not performed on the wheats used in this experiment. Another plausible explanation for the difference in animal performance might be a difference in the DE content of the test wheats. DE of the test wheats was calculated using a prediction equation from Zijlstra, *et al.* (1999) and this does, to a large degree, explain the animal performance differences observed.

Interestingly using August 2010 finisher feed price (€222/tonne) and pig price (150c/Kg DW) and using a fixed duration of feeding the differential in the margin over feed was €6.93 per pig between diets formulated with HQ as opposed to GQ wheat. This differential is huge especially considering the hectolitre weights of both wheats were similar.

Table 3: Effect of wheat quality on finisher pig performance (Lawlor and Lynch, 1999)

	HQ	GQ	PQ	s.e.	P%
Initial weight (kg)	38.1	38.5	38.8	0.7	NS
Slaughter weight (kg)	91.9	89.3	91.4	1.1	NS
Carcass weight (kg)	69.9	67.1	69.8	1.0	9+
Feed Intake (g/day)	2055 [a]	2086 [a]	2276 [b]	57	**
Daily gain (g/day)	727 [a]	667 [b]	703 [a,b]	18	7+
FCE	2.94 [a]	3.22 [b]	3.28 [b]	0.07	**
Lean (%)	57.0	58.4	57.3	0.6	NS
Kill out (%)	76.1 [a,b]	75.2 [a]	76.4[b]	0.4	7+

It is evident from this work done at Moorepark that producers need to be more scrupulous when purchasing feed ingredients. Better predictors of grain quality should be used. Near-infrared spectroscopy (NIRS) allows rapid determination of chemical composition compared to wet chemistry and the analysis cost involved will be money well spent. The cereals you are planning to purchase can then be priced according to their true nutritive / feeding value.

3. Sprouted grain

The germination of grain prior to harvest is a consequence of a wet, warm and prolonged harvest resulting in sprouted grain. During sprouting the starch in the grain is converted into sugars providing energy for germination and sprout growth. For this reason, sprouted grain has less starch and energy than unsprouted grain. The nutritive value of sprouted grain has been found to change greatly with time, being superior to unsprouted grain in the first day or two of germination but deteriorating thereafter.

The greater the degree of sprouting the greater will be the reduction in energy content of the grain. As with low hectolitre weight, ADG is usually not affected but FCE deteriorates. Trials with finisher pigs using diets containing 50% wheat that was 0, 20, 40 or 60% sprouted found that the relative energy value of sprouted to unsprouted wheat was 93%, 87% and 86% respectively.

This data indicates that grain energy content could decrease 0.3 - 0.4 % for every 1% of sprouted wheat in the diet. Bearing this in mind a pig diet with 15% sprouted grain could promote similar ADG with 4 - 6 % poorer FCE than a diet with sound grain. It has been estimated that levels of over 30% sprout damaged grain would be required before the energy difference in the diet would depress ADG.

4. Drying Temperatures

It is widely recommended that both wheat and barley are best dried at grain temperatures below 70^{o}C. Above this temperature, the grain is damaged and its feeding value reduced, with the greatest reduction occurring where exposure time is highest.

The deterioration in feeding value of cereals dried at high temperatures is as a result of the denaturing of protein within the grain which can leave a considerable level of the protein unavailable. This will inevitably result in reduced growth rates in pigs. A temperature of 104^{o}C for 30 minutes has been shown to reduce available lysine by 7%. Prolonged or high drying temperatures can also reduce vitamin levels.

5. Mycotoxin contamination.

Mycotoxins are defined as secondary metabolites of mould growth and are thought to be produced in response to stress factors experienced by the mould. A brief overview is given below and for a more extensive review please see (Lawlor and Lynch 2001a,b).

Weather damaged grain often leaves the kernel more susceptible to mould and fungal growth in the field and during storage if moisture content is not adequately reduced. This may result in the presence of mycotoxins (ie. toxins produced by the moulds). Mycotoxin contaminated grain when fed to pigs is likely to depress ADG as well as adversely affecting FCE.

If home compounding and buying large consignments of barley and / or wheat it may be wise to have a sample tested for mycotoxins prior to their incorporation into diets. Specific testing for the presence and quantities of mycotoxins is essential to determine toxicity since fungal / mould presence only determines the potential for toxins to be produced. Mould contamination can often occur in pockets in grain and sampling may actually miss these “hot spots”. Mycotoxins may also be present after fungi have lost their viability. Table 4 shows the maximum concentrations of three different mycotoxins that should be allowed in pig diets.

Table 4: Recommended max concentrations of mycotoxins in pig diets

	Dietary concentration		
Pig	Deoxynivalenol ppm	Zearalenone ppm	Aflatoxin ppb
Breeding herd	1.0	2.0	100
Piglets	1.0	1.0	20
Weaners	1.0	1.0	*
Finishers	1.0	3.0	200
Boars	1.0	3.0	*

* Concentrations not determined (Diekman *et al.*, 2008)

Fusarium is the most significant species from the point of view of mycotoxins. Probably the most serious mycotoxin associated with it is Zearalenone, an oestrogenic type chemical which causes reproductive disorders in pigs such as abortion, stillbirths, decreased litter size and prolonged oestrus. It has little effect on feed intake, weight gain or direct mortality. Feeding mould / mycotoxin infected grain can trigger off diseases which are present at low levels. However this is usually impossible to prove.

There are no practical methods of economically decontaminating large volumes of mycotoxin contaminated grain. Dilution with clean grain may be helpful when levels are found near the lower threshold where contamination begins to show slight animal effects. Adding absorbing clays, binding agents or glucomannan to the feed may also be beneficial where mycotoxin contamination levels are low.

Producers should aim to purchase mycotoxin free grain and keep it mycotoxin free during storage. This can be achieved by drying grain to 14-15 % moisture, screening the grain and maintaining temperature as low as possible. Using fungal inhibitors such as propionic - acetic acid will help prevent fungal growth in grain. Annual steam cleaning of feed and grain bins is also advisable to prevent the carryover of moulds. Bins should be allowed to thoroughly dry out following this procedure so it is best conducted in summer.

There may be a case for adding a mould inhibitor when manufacturing feed as grinding and pelleting can create conditions favourable to the reactivation of mould growth.

6. Fineness of grind

Grinding is a very effective method of increasing feed utilisation. By reducing particle size the surface area of the feed is increased thus allowing greater interaction with digestive enzymes. As a rule of thumb if there are whole or half seeds in the feed, the material was not ground finely enough and it is possible that 5-8% in feed efficiency is being lost. This can be an indication that there is a hole in the screen.

On the other hand grinding a meal to an average particle size below 600-700 microns (0.6 – 0.7 mm) increases the incidence of stomach ulcers in all classes of pigs. The increase in stomach ulcers with increasing fineness of grind is thought to be due to increased fluidity of the stomach contents and increased pepsin and digestive acids resulting in increased contact time with the sensitive oesophageal region of the stomach. Such very finely ground feed is also liable to bridging, which can lead to out of feed events. This in turn can also lead to stress, thus causing ulcers in the pigs. It is recommended that the average particle size should be between 650 and 750 microns. This recommendation is a balance between feed efficiency, processing costs, incidence of gastric ulcers and the potential for feed bridging (Richert and Derouchey, 2010).

Another method of determining the fineness of grind is the “modulus of fineness”. This is a measure of “average” particle size and figures of about 3 are considered ideal. Values higher than 3 are due to more coarse particles. Excessively fine grinding will increase the energy requirement and contribute towards stomach ulcers. Coarse grinding will result in some reduction in energy digestibility but provided that all grains are cracked the effect is likely to be small. A survey of milled barley and wheat from home millers was conducted in Moorepark in 2005 (Table 5). Thirty four samples of barley and wheat were collected by Teagasc Pig Advisers from 14 farms (at least one barley sample and one wheat sample from each). Farms varied in type of mill (hammer or plate). Mean farm tonnage of feed produced was 226tonnes per month. Hammer mill screen size varied from 3mm to 2mm. Fineness of grind was assessed using a six screen vibrating sieve with screen sizes 2000µm, 1000µm, 500 µm, 106µm, 71 µm and 53 µm.

Table 5: Percentage of sample in each size category by cereal (Moorepark, 2005)

	Barley			Wheat		
	Mean	Min	Max	Mean	Min	Max
Over 2000µm	2.0	0.2	7.9	2.9	0.2	12.8
1000 to 2000µm	31.3	14.4	70.1	30.1	10.4	68.3
500 to 1000µm	36.3	15.5	43.8	31.1	12.8	41.9
106 to 500 µm	16.4	5.4	24.7	17.1	2.9	26.8
71 to 106µm	11.1	2.7	22.9	13.7	3.3	30.8
Under 71 µm	2.9	0	6.9	5.2	0.3	14.1
Over 1000µm	33.3	15.0	76.3	33.0	10.6	79.3
Under 1000µm	66.7	23.7	85.0	67.0	20.7	89.4
Under 500µm	30.3	8.2	52.2	35.9	6.7	62.0
Modulus of fineness	2.91	2.35	3.72	2.81	2.20	3.8

Note: There should not be more than 6% in each of the two categories (1) sieve above 2000µm or (2) passing through the 106 µm sieve

Other

It is important to be aware that plant breeders do not necessarily have the animal feeding value of a grain in mind when developing new varieties. For instance most feed barley originates from varieties which were bred for malting purposes but failed for this purpose.

The protein content of malting and feeding barley in Ireland was low in 2009 and again appears to be low in 2010. Many factors such as yield, weather, levels of nitrogen applied etc. influence the protein content of a cereal. It is too early to say whether the drop in protein observed in the past two years is a real trend or just a blip.

Summary

Barley and wheat for feeding to pigs should have a hectolitre weight of in excess of 60 and 72 kg/hl respectively. Having said this, hectolitre weight is a poor predictor of animal performance. When purchasing grain, producers should be armed with better predictors of its nutritive value. NIRS is advanced enough now that some of these predictors can be cost effectively obtained in a timely manner. It is recommended to avoid grain with mycotoxin contamination because as well as reducing feed intakes and ADG, fertility problems in sows can arise from feeding it. Screened grain dried to 14-15% moisture should be stored in clean dry bins so that mould growth is avoided. The average particle size after grinding should be between 650 and 750 microns to maximise feed utilisation while minimising the incidence of stomach ulcers, feed bridging and energy cost associated with grinding.

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Future Sources of Pig Feed

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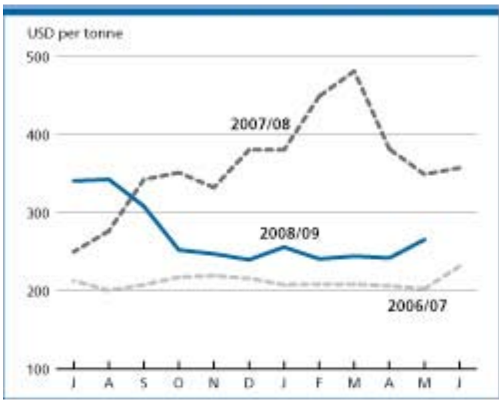
Feed costs account for at least 70% of the total cost of pork production. While some pig producers may think of only soybean meal, wheat and barley when feeding pigs, it is important to remember that pigs do not require any particular feed ingredient for normal growth but do require amino acids, energy, vitamins and minerals. Pig diets are formulated on a least cost basis, when one feed ingredient becomes expensive the formulation is altered to incorporate a cheaper alternative that offers a similar nutritional outcome when combined with other feed ingredients. The dramatic rise in wheat prices particularly in the last six months has put considerable pressure on the profitability of pig production not only in Ireland but worldwide. With profitability in pig production so strongly linked to feed costs, producers need to examine alternative feedstuffs to high priced cereals to maximize profit.

Feed prices – a history of volatility

The price of wheat globally has experienced cyclical changes over the past number of years with some periods of extreme price volatility experienced particularly during 2007/08 (Figure 1). This pattern of unpredictability is most likely to continue into the future. Wheat prices are at the mercy of numerous global issues which almost guarantee a future of fluctuations. One of the issues which impact greatly on wheat price is the food energy debate. Historically, the economies of food and fuel were separate. However, since the US developed enormous capacity to convert grain to ethanol much of the cereals that would have traditionally been grown to feed the population are now being grown for ethanol production. This in turn increased the costs of many food products and threatens food security worldwide.

The price of wheat is extremely sensitive to environmental conditions worldwide which impacts greatly on harvest yield. This was particularly evident in 2007/08 when drought conditions in Australia and poor harvest conditions in Canada resulted in a decrease in production of 10.3% and 6.7% respectively on the previous year’s production. World wheat stocks were at an all time low and wheat price soared to levels not seen in more than a decade.

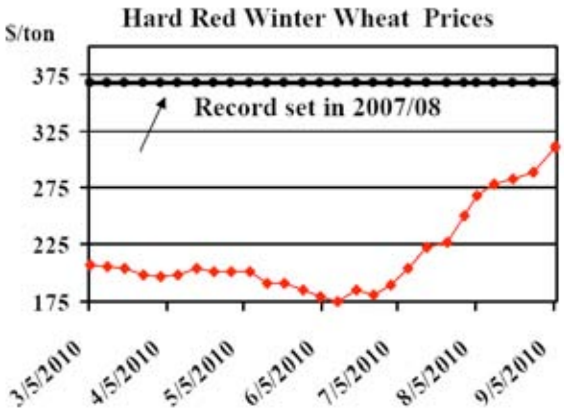
Figure 1. Wheat export price (US no. H.W. Gulf)



Source: FAO, 2010

Adverse weather conditions in Europe over the last number of months have led to less than ideal conditions for harvest of the 2010 cereal crop. Ripening of wheat was hampered by dry weather conditions resulting in lower than expected yields and a poorer starch content in the grain. In Russia and Kazakhstan part of the harvest was lost due to severe drought and fire. Russia, the Ukraine and Kazakhstan are three of the top six wheat exporting countries in the world together with the US, EU and Argentina. Events in these countries are in part responsible for the escalation in wheat prices of c.75% since June of this year, their fastest rate rise since 1973. However, these prices are still below the record average price set for wheat in 2007/08 (Figure 2).

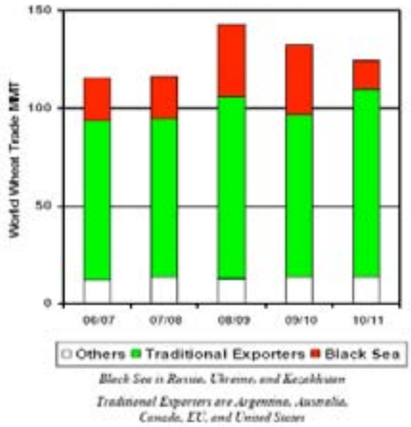
Figure 2: Average wheat price 2007/08



Source: USDA, FAS; 2010

As a result the global wheat supply is estimated to be reduced by about 2%. Supply will be further constrained by an export ban imposed by Russia and export restrictions in the Ukraine on wheat, both of which have put enormous pressure on the cereal market worldwide. The Middle East and Africa depend on cereal imports from Russia and must find alternative sources of wheat in the EU thus further exacerbating the cereal price crisis. Likewise, wheat consumers changing to other cereals such as maize and barley ensure that the prices of these cereals are also driven up as demand is increased. However, reduced wheat exports from the Black sea area (Russia, Ukraine and Kazakhstan) are expected to be offset by increased exports from the EU, US (+15%) and Australia (Figure 3).

Figure 3: Traditional Wheat Exporters Compensate for Black Sea Shortfall



Source: USDA, FAS; 2010

Another issue affecting supply and price of cereals is GM crops and the EU's approach to their authorization. The global production area of genetically modified (GM) crops has increased substantially each year since its introduction in 1996. As a result, sourcing non-GM alternatives has become increasingly difficult and these crops are only available at a premium price. However, GM crops must undergo rigorous pre-market risk assessment to receive authorization for use in the EU, a process which can take up to 33 months. This means that new GM crops, approved for use elsewhere in the world can be grown, harvested and available to other nations worldwide prior to EU authorization. The delay in the authorization process results in a premium being paid by the Industry for authorized GM alternative or non-GM alternatives.

However, in recent months the European Commission has proposed an overhaul of the EU's policy for approval of genetically modified crops. Among these recommendations, the EU has appealed for member states to adopt 'a more positive stance' on GMO authorization at the risk assessment stage and to avoid using the safeguard clause to address non-scientific issues. Adoption of these proposed changes will help to speed up the EU authorization of GMO and consequently EU's access to a greater supply of GMO ingredients.

Impact on the Irish pig producer

As a result of the supply and demand issues the impact on the Irish pig producer is that feed prices, which account for 70% of the total cost of production, have so far risen by €20-25 per tonne on last years prices and further price rises are forecasted (Table 1).

Table 1: Estimated Increase in Cost of Production as a Result of Increased Wheat and Barley Prices.

Cereal Prices, €/tonne		
	Wheat	Barley
Sept. 2010	225	194
Sept. 2009	111	97
Additional cost, €/tonne	+114	+97
Assume pig feed contains 75% cereals		
Additional cost/tonne of composite feed (€)	85.5	72.75
Assumptions		
Growing pig FCE	2.45	(PIGSYS, 2009)
Sale weight, kg	105	
Weaning weight, kg	7	
Kg gained from wean to slaughter	98	
Feed intake per pig (kg)	98 × 2.45 = 240	
Sow feed consumption (tonne/yr)	1.22	(PIGSYS, 2009)
No. pigs produced/sow/yr	23.3	(PIGSYS, 2009)
Sow fed intake/pig produced (kg)	1.22/23.3 = 52	
Feed intake (inc. sow) per pig (kg)	52 + 240 = 292	
	Wheat	Barley
Additional feed cost/pig (€)	0.292×85.5 = 24.97	0.292×72.75 = 21.24
Kill out (%)	76.3	(PIGSYS, 2009)
Additional cost/kg deadweight (cent)	31	26

The increased feed costs equate to an additional 25-31 cent cost to the producer per kg of deadweight. At a time when the Irish pig industry was beginning to enjoy a return to profitability after some turbulent times including a prolonged poor pig price and the dioxin scare, it is unfortunate that the industry has been yet again thrown into another crisis. For some producers, home compounders in particular, the extent of this crisis has been further exacerbated by favourable forecasts for grain prices during the Spring, resulting in many producers without forward grain contracts in place.

Ireland relies more on imports of animal feed ingredients than any other country in the EU. We are 52% reliant on imports while the UK are only 36% dependent, France 19% and Germany 26% dependent (Hughes, 2008). In particular in Ireland, our self sufficiency is hampered by lack of land area for cultivation of protein supplements required for animal feed. Pig production in particular is reliant on imported soybean meal and maize co-products (corn gluten feed, distillers dried grain) to achieve the high protein contents required for pig feed. The majority of these feed ingredients are imported from the US, Brazil and Argentina (Lawlor & Walsh, 2009).

Sources of pig feed for the future

The import price of cereals dictates the price charged for home grown cereals so there is no cost benefit from sourcing Irish grown cereals. In pig production, while creep and link diets have strict ingredient inclusion specifications and are expensive, diets for sows, weaner and finisher pigs are formulated based on the principle of least cost. When one ingredient becomes expensive it will be excluded or limited in the diet in place of a cheaper alternative. The principle behind this type of formulation ensures that nutritional quality of such diets is not compromised. However, findings by Kavanagh *et al*. (1999) suggest that least cost diets were associated with poorer pig performance than cereal-based diets. With the increase in wheat prices worldwide, pig producers formulating on a least cost basis must explore alternative ingredients which are (a) more economical for inclusion in pig feed, (b) maintain feed quality and (c) maintain or improve pig performance.

Some of these alternatives will be outlined below but their inclusion will be dependent on price and availability. It is also important to consider the inclusion level of certain ingredients, as above certain limits some co-products/cereals may be problematic for pigs.

GMO technology

The technology of genetic modification was first introduced 15 years ago. GM technology allows for the modification of the genetic material of living cells and organisms using techniques of modern gene technology. This technology allows for the transfer of desirable characteristic to living cells for example insect resistance to plants. Regulations (EC) 1892/2003 established 0.9% as base level for 'presence of GMO'. Therefore, in the EU, any food or feed containing more than 0.9% GMO is legally considered a GM food or feed.

GMO cereal production – the position globally

Since the introduction of GMO technology 15 years ago, global land area planted with GM crops has dramatically increased with an 80 fold increase from 1996 to 2009. In 2009, a record 14 million small and large farmers in 25 countries planted 134 million hectares, an increase of 7% or 9 million hectares over 2008 (James, 2009).

Twenty five countries grew GM crops (16 developing countries and 9 industrialized countries) in 2009. In order of area grown they were, USA, Brazil, Argentina, India, Canada, China, Paraquay, South Africa, Urguay, Bolivia, Philippines, Australia, Burkina Faso, Spain, Mexico, Chile, Colombia, Honduras, Czech Republic, Portugal, Romania, Poland, Costa Rica, Egypt and Slovakia. The first eight of these countries grew more than 2 million hectares each. The USA is by far the largest grower of biotech crops with 64 million hectares grown there in 2009 (James, 2009).

Irelands position on GM crops

Currently, no genetically modified plants can be cultivated in Ireland. However, GM crops/feeds authorized for use by the EU can be imported into Ireland and used in animal production. Ireland's strong dependence on cereal imports is particularly relevant to the pig industry as the high protein content of pig feed is achieved through imported soybean meal and maize co-products. These crops are sourced mainly from the US, Argentina and Brazil, are of GM origin and are mostly authorized for use in the EU. Between 2005 and 2007, over 3.4 million tonnes of GM feed ingredients was imported into Ireland to offset the deficit in domestic feed supplies (Lawlor & Walsh, 2009).

Much debate has centred on the issue of declaring Ireland a GM-free island in recent times as a means of enhancing the export potential of the Irish food industry. However, a ban on GM crops/feed can only be implemented under EU law if scientific evidence indicates health/environmental issues related to the GM.

The supply and cost of feed ingredients is affected by numerous factors some of which have already been mentioned including weather, currency, freight, energy costs and fund activity. A requirement for GM-free pig diets in Ireland would further elevate the cost of feed. Further cost would be incurred sourcing non-GM alternatives, substituting GM ingredients for other protein and energy products and increased cereal price arising from decreased availability. A GM-free status would put further pressure on the sustainability of the pork industry in Ireland.

Below is an estimate of the cost of formulating a GM-free composite pig feed on 11th September 2009. At that time GM-free soya was available at a premium of €35/tonne. All the maize being imported at the time was GM-free with no premium over GM maize. However, there was a premium for non-GM maize gluten and maize distillers of €10 and €18 respectively. In Table 2 below maize and maize products are not distinguished and a premium of €10 is assumed for non-GM over GM.

If we were to feed non-GM pig diets based on ingredient prices as of 11th September 2009 the cost of feeding a pig would increase by €2.51 (Table 2; a). The likelihood in Ireland is that alternative feed ingredients would be used instead of maize or maize by-products to formulate a GM-free diet, and consequently these alternatives would similarly increase in price. Table 2 (b) shows a scenario where the full €60/t premium for non-GM maize and maize by-products is absorbed. In this case the cost of feeding a pig would increase by €3.93. The ability of Irish pig industry to survive in a GM-free Ireland in the absence of a premium being paid for GM-free pig meat is very remote.

Table 2: Estimated Cost of Substituting Conventional for GM Ingredients on Irish Pig Industry.

Assumptions			
Feed intake (inc. sow) per pig (Kg)	285	(PIGSYS 2008)	
No of sows in Republic	148662	(Teagasc Pig Herd Survey 2009)	
No. pigs produced/sow/year	23.4	(PIGSYS 2008)	
Total pig feed required (tonne)	991427		
(a) Situation on September 11th 2009			
Inclusion of GM ingredients	(%)	Premium for Non-GM ingredient (€/tonne)	Premium for Non-GM diet (€ /tonne)
Soya	20	35	7.00
maize products	8	10	0.80
Soya oil	1	100	1.00
Additional cost / tonne diet (€)	8.80		
Total cost to pig Industry (million €)	8.7		
Total cost per pig (€)	2.51		
(b) Situation on September 11th 2009 but with access to cheaper GM maize products			
Inclusion of GM ingredients	(%)	Premium for Non-GM ingredient (€/tonne)	Premium for Non-GM diet (€ /tonne)
Soya	20	40	8.00
maize products	8	60	4.80
Soya oil	1	100	1.00
Additional cost / tonne diet (€)	13.80		
Total cost to pig Industry (million €)	13.7		
Total cost per pig (€)	3.93		

Source: Lawlor & Walsh, 2009.

Huge potential of GMOs

It is important to highlight the enormous potential of GM crops to stabilize world food supply and price into the future and also the substantial benefits they offer to the producer, consumer and the environment which include:

- Crops with better stress resistance; Bt maize offers resistance to insect damage which ensures a better yield and quality crop and drought and salt resistant rice which will grow under adverse weather and environmental conditions.
- More food from less land; higher yielding crops allow for less area to be planted for similar or greater yields

- Decreased environmental impact of food production; less use of pesticide and insecticide as crops are already resistant to pests
- Decreased cost of production; crops that are less susceptible to weather conditions will help to ensure a more consistent and predictable food supply thus avoiding massive rises in crop prices due to reduced supply
- More nutritious/functional foods; soybean has been engineered to be higher in oleic acid and lower in polyunsaturated fatty acids than conventional varieties. 'Golden rice' contains a precursor for vitamin A which has helped many third world people overcome vitamin A deficiencies

Other alternatives for least cost formulations

1. Distillers dried grain with solubles (DDGS)

Distillers dried grain is the residue remaining after the removal of alcohol and water from a yeast fermented grain mash. Distillers co-products are primarily from maize but may also be from barley or other grains. DDGS provides lysine, phosphorus, and energy and replaces soybean meal, dicalcium phosphate, and maize in pig diets. It is similar to maize as an energy source and although DDGS is relatively high in protein (27%), it retains the poor amino acid balance of grains and is particularly limiting in lysine (0.7%). The amino acids in DDGS appear to be less available than those in soybean meal so diets must be supplemented with synthetic amino acids to avoid a deficiency. Also, DDGS contains relatively large amounts of available phosphorus (0.71%) therefore inorganic phosphorus can be reduced.

Recent work by Xu *et al.* (2010) suggests that DDGS can be included in diets of grower-finisher pigs up to 30% without affecting growth performance or dressing out percentage. However, to avoid changes in fat quality of finisher pigs, diets should not contain greater than 20% DDGS. DDGS can be included up to 50% in both boar and gestating sow diets and up to 20% inclusion in lactating sow diets.

2. *Brewers dried grain*

Brewers dried grain is the dried residue of malting barley and often contains other grains in the brewing of beer. This co-product is low in energy, contains 13-16% crude fibre and is fairly high in protein (25%). However, the quality of the protein is poor for pig diets. Recommended inclusion level for brewers dried grains in pig diets is 5% (Kornegay, 1973).

3. *Corn glutens*

Corn gluten feed is a mixture of gluten meal and bran and may contain some solubles and part of the germ. Corn gluten is relatively low in energy and has a similar amino acid profile to maize. On an energy basis corn gluten feed is worth 70% of that of maize. Corn glutens can be included up to 30% in diets of finishing pigs (Yen *et al.*, 1971).

4. *Sunflower meal*

Sunflower meal is a high quality protein supplement which can be used to replace some soybean meal in pig diets. The low lysine content of sunflower meal (1.5 vs 2.95% in soybean meal) however limits the inclusion rate to supplying 25% of the protein supplement in the diet (Seerley *et al.*, 1974).

5. *Rapeseed meal*

Rapeseed meal is another source of highly digestible protein. Care must be taken however, to limit the inclusion of rapeseed meal in pig diets due to some of its anti-nutritional properties. Rapeseed meal contains glucosinolates which at high levels can interfere with growth. For growing pigs, low glucosinolate rapeseed meal should not make up more than half the supplementary protein but for finishing pigs low glucosinolate rapeseed meal can be used as the only protein supplement.

6. *Sorghum*

Sorghum is one of the five top cereal crops in the world, along with wheat, oats, corn, and barley. Sorghum originated in Africa and is a drought tolerant crop which can be grown under a wider range of environmental conditions than maize. Sorghum is often lower in energy and nutrient digestibility than other cereals such as maize and wheat in part due to the tannin content of some varieties.

The discovery of some cultivars with high protein digestibility in recent times means that sorghum is now comparable to maize and other cereals in terms of nutrient quality. Nayannor *et al.* (2007) found no differences in nutrient digestibility between maize and highly digestible sorghum when fed to growing pigs.

Summary

Extremely high cereal prices, particularly at present are crippling the pig industry by increasing the costs of production. The burden of such high prices would be much easier to bear if pig meat prices mirrored these increases. However, this is not the case at present and consequently profitability is being seriously compromised.

Cereal prices have a history of volatility and there are no indications that the future will be any different. More rapid adoption of new GMOs by the EU will undoubtedly help to increase the availability and stabilize the price of cereals. In the mean time however, the pig Industry must explore all least cost alternatives to high priced cereals to continue production as economically as possible and maintain the sustainability of the Irish pork industry.

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Responding to Increasing Feed Prices

Michael A Martin, Teagasc, Athenry

The rapid escalation in cereal prices following the 2010 harvest is set to put serious and immediate financial pressure on pig producers unless there is a corresponding increase in pig prices or these price increases prove to be short-lived and primarily due to market speculation. There is limited scope to achieve immediate savings in feed costs but every unit can evaluate its operation under a series of headings with a view to coping with the increased financial pressures.

Feed and Cost of Production

Pig feed is normally considered to represent 65-70% of the cost of production of pig meat. This is useful as a general rule of thumb. Results from PigSys (2002-9) confirm this with the exception of 2005 when feed prices were unusually low.

Table 1: Feed cost as % of total production cost (2002-9)

Year	Feed c per kg	Total c per kg	Feed % of Total
2002	81.3	119.9	67.8
2003	80.6	122.6	65.7
2004	83.9	123.9	67.7
2005	75.6	120.4	62.8
2006	79.6	123.0	64.7
2007	94.3	140.6	67.1
2008	106.7	153.0	69.7
2009	91.9	131.8	69.7

Source: Teagasc PigSys Report 2009

However, feed cost as a percentage of total production costs can vary significantly from unit to unit. At a minimum each unit must know what it's current feed cost per kg deadweight is. This has to be based on current feed prices and up to date reliable information on feed usage and efficiency.

Feed is by far and away the single largest component of the cost of production. Labour / management costs normally rank second but at about 14-15c per kg are only a fraction (15%) of the feed cost per kg. Any attempt to cut costs other than feed must not be at the expense of poorer feed efficiency and result in an increase in feed costs that exceeds the savings being attempted.

Pig Price and Feed Price Trends

The cost of pig feed ingredients increased dramatically after the 2007 harvest leading to a dramatic increase in the price of pig feed worldwide. The composite price of purchased compound feed in Ireland increased every month from June 2007 until July 2008. The total increase was €67 from €238 to €305 per tonne. Pig prices did not increase sufficiently to fully compensate for the increase in feed cost per kg (24c) until July of 2008 – a delayed response of almost 12 months.

Table 2: Pig feed prices, feed cost per tonne and pig price per kg dead weight (June 2007-September 2008)

Month	Composite Pig feed Price € per tonne	Feed Cost per kg Dead Weight c	Pig Price per kg Dead Weight c
2007 June	238	91	136
July	244	93	136
August	251	96	139
September	272	104	145
October	287	110	146
November	289	111	143
December	291	111	138
2008 January	297	112	137
February	299	113	137
March	301	114	140
April	304	115	146
May	304	115	150
June	304	115	157
July	305	115	162
August	303	115	169
September	294	111	167

Source: Teagasc PDU National Pig and Feed Price Monitor

The Margin over Feed Cost per kg Dead Weight for the 12 months July 2007 to June 2008 was 33.7c per kg dead weight. This was far short of margin per kg deadweight required to cover non-feed costs for pigs delivered to the slaughter plant. Over the three years 2007-2009 this is estimated to be at least 46c per kg dead weight (PigSys Report 2009). It is important to note that cost of production calculation does not include any provision for return on investment.

Despite this very difficult period the national sow herd declined only marginally but the level of indebtedness of the sector to feed suppliers and lending institutions increased very substantially. Profit margins since then have not been sufficient in scale or duration to recoup these losses.

The pig sector is poorly positioned to cope with the recent increases in feed prices unless there is a rapid and corresponding increase in pig prices.

Production Costs: Autumn 2010

As and from 1st September 2010 the average composite price of purchased feed was €266 per tonne. This calculates as 100c per kg dead weight based on average performance of PigSys recorded herds (PigSys Report 2009). Each €10 per tonne increase in the average composite price increases feed cost per kg dead weight by 3.7c. Alternatively, it takes a 4c increase in pig price per kg to compensate for an €11 increase in feed price per tonne.

By September 2010 the composite feed price had increased by €33 per tonne compared to June. This corresponds to more than a 12c increase in feed cost per kg dead.

Responding to High Feed Prices

The Teagasc Pig Farmers Conference in 2007 was devoted almost exclusively to dealing with high feed prices.

The realistic options available to producers may well be limited but it is recommended that each unit take time to review and reassess what they are doing. The initial aim must be to identify areas where immediate savings may be possible. The following could form part of a relevant checklist

1. Are you using the most cost-effective combination of pig diets over the life of the growing pig?

Use the following table to compare your herd with other herds and some suggested targets:

Table 3: Diet usage for growing pigs (weaning to 100 kg)

Diet	PigSys 2009	Target	My herd
Sow	52.3	52.3	
Creep	3.3	2.5	
Link	6.9	5	
Weaner	41.1	35	
Finisher 1	175.5	80	
Finisher 2		105.5	
TOTAL	279.2	280.3	
Feed Conversion (Wean to sale)	2.44	2.45	
Average Feed Price € / tonne	267	259	

*Based on purchased pig feed prices September 2010 and Finisher 2 diet €10 per tonne less than Finisher 1

Reduce the usage of the more expensive diets especially weaner diet.
If possible use a second stage finisher especially if selling heavy pigs.

2. Are all feeders /feed troughs in good working order so that there is no feed wastage

The feeders / trough in a pen of 20 finishers dispense about 14 tonne feed per annum. If 5% of the feed is wasted that is 700kg per annum costing about €172 at €245 per tonne.
On a 500 sow unit the annual cost of 5% feed loss/wastage is currently about €43,500 or almost €9000 for each 1%. As feed gets more expensive there is no case for using faulty feeders or damaged troughs

3. What impact will reducing slaughter weights have on your profitability?

Reducing slaughter weights will mean increased pig sales and thereby ease cash flow problems initially. But how does this affect profitability? As slaughter weight is increased Feed Conversion from weaning to sale deteriorates but the Kill Out increases, sow feed is spread over more weight and the composite feed price will decline so that there is little impact on feed cost per kg dead weight. Reducing sale weight will increase non-feed cost per kg dead weight and therefore reduce profitability when there is no effect on pig price per kg.

4. Do you regularly check the accuracy of inclusion of ingredients and supplements in your diets?

The real savings in feed cost achieved by home compounding vary depending on a number of factors. These include

1. Purchase of ingredients
2. Interest and depreciation on mill
3. Energy costs
4. Milling losses
5. Interest on working capital for mill
6. Mill repairs and maintenance
7. Milling labour costs
8. Pig performance - related to the quality of the feed produced

At least 30% of pig feed is now manufactured on pig units. One issue for home milling operations is the accuracy of inclusion and especially in relation to the accuracy of inclusion of the mineral/vitamin supplement. Many of these supplements include amino acids necessary to achieve the recommended level of essential amino acids, such as lysine, in the diet. Incorrect inclusion rates of these supplements will increase the feed cost per kg deadweight. Excessive inclusion will increase the feed price per tonne with no corresponding improvement in Feed Conversion. Where the inclusion rates are too low pig growth rates and feed efficiency will be adversely affected with the cost of the reduced performance likely to far outweigh any reduction in the cost of feed per tonne.

5. Have you minimised the number of unproductive pigs in your herd?

(a) Sows: Sows that are neither pregnant nor lactating are unproductive. Based on 12 empty or unproductive days per reproductive cycle the average number of unproductive sows should be less than 8% of the herd. Unproductive sows have a much higher daily feed requirement for maintenance than pregnant sows and have a very poor Feed Conversion Efficiency. Sell cull sows as quickly as possible

Table 4: Relationship between the number of litters per sow per year and average percentage of unproductive sows in herd

Litters per Sow per Year	Empty Days per Litter	% Unproductive Sows
2.37	11.5	7.5
2.30	16.2	10.2
2.25	19.7	12.2
2,20	23.4	14.1

(b) Maiden Gilts: In 2009, the average sow replacement rate in PigSys recorded herds was 52.2% per annum. Sow culling averaged 46.4% with an additional 5.8% sow mortality. At this replacement rate on a 500 sow herd there would be exactly 5 gilts farrowed per week. Allowing 9 weeks on average from gilt selection / purchase to service the number of maiden gilts required would be 45 or 9% of sow herd size. Not all gilts selected or purchased are served and not all gilts served farrow. Even assuming a high 25% of the gilts selected or purchased do not farrow the average number of maiden gilts over the 9 week period would rise to about 60 or 12% of the sow herd size. In PigSys recorded herds in 2009 the average number of maiden gilts per 100 sows was 13.6 or 13.6%. Extra gilts will be consuming at least 2.75kg feed per day. Each extra gilt per 100 sows will consume one extra tonne feed per year. How many maiden gilts do you need to carry?

6. Is your herd worm control programme effective?

The incidence of milk spot livers in pigs slaughtered in Irish plants is reported to be substantial. Not alone does worm infestations result in the condemnation of livers, it adversely affects pig growth rate and feed efficiency. Every unit needs to fully implement a strategic worm control programme based on the results of the examination of livers at slaughter and on veterinary advice. The cost of a comprehensive strategic worm control programme would be in the order of 35c per pig produced or less than 0.5c per kg dead weight. What is the level of level of liver damage in your slaughter pigs?

7. Are your pig vaccination programmes fully effective?

Two of the key vaccination programmes on most units now are those for Mycoplasma pleuropneumonia and Post-weaning Multi-systemic Wasting Syndrome (PMWS). Both programmes involve significant costs but when carried out correctly, in terms of administration technique, timing and dosage and using vaccines that are effective the results achieved prove these programmes to be highly cost-beneficial. Growth rates on pig farms in Ireland showed a significant improvement in 2009 and this is likely to have been due in part to improved pig health and lower mortality as well as genetic improvements.

Table 5: Growing pig performance on Irish pig farms (2008-9)

Year	2008	2009
Average Live Weight sold kg	100.8	102.9
Average Daily Gain Weaning to sale	622	660
Feed conversion Weaning to sale	2.47	2.44
Weaner Mortality	2.85	2.1
Finisher Mortality %	2.8	2.2

Source: Teagasc PigSys Report 2009

8. Are all additives included in your diets necessary and cost beneficial?

The use of non-medicinal additives or medication is justified if there is a nutritional or pig health necessity and the value of the improved performance outweighs the cost of their inclusion. The decision not to use an additive is much more difficult than the decision to continue its use. The use of all additives should be reviewed regularly and in conjunction with your veterinary adviser.

Table 6: Approximate cost per pig of an additional €5 per tonne cost of pig feed

Diet	Cost per pig c
Dry Sow	17
Lactating Sow	9
Creep	2
Link	3
Weaner	21
Finisher	88
Total	140

Conclusion

The effect of a substantial increase in feed prices on profitability will be mainly determined by how quickly pig prices respond to the increased costs of production. Despite this each pig producer may find some scope to reduce feed costs. The challenge is to find these opportunities.

Pig health, pig welfare and food safety – preparing for the challenges of the twenty-first century

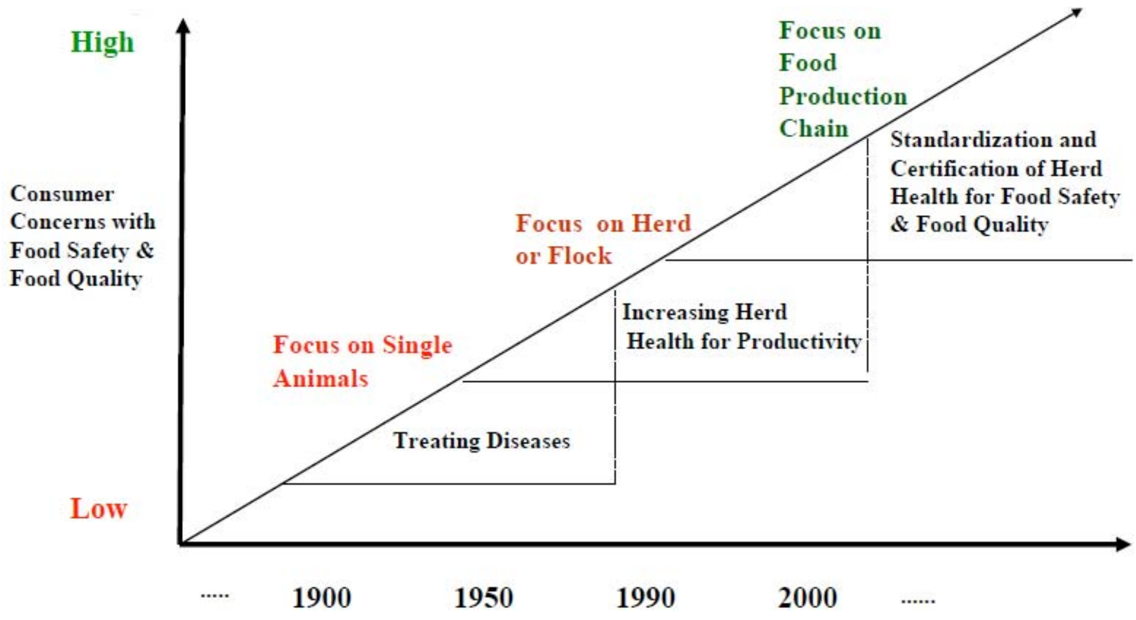
Derek Armstrong, BPEX Veterinary Programme Manager

Good pig health is based on good pig management. Unless management and husbandry is excellent attempts to improve pig health are likely to fail. Improving pig health is a major opportunity to improve efficiency throughout the supply chain - on farm and in abattoir. Any pig industry that wants to remain internationally competitive in the twenty-first century will have to consider developing a strategy to improve pig health. Unless farmers are prepared to engage, collaborate and co-operate programmes to eliminate disease are unlikely to be successful.

Background

There have been massive changes in pig production over the last five decades with tremendous improvements in productivity. The goal for leading producers in the EU is now over 30 pigs per sow per year, double the average of c. 15 piglets per sow per year in 1960. Average daily gain in growing-finishing pigs was barely 500g then, but is now close to 800g. Through intensive selection and breeding programmes the pig itself has changed, especially in relation to leanness. The genetic potential for performance of pigs is much higher than is generally achieved on farms. Over the same time period the size of pig herds has increased dramatically driven by falling margins and the benefits from economies of scale. Research and development in the fields of nutrition, housing, herd management, general hygiene and health care has helped to drive improvements in the efficiency of pig production.

Over the same period consumer expectations for food safety, quality and animal welfare have also changed. Increasingly the consumer and society demand high quality and safe food from healthy animals that have been kept in "high welfare" husbandry systems that minimise risk to the environment and to human health and where there has not been a need to routinely use antibiotics. EU and national legislation have set basic mandatory standards for animal health, animal welfare, food safety and increasingly for environmental protection.



The changing role of animal health care (Blaha, 2008)

There has been significant progress in developing technology to protect and improve pig health but there have also been equally rapid changes in disease challenges. Effective vaccines, antimicrobials and anthelminthics mean that the classical single agent diseases like Erysipelas and parasitism should no longer be issues on well-managed pig farms. The major notifiable diseases, FMD and CSF, have been eliminated in the main pig-producing countries, although they are capable of exploiting weaknesses in biosecurity and remain a threat. New viral diseases have emerged with worrying regularity – Parvovirus in the 1970s, Porcine Reproductive and Respiratory Syndrome (PRRS) in the 1980s and Porcine Circovirus Diseases in the 1990s. The most important health issues on pig farms tend to be the multi-factorial respiratory and gut diseases that significantly reduce production efficiency and add cost.

The severity of disease expression often depends on the way pigs are reared as weaners and growers. In the absence of a vaccine and specific treatments for PMWS Professor Madec and co-workers in France demonstrated the practical value of management practices in the control of losses. The measures primarily involved herd management (eg pigs weaned into small groups, reduced moving and mixing of pigs and all-in all-out production), high levels of hygiene, cleaning and disinfection, close control of the environment and controls on the flow of staff, pigs and air. These changes to management were designed to reduce the 'infection pressure' from PCV2 and any other infections. There were significant reductions in losses when the rate of compliance with the recommended measures was high.

Vaccines and medicines help to control but do not eliminate disease. They are much more effective if used in combination with good management. Virtually every decision and action taken on a pig farm can have an affect on health status. Even apparently small changes in husbandry practice can easily disturb the balance in a herd and lead to problems without any introduction of a new pathogen. Improvements in pig health status though disease elimination programmes will only be sustainable if good management practices and high standards of husbandry are already in place.

Management

Good management is not just the cornerstone for good herd productivity but also for disease control. Management factors undoubtedly play a major role in determining the impact and outcome of disease challenges. Attention to detail in areas like ventilation, hygiene, all-in all-out production, reduced movement and mixing and pig flow can significantly reduce impact on health. Disease on pig units is more readily controlled on well managed units, and the effects of disease will generally be less severe where pigs are under less stress. High standards of facilities and management will limit the impact of multi-factorial diseases, reduce the associated costs and improve physical performance.

Nutrition

The level of feeding, the form of the feed and the balance of nutrients in feed are major forces influencing the likelihood of incidence of disease. In an outbreak of disease, the quality of nutrient provision will influence the severity of disease, and the significance of its consequences. Macro and micro dietary components e.g. minerals and vitamins also affect the pig’s ability to respond to disease challenges. Feed is also a critical factor affecting the microbial population in the gut of the pig, and salmonella in particular. The demand for nutrients has been shown to be different depending on the level disease challenge on a farm and in the future diets could be tailored to optimise individual farm performance.

Genetics

Genetic selection has been biased towards production traits, and has generally taken place under conditions of good management and low disease challenge. It is not clear whether pigs selected under these conditions are the most efficient where the levels of disease challenge are high. Genetic interactions influence general robustness and the ability to resist specific disease agents. Future breeding programmes could benefit from advances in genomics that should allow easier and faster selection for disease resistance traits.

Biosecurity

Biosecurity can be defined as the measures that are taken to reduce the risk of disease agents being introduced and spread. Most people are aware of what is best biosecurity practice (e.g. controls on pig importation, visitors, vehicles, rodents) but it is not always consistently implemented despite the long-term benefits of preventing disease getting on to farms in the first place. Enhanced external biosecurity can reduce the probability of disease organisms being transmitted between herds. This might include isolating purchased stock with the intention of ensuring that they are not infectious when they enter the herd, effective cleaning of vehicles that transport pigs and preventing access of visitors that have been in contact with pigs. Unless there is a clear commitment to sustaining high levels of biosecurity investing in disease elimination may be a waste of time and money as the probability of a breakdown during the pay-back period is high.

Cleaning and disinfection

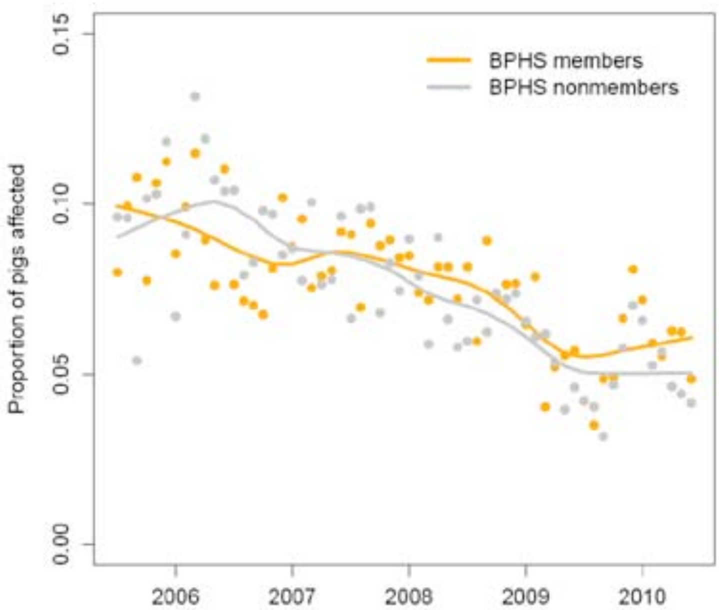
Cleaning and disinfection is probably the most important job on a pig farm. A significant proportion of those responsible for the task do not understand what ‘clean’ means and how easily and quickly residual dirt inactivates disinfectants. A lot of the time, money and effort spent on cleaning and disinfection is wasted because the job is not done properly. As a result disease and Salmonella recirculate from the last batch of pigs to the next batch that was thought to have been moved into ‘clean’ conditions. The other main contributors to the recirculation of disease within pig farms is holding pigs back, mixing pigs and the use of continuous flow systems rather than all-in all-out production.

Recording

Disease directly affects mortality rates, condemnation rates in abattoir, levels of medicine usage and pig performance. Good recording of these are essential to measure the effects of disease on herd performance and also to help gauge the impact of control strategies.

Surveillance

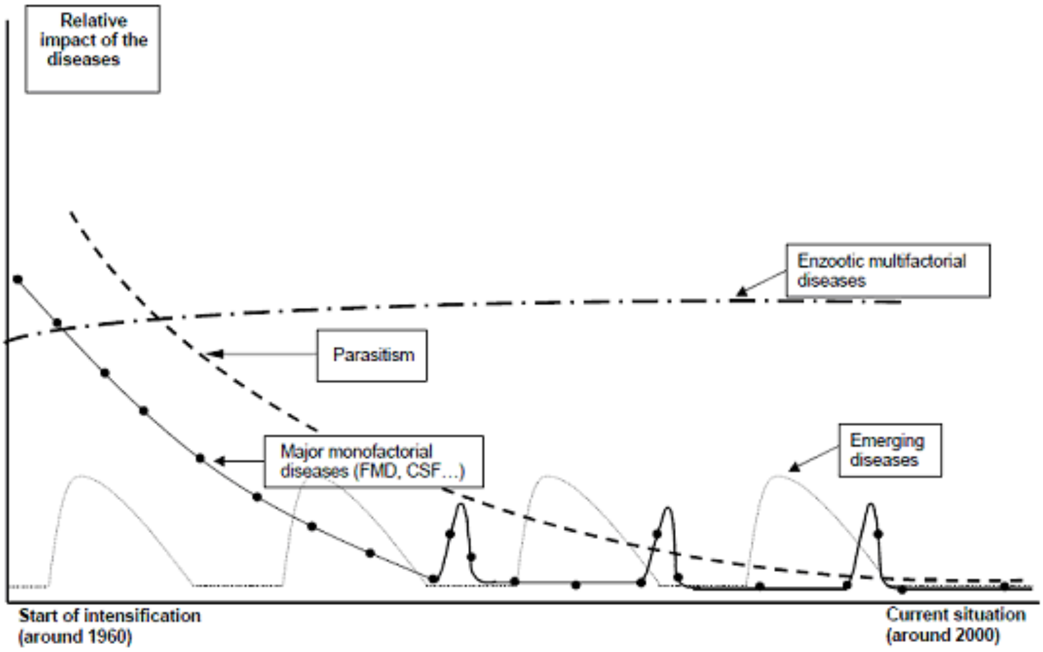
It is important to know what diseases are present not just on your own farm but also on farms from which it could spread to your unit – mainly neighbouring farms and farms that supply pigs to your farm. Disease breakdowns need to be detected as soon as possible and it is critical to know when there are any breakdowns on farms with which there is direct or indirect contact. One particularly useful source of data is the information recorded in abattoirs from slaughter pigs relating to the damage to organs caused by disease. In the BPEX Pig Health Scheme (BPHS) trained veterinarians record visual assessment scores for a range of health conditions in pigs in abattoirs. BPHS reports the results to participating abattoirs, sponsors, producers and vets. BPHS reports are being used routinely to tackle health issues on farm and to guide the selection of control strategies, such as vaccine and worming policies. Research by the University of Cambridge found that in a batch where 10% of the pigs had pleurisy the costs to the producer was in the order of 226p/pig and it also increased processing costs by 29p/pig in abattoir. Management factors were found that were different on units that had a consistent pleurisy problem from those that did not.



Changes in severe Enzootic Pneumonia-like lesions detected through BPHS (Sanchez, 2010)

New and emerging diseases

When new diseases agents emerge it usually takes a considerable amount of time to identify the cause and the disease process. It is important that marked increases in mortality and unusual clinical signs are investigated and monitored so that new and emerging diseases are identified as quickly as possible and not allowed to spread.



Schematic representation of health problems of pigs in Europe in relation to intensification process (Madec and Rose, 2003)

Disease elimination

There is an increasing international interest in the elimination of disease from regions and countries. Eradication of PRRS from the North American pig population is the long-term goal of the American Association of Swine Veterinarians. Regional programmes to eliminate PRRS have been set up in Minnesota, Michigan and Illinois in the US, in Canada and in Mexico. Chile has reported elimination of PRRS and Brazil also appears to be PRRS free. The SPF (Specific Pathogen Free) system in Denmark started in 1968. With the support of funding through the Rural Development Programme for England BPEX is working with producers to improve the health status of pigs in England. This aims to increase the efficiency throughout the supply chain, reducing the costs of production, improving pig performance and pig welfare and also to provide a better quality carcase for processing.

BPEX Health Improvement Programmes

Improving the health and welfare of pigs is vital to restoring the competitiveness of the British pig industry. The Pig Health Improvement Programmes recognises that the health status of a particular pig herd is the result of the interaction and transmission of disease agents within and between herds. Infectious diseases can be transmitted between herds via aerosol, pig movement, vehicles, birds, insects and rodents. Individual efforts to control the transmission of infectious disease often result in failure because of subsequent re-infection and breakdown. This probability can be reduced by a more coordinated approach between producers with the support of their veterinary surgeons. The programme aims to encourage collaboration and communication between producers and the rest of the supply chain.

The barriers to health improvement on pig farms are not technical – the diagnostics and elimination strategies required to make progress are readily available and well described. The major need is for co-ordinated action on pig farms and the key objective of the health improvement project is to help producers to form groups and to work together on health improvement. A fundamental requirement is that producers must be prepared to honestly share information on the health status of the pigs on their unit. The specific aims are to:

- Facilitate collaboration and co-operation
- Promote high standards of biosecurity on pig farms and in the supply sector, e.g. haulage, deadstock collection and pig transport
- Promote openness and honesty between producers so that people can identify and overcome the main challenges to the control and elimination of infectious diseases
- Map the location and health status of pig herds - available online to members
- Provide support and tools for producers to improve health status
- Establish areas of disease freedom
- Establish networks throughout the industry to withstand future outbreaks of disease

The programme (www.pighealth.org) started in 2009 and there are now 2 producer led schemes, Yorkshire and Humberside Health and Eastern Pig Health. Members of the two schemes share details of the health status of their units and work together to develop plans to improve pig health and biosecurity. The next step is to extend these schemes to other regions and to build on the initial collaboration networks developed to formulate and deliver real improvements in pig health. The successful eradication of Aujeszky's Disease in GB in the 1980s has shown what is possible when the industry is prepared to work together. Improvements in pig health should also help the industry to meet the growing legislative and consumer demands for higher levels of pigmeat safety.

Zoonoses National Control Programme for Salmonella in Pigs

The primary objective of the Zoonoses National Control Programme for Salmonella in pigs (ZNCPig) introduced in April 2008 is the reduction of risk to consumers from Salmonella in pigmeat products. A whole chain approach to risk reduction has been adopted with a focus on processors and producers working together to reduce Salmonella within supply chains. ZNCPig is being delivered by the industry in partnership with the Food Standards Agency and defra.

There will only be a reduction in food safety risk if action is taken both on pig farms and in slaughterhouses. All assured pig farms should have a Control Plan for Salmonella which can be integrated with the farms health and welfare plan. Vets review the on-farm Control Plan and will need to check that the unit's management is actually taking the action agreed in the Control Plan. They will also need to evaluate whether the Control Plan is adequate in their judgement to control Salmonella on that farm. Abattoirs and their supply chains are being encouraged to work together to address the Salmonella risk. Progress in reducing the risk to consumers can be measured through monitoring the prevalence of Salmonella on pig carcases in abattoirs.

Salmonella reduction on-farm is extremely difficult and requires the same commitment to basic principles of good management, hygiene and husbandry as is needed to maintain high health status. In addition where levels of Salmonella are high, reduction will require changes to feed form and formulation eg more barley in diet; increase particle size in pellet; addition of organic acids to feed or water. Liquid feeding is the best option for salmonella control and there are production benefits, but is not an easy or cheap option to implement on a farm set up for dry feeding.

Summary

Good management practices are the corner stones for good herd productivity and good herd health. The incidence and severity of disease in pigs is undoubtedly affected by management and husbandry practices. Their role is particularly important in the multi-factorial respiratory and gut diseases that are most commonly seen on pig farms. Management changes can easily disturb the balance in a herd and lead to disease problems without the need for introduction of a new pathogen. There will be new disease challenges in the future and as with PRRS and PMWS these are likely to cause more severe losses on farms where the level of disease challenge is already high.

There is growing international recognition that living with key diseases is not a sustainable option. Vaccination and treatment exert selection pressures on disease causing organisms which respond by developing resistance or by becoming even more pathogenic. To remain competitive the pig industry should look at best practice in other industries and adopt and apply the Japanese principles of kaizen or gradual continuous improvement. Improving pig health status, particularly where it involves elimination of certain diseases will only be effective if farmers are prepared to work together and to openly share information on health status. Consumers expect the pork and bacon they buy to be safe and they assume that it has come from healthy pigs kept in conditions of good welfare. Their expectations need to be met to maintain confidence in the excellent product that they enjoy eating.

Surviving the First 24 Hours

Seamas Clarke, Ballyhaise & Ciarán Carroll, Moorepark

Over 340,000 litters are born annually in Ireland, 6,550 per week. Pre weaning losses amount to 303,000 piglets annually or almost 7,000 piglets per week (Teagasc PigSys Report: Average pre-weaning losses 2009). This is equivalent to the weekly kill in a sizable factory's slaughter plant! In addition, the recorded annual born dead of 290,000 makes for a serious 'opportunity loss' build up. Over 593,000 piglets are lost annually either as born dead or pre weaning losses. These losses amount to in excess of €30 million per annum to the Irish pig industry and to you as an individual producer in Margin over Feed Costs!

Piglet Losses

Some piglet deaths are inevitable, but the variation shown in Teagasc 2009 Pigsys Report between the best farms and the rest shows that there is scope for savings on most Irish pig farms. Teagasc figures for Pigsys clients in 2009 show pre weaning losses at 9.8%. Unfortunately there are many farms where the figure is double this.

Table 1: Piglet Losses in PigSys Recorded Herds 2009

Herds	Average	Top 25%
No. Born Alive	11.78	11.72
No Born Dead	0.85	0.69
Piglet Mortality %	9.8	7.0

Pre weaning mortality ranged between 25 and 35% in the 1920 – 1930's. The advent of the farrowing crate in the late 1950's heralded a reduction in deaths. This coupled with better housing, management, heat control, vaccines and antibiotics led to pre weaning mortality dropping to 10% at the end of the century.

Colostrum is King

One study (Damm et al., 2005) reported that 72% of live-born piglets that died had not consumed colostrum. A simple post-mortem will confirm which dead piglets did receive colostrum.

The piglet is born without brown adipose tissue, the fat that helps it thermo-regulate i.e to regulate body temperature. The newly born piglet has an energy demand for maintenance and growth of 1MJ for the first 24 hours. It arrives into the world with 0.42MJ in reserves (0.4MJ in intramuscular glycogen and 0.02MJ in fat). The missing 0.58MJ must come from colostrum if this energy demand is to be met.

We sometimes think of colostrum only as the antibody provider. However, it really is a 'power pack' like the energiser drinks so well advertised by our drinks industry to sportspeople. Colostrum has 5.87 – 6.28MJ energy per litre. At 30% dry matter this is equivalent to approximately 18MJ energy per kg dry matter. Colostrum production lasts about 24 hours, with peak production at 12 hours post farrowing. Devillers et al. Canada 2007 in a study with 43 sows found that the total colostrum production varied from 1900g to 5910g with an average of 3570g. Daily milk output varied between 4,600 and 9,600g with an average of 8,000g per day. The sow's last farrowing house performance record should be available for decision making in regard to fostering. S.A.L.T is a record worth recording, Suckling Ability Last Time!

Various trials show that piglet colostrum intake is also variable, ranging from 200 – 360g per kg birthweight in the first 24 hours after birth. A healthy sow is capable of feeding 12 – 14 pigs adequate amounts of colostrum. Remember a 1.5 kg piglet is capable of consuming 450g per kg birth weight when an unrestricted supply of colostrum is available, leaving less for the rest of the litter. Small weak pigs should be prioritised and given advantage early! A sow suckles 15 – 20 times per day (less than once per hour) but milk flow only lasts about 10 – 20 seconds. Small, chilled, inactive piglets can miss out!

The pregnant sow does not share her antibodies with her unborn litter. Layers of placental tissue prevent antibody cross over in the womb. Colostrum is the only source of antibody for the piglet covering its 14 days of life. These antibodies are the defence it has against the pig herd diseases on a farm. The piglet's digestive tract can absorb the immunoglobulin whole, for a short period only. The immunoglobulin in the colostrum drops by 50% six hours after farrowing. Pity the late born piglet! The early suckled pig gets the greatest amount of antibody. In the 24-36 hours after birth the piglet's digestive tract changes and breaks down the immunoglobulin into nutrient constituents which have no further antibody function.

Table 2: Composition of sow colostrum and milk

	Colostrum	Milk
Total solids %	30	20
Lactose %	4.5	4.5
Fat %	8.5	8.5
Protein %	17.0	5.5
Ash %	1.0	1.0

Source: English et al.

Colostrum is vital as an energy source for the new born. Due to its higher dry matter, its antibody content and its bioactive components it is the source of life to the new born! It stimulates muscle protein development, greater colostrum intake results in more muscle development. Think back on colostrum intake the next time you see variation in your finisher pens!

Back to Nature

In nature the sow makes a bed for her offspring! She does not select a windy cold site for the job! She selects a dry, sheltered corner. She knows that the main threat to her offspring's survival is the cold and wind. Many of our €3,500 – €4,000 pent house suite style farrowing pens fail to live up to the primitive outdoor sites selected by our modern day sow's ancestors. Too often the piglet is born onto and/or into cold wet slats with unwanted air movement!

The sow and the farrowing environment are the enemies of the newly born piglet. Chilling and crushing cost pig farmers millions of euro each year! Survey results show that at least 50% of all pre weaning mortality occurs in the first 48 hours.

The smell and heat provided by the mother are very attractive to the newly born pig.

The 'squashability' ratio is very much against the piglet at 200-250:1 – 1.5.

Successful farrowing house management provides the correct environment for the weakest piglet born!

Areas to attend to include:

- Crate width design and adjustment
- Anti crush attachments
- Slat surface temperature and grip for newly born
- Air temperature ensuring no loss of body heat
- Air movement and its cooling effect on moist weak piglets ; maximum air speed of 0.15m per second

- Heat provision to maintain body temperature: skin temperature of at least 32°C
- Sow health, gut & body condition, hoof care
- Teeth clipping strongest pigs in each litter
- Support to smallest piglets to suckle
- Lock up first born 6 piglets [1 hour period] 3 hours after start of farrowing
- Initiate milk let down by rubbing front teats
- Speed up farrowing, especially old sows, by strategic use of oxytocin
- Iodine spray on navels

Birth Weight

Birth weight has major influence on piglet survival.

Table 3: Influence of birth weight on piglet survival

No piglets	94	196	237	96
Birth weight kg	1	1.3	1.6	1.8
No deaths	39	28	24	6
Mortality %	41%	14%	10%	7%
Weight at death kg	0.8	1.4	2.0	1.9

Source: le Dividich and Rooke 2006

As litter size increases birth weight drops. Historically litter sizes were lower and only 9% of piglets born were below 1kg at birth. Today's large litter sizes, circa 12 born alive have over 20% of the litter below 1kg at birth. Small piglets have the greater surface / body volume ratio so they are most susceptible to chilling. Greater care must be taken with these large litters. French and Danish production figures show a 4 – 5 percentage point increase in mortality as litter size increased by two pigs. Remember that colostrum intake drops by 30g per 100g decrease in birth weight.

Birth weight has a negative affect on days to sale weight. Each 100 g reduction in birth weight delays sale by 2 – 3 days.

Inducing sows at incorrect farrowing dates may result in premature farrowing. Piglets will weigh less at birth and the sow may produce up to 40% less colostrum. You must know your herd gestation interval before you can successfully induce sows to farrow. There can be significant differences in average gestation lengths between herds

Conclusion

Pigs over 0.9kg at birth can be saved and are worth saving! Standard levels of husbandry will ensure that pig's survival. At today's labour and feed costs and carcass price return the 'saved piglet' can easily justify 3 hours of a stockpersons time. Where can you get a better return for your money on your pig farm?

Improving pig welfare will reduce carcass losses

Laura Boyle and Dayane Lemos Teixeira

Introduction

Pig carcasses (whole or partial) and some internal organs are condemned at the factory because they are considered unfit for human consumption owing to health problems in the pig. Whole carcass condemnations in particular represent serious financial loss to the producer of the order of €110 each. However, penalties for extra trims and partial condemnations will also eat into the pig price. It is critical that such losses are reduced. However, there are other equally important reasons for reducing carcass losses. Not only do they represent a waste of limited and expensive resources including water, feed and energy, but they also reflect a potential threat to food safety. A recent study found that for every one percent increase in partial condemnations, the proportion of carcasses contaminated with *Enterococcus* spp. *and Campylobacter* spp. (major foodborne pathogens) increased by about 5% (Hurd et al., 2008). Finally, owing to their association with pig health, carcass condemnations reflect welfare problems for pigs on farm. Nevertheless there is a worrying scarcity of readily available information on reasons for carcass condemnations, the numbers of pigs involved and associated financial loss to the Irish economy etc. The information presented in this paper will go some way towards addressing this knowledge gap.

Casualty animals

The first step in reducing carcass losses is to understand what conditions are causing the losses. In this regard, casualty animals represent the most easily recognisable cause of carcass condemnations. Casualty pigs are those that show obvious clinical signs and symptoms of illness (e.g. are down), an abnormality (e.g. large hernia), or injury (e.g. cannot walk) on arrival at the factory. In the factory these animals are penned separately in the lairage and are kept until last for slaughter for welfare reasons. In clear cut cases, casualties will have been identified at the farm and provided they can walk, are penned separately on the truck. Or they will have been injured, fatigued or excessively stressed during transit and are deemed as casualties by the veterinarian in the lairage.

However, not all pigs with obvious clinical symptoms are classified as casualties either by the producer or by the factory vet. Once pigs are ambulant, those with badly bitten tails or external abscesses may not be easily identified. These problems may also simply not be considered serious enough for the pig to be assigned casualty status. Nevertheless, the pain associated with some of these conditions means that the crowded lairage is no place for such pigs. Similarly, pigs can be acutely ill (i.e. depressed, feverish and off feed) but the fact that they are able to walk means that they are loaded for slaughter and are not detected in the factory until the post mortem stage. Here the entire carcass is often rejected.

Casualty animals that were injured in transit (e.g. fractured limb) will often be condemned and euthanised in the lairage for humane reasons. On the other hand, fatigued or stressed pigs given the time to recover in the lairage will not necessarily have a health problem that makes them unfit for human consumption. However, the whole or large parts of the carcasses of casualty animals are often condemned which raises the question as to why they were delivered to the factory in the first place? In some countries, producers are discouraged from doing this by disposal charges applied to casualty animals that are subsequently condemned.

The casualty animal represents a small proportion of carcass losses but they also represent a highly visible source of pain and distress which is unnecessary in many cases. Hence, it is in everyone's interest that they are kept to minimum. This often calls for a more ruthless culling policy for sick and casualty animals on pig units.

Sub-clinical health problems and types of condemnations

The majority of condemnations are because of sub-clinical disease. This means that there are no visible symptoms in the live animal; indeed the animal can appear healthy. However, at the post mortem meat inspection, diseased parts of the animal are identified and the meat is rejected as unfit for human consumption. Whole carcasses will be condemned if the health problem is systemic (e.g. septicaemia) or extensive (e.g. multiple abscesses). Partial condemnations are where the problem is localised such that the head, individual legs, the belly or parts of the skin are rejected. Of course the 'plucks' (liver, heart and & lungs) of slaughter pigs are also rejected because of disease although farms are generally not penalised by the factory for pluck condemnations. Trimmings (e.g. of the area around a swollen joint) can account for an average 2kg in every 1000kg slaughtered (0.2%) being deducted from the pig price. Furthermore many carcasses that require trimming are also downgraded with a financial penalty imposed on the whole carcass.

Factory survey

Method

Six factories in both the Republic and Northern Ireland were visited for three consecutive days during summer 2010. One of two researchers recorded the slap number, sex, tail length (long or docked) and tail injury score (Figure 1) of all the pigs killed in each factory on those days. This amounted to 36,963 pigs. Inspections were conducted after the pigs came out of the scalding tank and prior to dehairing in all factories. All partial and total carcass condemnation records were also collected for each of the days on which the factories were visited. Data on pluck condemnations were not collected.

Figure 1: Photos representing each of the injury scores attributed to pigs tails

Score: 0 1 2 3 4

Results

Tail data

Almost all of the pigs had short tails (99%). The proportion of pigs with each of the tail scores described above is shown in Table 1.

Table 1: The proportion of pigs with each of the tail injury scores

Tail injury score	Proportion of pigs
0	41.8%
1	51.9%
2	5.2%
3	0.6%
4	0.5%

Scores of 1 could not be conclusively attributed to tail biting as the scalding procedure can sometimes damage carcasses slightly. More male than female pigs received scores of 2, 3 and 4. In total 328 pigs received the more severe scores of 3 and 4.

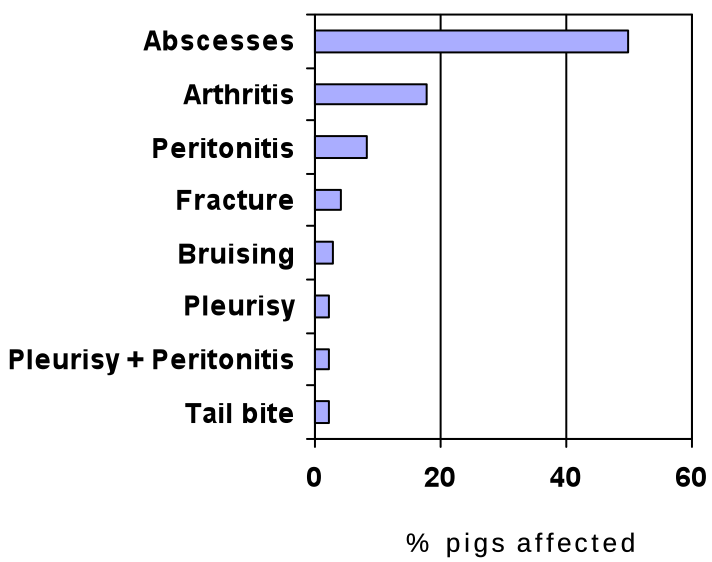
Condemnation records

Either all or part of 441 pigs (1.2%), were condemned (see Table 2 for breakdown). Included in this figure were 5 pigs that were dead on arrival, 4 pigs that died in the factory and 7 pigs that were euthanised in the lairage for welfare reasons. The reasons for the condemnations are described in Figure 2. In some cases multiple reasons for condemnations were given. Apart from where peritonitis and pleurisy occurred together the first condition listed was taken as the reason for condemnation in this preliminary analysis.

Table 2: Numbers and associated percentages of whole and partial carcass condemnations

Condemnation	No. of pigs	Proportion of pigs
1 limb	239	54.2%
Whole carcass	135	30.6%
1 shoulder	15	3.4%
Head	12	2.7%
Tail	10	2.3%
2 limbs	9	2.0%
Other	21	4.8%
Total	441	100%

Figure 2: Reasons for condemnations



Almost half (49.7%) of the condemnations were for abscessation (often referred to in condemnation reports as pyaemia). This figure includes localised abscesses, multiple abscesses and external abscesses (4 cases). The next most common reasons for condemnation were arthritis (17.7%), peritonitis (8.4%) and fractures (4.1%) followed by bruising, pleurisy, pleurisy and peritonitis and tail biting all of which were in the range of 2.3 to 2.9%. Other reasons for condemnation included jaundice, abnormal accumulation of fluid in the abdomen (i.e. ascites), emaciation and swelling. The figure for tail biting corresponds to the ten tails that were condemned (Table 2). We do not know if there were also abscesses in this region and by the same token we don't know whether pigs condemned for abscesses also showed evidence of bitten tails as associations between the two are rarely made in condemnation reports. It must also be noted that in many cases the reasons given for condemnation used terminology that was difficult to understand, the reports were sometimes difficult to read and there was huge variation in the depth of the information provided. These are important issues that need to be addressed if the communication of reasons for carcass losses to producers is to be improved.

Definitions, symptoms and risk factors

Definitions, symptoms and risk factors for abscesses, peritonitis, arthritis and pleurisy are provided below:

Abscess

Definition: Abscesses are pockets of pus that contain dead cell material and large numbers of bacteria. These primarily enter the body through damage to the skin but can also arise as secondary infection to other conditions such as swine pox, PRRS or pneumonia. Abscesses become walled off from the body tissues or are disseminated in the blood to develop abscesses elsewhere in the body.

Symptoms: Near the skin surface (i.e. externally) abscesses have an inflamed appearance and are very painful. Internally they can produce a variety of symptoms, depending upon the affected organs. Initially, there may be localised pain in the region of the abscess. Frequently, however, the major symptom is a chronic, low-grade fever.

Risk factors: Navel care, injecting, teeth clipping/tail docking, fighting, tail/ear biting, injury to the skin or foot caused by the floor or pen fixtures and fittings.

PMWS is also associated with septic pleurisy which sets up abscesses within the musculature of the rib cage.

Arthritis

Definition: The inflammation of one or more joints in the body which may be infectious (erysipelas) or non-infectious (i.e. degenerative joint disease or osteochondrosis - OCD).

Symptoms: Pain is a constant and daily feature of the disease. Pain occurs due to inflammation, damage to the joint and muscle strains caused by forceful movements against stiff, painful joints.

Risk factors (OCD): Stocking density, flooring, exercise, growth rate, genetics and nutrition.

Peritonitis

Definition: An inflammation of the peritoneum, the serous membrane that lines the abdominal cavity and viscera.

Symptoms: The main manifestations of peritonitis are acute abdominal pain, abdominal tenderness, and abdominal guarding, which are exacerbated by moving the peritoneum, e.g., coughing, hip movements.

Risk factors/causes: Hernias, umbilical infections, torsion of the intestine, Glasser's disease.

Pleurisy

Definition: Inflammation of the lining (pleura) of the pleural cavity surrounding the lungs. The inflamed pleural layers rub against each other every time the lungs expand to breathe in air. In pigs common causes of pleurisy include viruses such as flu, PRRS, swine fever and the bacteria *Actinobacillus pleuropneumoniae*, *Haemophilus parasuis* and *Pasteurella multocidia*.

Symptoms: Sharp or stabbing pain in the chest that gets worse with deep breathing, coughing or sneezing. The pain may stay in one place, or it may spread. Sometimes it becomes a fairly constant dull ache. Unsurprisingly it also reduces daily liveweight gain.

Risk factors for pleurisy are shown in Table 3.

Table 3: Risk factors for pleurisy

MORE pleurisy	LESS pleurisy
Single site farrow-finish system	Cleaning finisher pens before refilling
Failing to implement 'all-in, all-out' production and housing pigs of more than one month age difference in the same airspace	Disinfecting finisher pens before refilling
Repeatedly mixing pigs WELFARE ALERT!	More down-time for grower pens before refilling
Repeatedly moving pigs (even without mixing)	More down-time for finisher pens before refilling

Association between reasons for carcass losses and pig welfare

As already discussed the welfare of casualty animals is obviously poor. Similarly the welfare of animals that died in transit or at the factory must at some stage have been very poor. But how do the other sub-clinical conditions that cause carcass losses relate to pig welfare? Any condition that causes pigs fear, pain or distress obviously compromises their welfare. Most of the conditions described above are directly associated with pain and even where there is no pain as in the case of some internal abscesses, the condition is associated with malaise. In any case, abscesses certainly reflect past instances of poor welfare for the affected pig. For example the affected pig may have had a navel infection caused by an unhygienic environment in the farrowing pen, it could have had its teeth clipped by an inexperienced stockperson or by a faulty clippers leading to a gum infection. It could have had its tail bitten as a result of overcrowding, suffered excessive skin damage caused by re-mixing or damaged its foot on a broken or poor quality slat. All of these situations of poor welfare involve damage to the skin or the mucosal layers and provide a point of entry for bacteria that can cause abscesses. The means of addressing these problems are relatively simple and go back to basic pig husbandry skills. They include 1) regular training of staff; 2) keeping the physical environment clean and well maintained and most importantly 3) avoiding re-mixing and overcrowding of pigs at all costs. Re-mixing and overcrowding are known to be highly stressful experiences for pigs and have a detrimental impact on the immune system and growth rates. Decisions to avoid or at least reduce these practices will not only improve pig welfare and reduce health care costs on the farm but will also significantly reduce carcass losses.

The particular cases of tail biting and hernias

Tail biting

The results of the tail biting survey clearly indicate that tail docking does not eliminate tail biting. We also know from trials at Moorepark that leaving the tails long does not necessarily cause tail biting. However, where we experienced isolated outbreaks of tail biting in our long tailed pigs, good husbandry practices halted the problem.

These practices included:

- Identification and temporary removal of the biter
- Identification, isolation and treatment (antibiotics, analgesics, wound healing ointment) of the badly bitten pigs
- Re-introduction of these animals to the pen in the presence of good forms of environmental enrichment (e.g. natural fibre ropes) to distract the pigs from fighting

This prompt action meant that the tails healed and no carcasses were condemned at slaughter. We are aware that such practices are more difficult to implement on commercial farms. However, it is clear that for tails to achieve the scores of 4 and 5 shown in Figure 1 the affected pigs are being left in the pen in the presence of the biter and are not receiving any treatment. Such serious tail damage even at levels of just 1% of the pig population are unacceptable and entirely avoidable. Whether pigs tails are long or short, poor husbandry and housing practices are the main risk factors for tail biting. Managing the problem therefore means employing the same pig husbandry skills that were described above for minimising the welfare problems that contribute to abscesses. In any case, routine tail docking is prohibited by national legislation and is only permitted where there is evidence that injuries to other pigs' tails have occurred. We will have to start making a greater effort to address the issue.

Hernias

Hernias represent two of the more common anatomical defects that occur on pig farms. A hernia occurs when there is a rupture or protrusion of an organ or part of an organ through an opening in the surrounding wall. Common sites for hernias include the navel or groin. It is often suggested that genetics are the main risk factor for umbilical hernias. However, in general this condition is not simply due to the inheritance of a few genes. Environmental conditions play a huge role in the incidence of this defect. Navel infections early in life are definitely linked to the incidence of this condition as infection of the umbilical stump contributes to the failure of the umbilical cord opening to close. Proper sanitation and hygiene will go a lot further in reducing the incidence of this condition than trying to eliminate certain boars or dams. Other factors include abnormal stretching of the umbilical cord either during farrowing or caused by placing naval clips too close to the skin.

The welfare of animals severely affected with hernias is compromised because hernias and the associated condition of peritonitis cause considerable abdominal pain and discomfort. Furthermore, if the intestine becomes completely obstructed or if the hernial sac is injured or abscessed welfare becomes even poorer. In addition mortality rates of pigs with hernias in the finisher accommodation are significantly higher than that of unaffected pigs (Straw et al., 2008). Moderate adhesions do not severely diminish performance, and the carcass values of affected and unaffected pigs are similar. However, peritonitis interferes with evisceration at slaughter, necessitating trim loss for small hernias and, at some abattoirs, condemnation of > 50% of pigs with large hernias. Handling animals with hernias requires extra labour during processing, as intestinal adhesions cannot be distinguished from infectious peritonitis. Adhesions predispose to rupture of the intestines during the slaughter process, contamination of the carcass with intestinal content, and subsequent condemnation.

Depending on the availability of pens to isolate pigs with hernias and the quality of care of affected animals on a particular unit, euthanasia of affected animals when they are identified would be a better option than placing them in the finisher accommodation. If they are transferred, affected pigs should be sent for slaughter well before the hernia becomes so large that it impedes movement or touches the ground. Animals with hernias that big should never be transported.

Conclusions

Reducing trim and condemnation rates can result in big paybacks. Pigs may appear healthy on the outside, so the only way to identify problems is to closely monitor trim and condemnation rates. Unfortunately the information available to the pig farmer as to the detail of carcass rejection is often vague or confusing. Where regular problems are experienced it is well worthwhile requesting that your own veterinary surgeon attend the abattoir to undertake a detailed examination of any detained carcasses. Where whole carcasses are rejected these losses should be added to the on-farm mortality figures as constituting unmarketable animals.

Many of the reasons for carcass losses are preventable. Being mindful of challenges to pig welfare throughout the production cycle and attempting to minimise them will ultimately pay dividends in terms of reduced carcass losses.

Producer checklist

- Hygienic practices and well trained staff
- No overstocking or re-mixing of pigs
- Good injection practices (i.e. appropriate site and needle gauge, hygiene, etc.)
- Prompt and appropriate (isolate, hospitalise, treat) treatment of obvious damage to the skin (e.g. external abscesses, bitten tails)
- Regularly updated and observed Health and Welfare Plan
- Improved housing and husbandry practices are the first port of call (vaccinations and other medications can follow)
- Ruthless in making decisions on euthanisation of sick and casualty animals

Constraints on selling heavier pigs

Michael McKeon and Gerard McCutcheon

The carcase weights in Irish factories are averaging c.80kg for the first 8 months of 2010. What is the optimum live weight at which to slaughter your pigs? The requirements of the processor and individual deals done with processors are very important factors that must be considered. The finisher feed accounts for at least 60% of total feed used and feed efficiency in the finisher section can have huge effects on financial returns.

Trends

Slaughter weight of Irish pigs has increased greatly in recent years. The average carcase weight of pigs slaughtered in Ireland in 2009 was 78.4 (Table 1) up from approximately 68.4 kg in 1999.

Table 1: Trends in pig carcase weight at (kg) slaughter in Ireland.

Year	1999	2001	2003	2005	2007	2009
Avg. wt. (kg)	68.4	69.6	71.3	74	74.9	78.4

Source: PigSys Report 2009

Most other EU countries routinely castrate male pigs destined for the meat counter thus allowing much heavier weights without running the risk of boar taint. However this practice is becoming less acceptable and alternatives are being considered in some of these countries. Ireland and the UK produce entire male pigs and as our slaughter weights were traditionally low (consequently young pigs) this safeguarded us from boar taint problems.

What is the current situation?

The slaughter weight of pigs in Ireland is dictated largely by the minimum and maximum weight limits set by the main processors. Each processor has its own distinct range. Table 2 shows the minimum and maximum carcase weight limits for pigs sold to various processors (note that each processor may have different weight thresholds for specific markets).

Table 2: Survey of producers for processor minimum– maximum carcase weight limits

	Min	Max
Processor A	55	85.5
Processor B	65	85
Processor C	65	95
Processor D	55	80
Processor E	55	90

Failure by a producer to supply pigs within the maximum and minimum weight range can be very costly. Each processor has its own system for deductions on over and under weight carcases but generally the further carcase weight is outside the optimum range the greater is the penalty. Table 3 shows the live weight limits of pigs that should be selected to avoid underweight and overweight penalties for some of the processor weight limits.

In determining minimum live weight at sale account must be taken of the lower kill out of entire males. In determining maximum live weight at sale allowance must be made for the higher kill out of gilts and, in addition, the expected weight gain of the heavier pigs in the interval to the next sale e.g. week

Table 3: Proposed live weights to maximum number of pigs within specified weight range

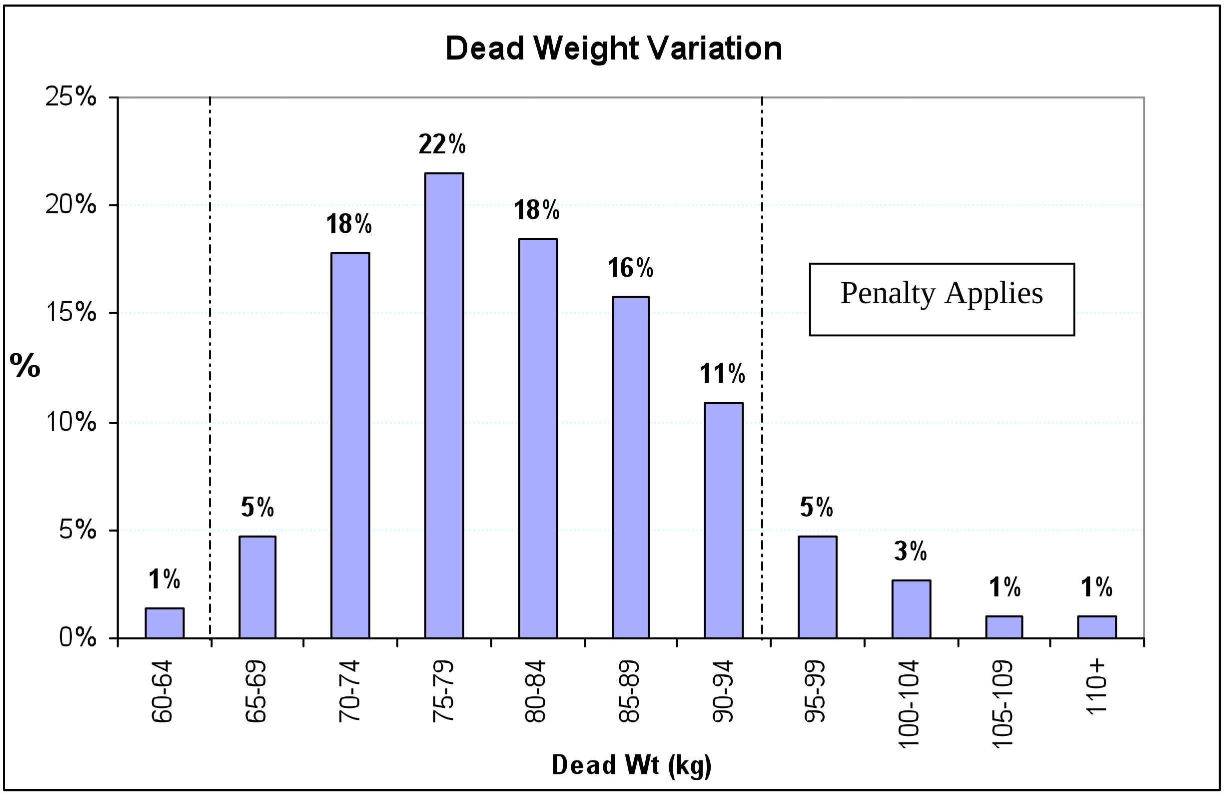
	Minimum	Minimum	Maximum	Maximum
Dead weight (kg)	55	65	85.5	95
Kill out (%)	71	73	78	78.5
Live weight limit (kg)	77.5	89	103*	114*

*Based on up to 7 kg weight gain in last week.

Slaughter weight variation:

There will always be some degree of weight variation when sending pigs to slaughter but it is important for units to analyse their factory returns to ensure that they are not being penalised for excessive variation. Ideally units should select the heaviest pigs in a pen three weeks before their expected slaughter date to ensure that these pigs are not excessively heavy at slaughter thereby incurring poor FCE and overweight penalties. Figure 1 shows a unit which has a wide slaughter weight variation with 11% of pigs outside the processors slaughter weight range of 65-95kgs dead. Analysis of factory returns shows that these penalised pigs cost the unit approximately €300 per week.

Figure 1: A Pig Unit's Slaughter Dead Weight Variation



What is an ideal slaughter weight?

The following example uses data from a trial conducted at Moorepark where pigs were slaughtered at five target live weights between 80kg and 120kg (Table 4).

Table 4: Effect of slaughter weight on pig performance

	Slaughter Weight LW (kg)				
	80	90	100	110	120
Days (from weaning at 28 days to slaughter)	105.6	116.8	127.2	140.3	147.3
Average Daily Gain (g)	715	737	756	737	748
FCE (weaning to slaughter)g/g	2.24	2.39	2.41	2.48	2.55

Mullane J. (2005), Moorepark Research

For this trial it was found that targeting live weight at slaughter of 110kg was the most economical strategy. This processor had an upper limit of 85.5 kg and above this live-weight the penalties incurred for overweight pigs were sufficient to severely reduce margin over feed per pig thereby outweighing the benefits of increased weight. In this case it was advisable to sell all pigs above 103kg live on a given week to maximise the number of pigs approaching this weight and also to avoid pigs exceeding the upper carcase weight of 85.5kg.

Situations where the upper weight limit is more "relaxed"

Processors tend to accept pigs heavier than their maximum declared weight limit from specific customers and in times of short supply. Allowing this increase in slaughter weight (without penalty) is very profitable for the producer, since the costs of sow feed and most non-feed costs associated with producing the pig have already been incurred. The main costs associated with the extra weight is the additional finisher feed used, interest on increased borrowings, building depreciation on additional accommodation required and increased repairs and maintenance associated with increasing slaughter weight. These costs can be easily calculated using financial information for individual herds. If the producer has scope to go to higher weights then a number of factors will influence this upper limit:

1. Feed Conversion Efficiency (FCE):

There are a huge range of factors which can affect feed conversion efficiency. The pig environment, genetics, feed wastage, diet balance and availability and stocking rate are some of the more important factors. The sale of heavier pigs will also affect the FCE (see figure 2).

Figure 2: The Effect of Increasing Liveweight of Gilts & Castrates on FCE

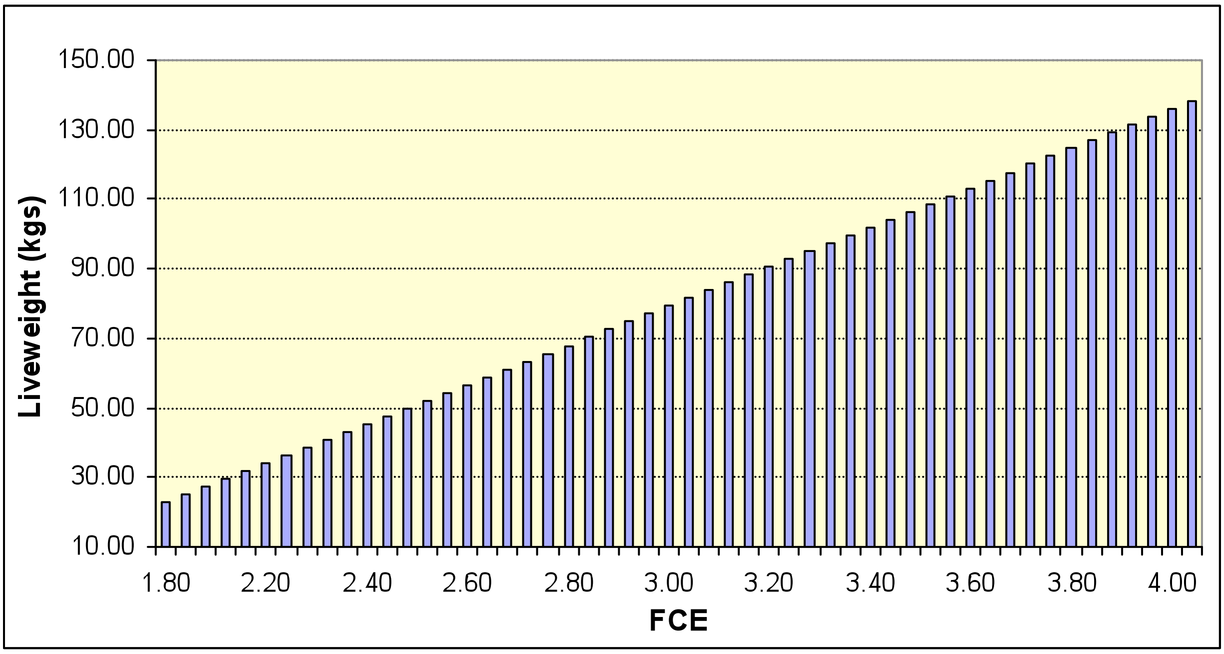


Figure 2, derived from the US National Swine Nutrition Guide shows the effect of increasing sale weight of gilts and castrates on FCE. For pigs 100-110 kg the FCE is estimated at 3.5.The replacement of castrates by boars in an Irish context would improve the FCE but it will still follow the same trend.

Research shows that males have a better FCE than gilts at heavier weights therefore the option of split sexing at weaning might be a further refinement in improving FCE. If a unit has only sufficient accommodation to bring pigs to 104kgs then perhaps it should look at slaughtering gilts at 99 kg and bring the boars to 109 kg live weight. This will allow the unit to maintain its average slaughter weight while gaining from the boars superior FCE. A further cost saving refinement of this system could be to feed the females a separate diet after 65kgs due to their lower nutritional requirements. This is especially relevant during the current high feed prices.

2. Is the incidence of boar taint likely to increase?

Boar taint is an unpleasant odour that is released during the cooking of pig meat from entire male pigs. Only a proportion of boars produce this odour and not all consumers are sensitive to it. Nevertheless it is a potential problem for the industry, since one bad experience by a consumer could put a person/family off pork for life. Research found that the incidence of taint causing compounds in the carcase increases as slaughter weight exceeds 100kg live weight and that the incidence of boar taint is more a feature of age rather than weight. However, there is no way of knowing the age of a pig at slaughter and so maximum carcase weight limits though not entirely accurate are the only practical safeguard against boar taint.

A narrower carcase weight range (particularly at heavier weights) might predispose to greater boar taint problems as the weight is the main selection criteria rather than the age.

3. Space Allowance:

Obviously as the pig gets bigger it requires greater space allowance. If pigs become over crowded then their feed intake and average daily gain will decrease due to restricted time and space at the feeder. The research indicates a 1% decrease in feed intake for each 3% reduction in floor space per pig. The recommended floor space allowances are shown in Table 5.

Table 5: Recommended floor area for finisher pigs

Exit Weight (kg)	M^2	Ft^2
60	0.55	6
100	0.75	8
109	0.85	9

Under the current welfare regulations once a pig reaches 110kg live weight it must be provided with a minimum of 1m^2 floor area (10.8ft^2) per pig.

Summary

It is impossible to give one recommendation for an optimum target live-weight at slaughter for the industry. Each processor has different upper carcase weight limits, different penalty structures and even within processor different suppliers may have negotiated different upper carcase weight limits. Without an upper weight limit each additional kg produced is very profitable. Where a carcase weight limit of 85.5kg is set then producers should target all pigs exceeding 103kg for slaughter each week to maximise profitability. However the industry as a whole must always be mindful that increasing slaughter weight also increases the risk of boar taint raising its ugly head.

Teagasc Service to the Pig Industry

Teagasc provides a range of services to the pig industry in research, advice and training, as well as confidential consultancy on all aspects of pig production, meat processing, feed manufacture, economics and marketing. Contact numbers are as follows:

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Notes