The Worshipful Company of Farmers

CAN BIG BE BEAUTIFUL?

THE RELATIONSHIP BETWEEN SIZE OF UNIT AND SUSTAINABILITY IN HOUSED LIVESTOCK SYSTEMS

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A desk-based research project for the Worshipful Company of Farmers

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Foreword

Few issues divide opinion more starkly, among producers and consumers alike, than increasing scale and intensification of livestock production. Depending on which side of the divide one sits, it is either the logical and inevitable evolution of an industry, driven by unrelenting technological and socio-economic factors, or 'factory farming' – the elevation of corporate greed above concerns for the environment, animal welfare and the wider interests of society.

The highly partisan nature of this debate often results in rational and evidence-based discussion being lost beneath a tide of emotion and single-issue politics, as all parties seek to defend their often ideologically entrenched positions.

This was brought into sharp focus in 2009 with the proposal to build a dairy farm on a greenfield site at Nocton in Lincolnshire, that would have housed up to 8,100 high-yielding dairy cows all year round. The proposal was met with a level of resistance from opposition groups never before seen in the UK and elevated what would otherwise have been merely a local or agricultural news item to the mainstream media overnight.

The proponents of the project presented Nocton Dairies as the future of the British dairy industry. They claimed that their proposal not only represented crucial investment in a declining sector, but would produce a world class, state-of-the-art facility, operating to the very highest standards of animal welfare and environmental compliance, as well as creating 80 much needed new rural jobs and supporting many more.

Opponents, on the other hand, claimed that the proposed 'mega dairy' was fundamentally unsustainable and posed unacceptable risks to both the environment and to animal welfare. Furthermore it would potentially drive traditional family farms out of business and blight the quality of life for local residents.

At the same time a proposal by Midland Pig Producers to develop a 2,500 sow breeder-finisher pig unit at Foston in Derbyshire met with similar opposition. Despite both projects making what appeared to be plausible claims as to how they would 'raise the bar' with regard to facility design and management practice, opponents remained wholly unconvinced.

Nocton and Foston brought to a head a debate that has been rumbling on for many years, and in so doing exposed not only the strength of feeling in some quarters with regard to the acceptability of intensive livestock production but also the level of unawareness among the wider consuming public about how food is produced today and the challenges the agricultural industry faces with regard to delivering a sustainably-produced, affordable food supply tomorrow.

Ironically, days before the planning application for Nocton Dairies was withdrawn, the UK Government published its much acclaimed Foresight report into the Future of Food and Farming, that called for new and innovative thinking around sustainable food production to meet the ever growing demand for food around the world; and in so doing introduced the concept of '*Sustainable Intensification'* into the agricultural lexicon.

So who is right? Is large-scale, intensive livestock production a viable and indeed inevitable route to a sustainable food supply, forming at least part of the solution for the future, or do the associated risks render such systems fundamentally unsustainable?

In compiling this report we have sought to examine the evidence for and against this argument in the context of an increasingly resource-constrained and competitive market place, and have chosen to focus on the dairy industry as the principal exemplar for a number of reasons, namely:

- The current debate around scale and intensification of milk production in the UK
- The potential impact on the industry of the proposed removal of EU milk quotas in 2015
- The authors' specific area of expertise and experience.
- The fact that the arguments for scale and intensification in the monogastric *(pig and poultry)* sectors are better understood, and the process of intensification and industry rationalisation more established than is the case in the dairy sector

This last point raises the issue of differing perspectives on scale and intensification according to sector. Monogastric farming systems, whilst undoubtedly posing their own diverse management challenges, are in the main less complex than milk production and as such, have historically lent themselves more readily to both intensification and increasing scale.

Neither have they been afforded the same level of historical support or market protection, in the form of the Milk Marketing Board and subsequently EU milk Quotas, that the dairy sector has 'enjoyed' for much of the past 50 years.

This has undoubtedly insulated UK dairy producers, to a degree, from the Darwinian forces of the marketplace and has consequently resulted in a lower level of rationalisation in the UK dairy sector than has been observed in the pig and poultry sectors over the same period.

However, with the Milk Marketing Board long since consigned to history and the imminent removal of EU milk quotas in 2015, the outlook for milk producers in the UK, whilst offering potential opportunities for expansion, is decidedly more challenging than it has been in the past. Consequently the sector will need to focus on genuine drivers of Economic, Environmental and Social sustainability to safeguard its competitive position in the longer term.

The aim of this report is not to compare intensive livestock systems with other systems of production and reach a conclusion on which is best; rather to objectively examine the impact of increasing scale on the sustainability of such systems and bring some focus and rationale to a debate that has until now majored on emotion rather than evidence.

Executive Summary

Sustainability, or the 'capacity to endure' has three principal pillars: Economic, Environmental and Social. Whilst all are essential to support the long-term survival of a business, or indeed an industry, it is economic competitiveness that underpins the short term viability of any commercial entity, particularly one engaged in the production of relatively low-value, low-margin commodities such as milk.

To paraphrase the economist John Maynard Keynes, "*In the long run we're all dead*", so it is therefore critical that any business maintains economic viability if it is to survive in the short-term, but without compromising its broader environmental or social obligations.

In most industries, the evolution of new technologies and management practices supports increases in the optimum scale and intensity of production due to progressively more realisable economies of scale, which risks rendering more 'traditional' scale businesses less competitive over time.

Consequently what was an efficient, sustainable farm yesterday may not be so tomorrow, particularly when one factors in the move towards ever-greater market deregulation. However with increasing scale and intensification come new and ever greater risks that must be effectively managed if that business is to be genuinely sustainable going forward.

The UK boasts a broader spectrum of livestock production systems than many other countries and this is particularly evident within the dairy sector. Our benign, maritime climate favours grass production, particularly in the west of the country, where the majority of the UK dairy herd can be found, and as such the industry has evolved to exploit this valuable and relatively low cost resource.

However a significant *(c.7bn litres per annum)* and historically high value, liquid milk market has created demand for year-round supply of milk that, in turn, has supported the development of more intensive systems of production than are typically found in other grass-based, but predominantly export-focused milk producing countries such as New Zealand and Ireland.

A recent analysis of the profitability of dairy farming in the UK, conducted by DairyCo, concluded that efficient milk production was possible under any of the major systems of production practiced in the UK and at pretty much any scale. This was cited by those opposed to the development of large-scale intensive dairies as evidence that they were no more efficient than any other system of milk production and thus the greater environmental and social risks associated with them rendered them fundamentally unsustainable.

However closer analysis of the supporting data revealed that more specialised systems of production – i.e. low input grass-based and High-yielding intensive systems – were on average significantly more profitable than the more traditional "Composite' system of production.

The relationship between scale and profitability is more difficult to establish from the report, but this could be explained by the fact that the optimum scale of production varies according to the system employed, which was not explicit in the DairyCo analysis.

Intensive, predominantly housed systems only really begin to realise economies of scale at around the same point that low-input grass based systems, for reasons of logistics, tend to start encountering diseconomies of scale – i.e. around 500-700 cows.

Data from the US, whose dairy industry is predominantly based around an intensive, year-round housed model, shows significant reductions in the long-run cost of production as herd size increases. USDA figures show herds with over 1,000 cows have typically 30-35% lower operating costs than herds of 100-199cows.

Given that there was no data in the DairyCo sample from any of the albeit small number of genuinely large *(1,000+ cow)* herds currently operating in the UK, one can understand why the report failed to recognize any significant relationship between scale and cost of production.

However, whilst the optimum scale for either system is significantly larger than the current UK average herd size of 140 cows, it would appear that, where the evidence exists, there is a very strong link between reducing cost of production and increasing herd size for intensive housed dairy systems.

Risk Management

An oft-quoted weakness of larger, more intensive dairy systems is their perceived vulnerability to movements in both milk price and the cost of feed, as these businesses tend to buy in a far greater proportion of their feed than smaller grass-based dairy farms. However in markets where large scale intensive systems have evolved over time, mechanisms that allow farmers to manage commodity risk have evolved in parallel, allowing dairy *(and indeed pig, poultry and beef)* producers to hedge their exposure to both input and output prices, thus limiting their vulnerability to market volatility.

The effectiveness of this approach can be seen by the response of the US dairy industry to a 60% drop in the milk price between 2008 and 2009. The steady growth in US milk output of the previous five years effectively stopped during that period as producers reduced the amount they fed due to the lower marginal value of milk and increased culling rates to remove less efficient cows from their herds. However as the price recovered, the growth in milk output quickly resumed, suggesting that as a consequence of effective risk management, the US dairy industry is far more resilient to external price shocks than some critics suggest.

Whilst the evidence used to support the assertion that intensive, housed dairies are indeed economically sustainable at larger scale, is based on data from the US, there is no obvious reason to assume that the same principles would not apply to large-scale housed systems in the UK, provided the supporting risk management infrastructure can be developed. Whilst such structures are currently in their infancy in Europe, the increasingly global nature of commodity markets and improved access to risk management instruments and services in other agricultural sectors would suggest that there is little if any reason why this could not be replicated in the dairy sector.

Environmental Sustainability

From an Environmental Sustainability perspective, there are as many arguments to support the case for intensification as there are to undermine it.

Opponents of large scale intensive systems tend to quote absolute quantities of resources used and waste, GHGs and pollutants generated by large-scale production units, *(often referred to as CAFOs or Confined Animal Feeding Operations)*, and the attendant environmental risks they pose, whereas those in the pro-intensification camp argue that on a per unit of output basis, more intensive systems use fewer resources and produce less waste and lower Greenhouse Gas (*GHG*) emissions .

Specific evidence based on UK data is difficult to come by, whereas the US industry is again better resourced in this regard. A paper by *Capper et al* published in the Journal of Animal Science in 2009 looked at the total resource requirement of the US Dairy industry to produce 1billion litres of milk in 2007 *(intensive feedlot-based industry)* compared to 1944 *(extensive pasture-based industry)*

The results showed that the industry in 2007 required significantly less land, animals, feed, water and energy and generated significantly less manure and GHGs to produce the same volume of milk than was the case in 1944. Consequently the carbon footprint of a litre of milk produced in the US in 2007 was estimated to be 37% of that generated in 1944.

Many of these gains can be attributed to improved genetic potential of both feed and forage crops and the dairy herd itself, but the realisation of that potential is only possible with the use of modern management practices.

This is reflected in Carbon footprint figures for UK milk producers where, subject to variations in methodology, larger more intensive dairies tend to operate at significantly lower carbon footprint figures per litre of milk *(<1,000g CO_2 eqv./ litre)* than the UK industry average of c.1,300 CO_2 eqv./litre[1], which is, in turn, significantly lower than the global average of 2,400 CO_2 eqv./litre.

[1] The E-CO2 Project/DairyCo; Food Climate Research Network http://www.fcrn.org.uk/research-library/consumption/carbon-footprinting/report-uk-dairy-sector-ghg-emissions

On this basis at a system level, intensification of production would appear to offer some clear advantages in terms of resource requirement and thus long term sustainability, however this does not take into account environmental risks at the individual farm level.

The argument against large-scale intensive livestock units invariably centres around the perceived threat posed to groundwater and the wider environment by the large quantities of manure generated, stored and spread by these farms. However, where cited, evidence of breaches of environmental regulations are more often than not from older facilities that were designed and built to far less stringent standards than are required in the US today, and certainly would be required in the EU, both in the planning and permitting process and during the operational life of the facility.

All dairy farms in the UK are required by law to have sufficient manure storage and land under their control to spread manure over, to comply with current NVZ regulations, so pro-rata a larger farm represents no more risk to the environment in this regard than a smaller farm. Furthermore, smaller farms are in reality more likely to be subjected to a lower level of scrutiny than larger farms, simply due to the lower level of ultimate hazard they pose and the resource constraints of the relevant regulators and monitoring agencies.

It is our considered opinion that whilst the risks of environmental pollution from large scale intensive livestock farms should not be underestimated, many of those risks can often be more cost effectively managed and mitigated at scale due to the businesses ability to spread the cost of environmental compliance systems and infrastructure over a larger number of litres of milk or kilograms of meat sold.

Often the most effective mitigation technologies, such as Anaerobic Digestion and formal Environmental Management Systems, e.g. ISO 14001, have a minimum efficient scale of operation that can put them beyond the reach of smaller producers. However the approach that the industry takes to mitigating and managing environmental risk needs to be more clearly and proactively communicated to relevant stakeholders and regulatory authorities, to enable a more robust and objective environmental assessment and risk evaluation framework to be developed for large livestock units.

A return to mixed farming

Due to the nature of their feed requirements, there is a compelling case for locating large scale dairies in arable areas of the UK, as was proposed by Nocton Dairies. This would not only better exploit closer proximity to sources of valuable but bulky food industry by-products, but also provide access to large areas of arable land required for cost effective production of high-quality, high dry-matter forages such as maize and alfalfa, which in turn would benefit from the nutrients in the manure.

This also potentially reduces the environmental risk posed by manure as arable areas, by definition tend to have a much lower existing livestock density than traditional dairying areas, allowing manure nutrients to be more optimally utilized according to crop needs across a larger land area. The potential economic and environmental benefits of this are discussed in more detail in the main body of the report, but the reintroduction of ruminant livestock into arable areas could potentially help recreate a more environmentally sustainable mixed-farming model in the east of the UK whilst at the same time reducing pollution pressure on water resources in the west.

Animal welfare

The Social sustainability of increasing scale in intensive livestock production is perhaps the most contentious and difficult to address due to the deep-seated emotional and ideological drivers of stakeholder attitudes towards both animal welfare and perceived threats to the individual's quality of life.

As with the environmental risks, the risks to animal welfare posed by large-scale intensive livestock systems are often based on hypothetical risk factors drawn from observed industry trends, and simply scaled up rather than based on specific evidence.

Whilst established expert reports into dairy cow health and welfare such as the EFSA Report in Europe and the FAWC Report in the UK, highlight the increased *potential* risk associated with increasing scale and intensification, they both stop well short of implying any direct correlation between either and compromised welfare. Indeed both state quite overtly that large scale intensive systems, managed appropriately, are more than capable of providing the requisite levels of animal health and welfare.

Animal health and welfare and animal performance are strongly correlated. Successful livestock farmers understand this and it is often the provision of higher standards of both that contribute to higher profits that in turn enable some producers to expand their operations, whereas the opposite is often one of the underlying causes of higher costs of production and lower profitability on less successful farms that do not grow.

What data does exist for intensive milk production would tend to suggest that health and welfare is at worst 'scale-neutral' and that the evidence would indicate a trend towards higher standards of health and welfare on many larger farms due to a generally higher standard of management employed and increased investment in specialist staff, facilities and operating procedures designed to deliver optimum health and welfare.

However the industry has again singularly failed to communicate this effectively and in so doing has left the door open to criticism of its practices by individuals and organisations that are fundamentally opposed to large-scale intensive production systems. This is an area that requires considerably more work on the part of the industry if it is to stand any chance of gaining consumer confidence

and acceptability of such systems in the face of sustained campaigning by welfare pressure groups.

One welfare area that undoubtedly needs further research is the 'Fourth Freedom' or the ability of animals reared and managed under intensive production methods to exhibit 'natural behaviour'. Of all the welfare parameters defined by the 'Five Freedoms', this is the one most open to interpretation and ambiguity and therefore the one on which opponents of large scale intensive livestock farming are increasingly focusing their attention.

Understanding animal behaviour and the relationship between environmental stress factors and wider animal health and productivity is increasingly acknowledged as a critical driver in providing an optimum environment for livestock to sustainably express their genetic potential. The development of a robust evidence base around this will be fundamental to the future development of sustainable livestock production systems whether intensive or extensive.

Wider social impacts

Stakeholder concerns over the wider social impacts of large-scale intensive livestock farming are potentially harder to objectify as they have to address deep seated fears around impacts on public health, compromised quality of life and a changing way of life.

Modern technology, best practice and established regulatory frameworks have been shown capable of successfully mitigating the underlying causes of the vast majority of stakeholder concerns, however the perception of risk is often every bit as important as the reality and must be managed accordingly. There also has to be confidence among stakeholders that commitments to mitigate impacts will be delivered upon.

From a neutral perspective it is easy to see how such concerns, particularly from those who are, or who feel they might be, directly affected by the development of a 'mega dairy' or 'pig factory' in their immediate vicinity, evoke a disproportionate response, particularly if fuelled by inaccurate and inflammatory media reporting and pressure group activity.

'Nimbyism' *('Not In My Back Yard')* is not unique to the livestock industry and is an increasingly significant hurdle to business development and expansion across the wider economy. The solution is often sustained and effective communication, along with engagement, flexibility and compromise. Proactive management of key stakeholder relationships is as fundamentally important as the physical measures taken to manage the more tangible risks and impacts associated with any new or expanding business.

The UK livestock industry needs to rapidly establish greater competencies in this area as it is currently lagging behind other industries, and critically the NGO community, in the way it manages stakeholder relationships and communicates with consumers.

One other key social impact of large scale farming is the perception it drives traditional 'family farms' out of business. There are two hypotheses supporting this: one that economies of scale create a lower average cost of production and thus a lower average milk price at which smaller producers cannot survive; the other is that it is more cost-effective for purchasers to work with and collect milk from larger farms, and therefore more lucrative or beneficial contracts are awarded to these and smaller producers are left with less advantageous contracts.

However, to counter this, none of the farmers planning to exit dairy farming in Britain over the next two years cite competition from large farms as a reason, according to the DairyCo annual Intentions Survey. Indeed, it appears farmers are making the decision to exit for other reasons, leaving a vacancy of milk production picked up by those who see an opportunity to expand.

The reality is there could be an element of both 'push' and 'pull' behind the trend for expansion of herd size, and this area merits further study. However, it is a concern that imposing arbitrary limits on maximum size of farm or herd, while little evidence-based justification for such limits exists, will only undermine the longer-term competitiveness of the UK industry; and for the incumbents, who have often invested many years if not generations-worth of time and capital in building sustainable and competitive businesses, such restrictions could be considered restraint of trade.

Conclusions

For centuries agriculture has followed a path of continued intensification and increasing scale, by exploiting advances in technology and management practice, that in turn has sustained an ever-growing world population, whilst at the same time, freeing up that most valuable of resources, human capital, for other endeavours that have shaped the world we live in today.

That process is evolutionary and unrelenting, and provided that the methods employed do not unduly compromise standards of animal welfare, environmental impact and quality of life, then there is little if any objective evidence to suggest why it should not be allowed to continue. The rate and extent of that evolution and the inevitable reduction in producer numbers that are a consequence of it, will ultimately be dictated by resource availability and the price consumers are prepared to pay for the end product.

There are undoubtedly risks associated with increasing scale in intensive livestock production, but high standards of technical and risk management and the judicious use of technology are key to successfully mitigating them and capturing the clear commercial benefits that exist.

We would therefore conclude that the economies of scale that are achievable in intensive housed livestock systems will continue to be a powerful driver of rationalisation over time, in an increasingly deregulated livestock sector.

Ultimately the market will dictate how and where food is produced, but we do not see this as a zero-sum game. The UK currently has a significant net deficit in both dairy products and pigmeat and the potential exists for UK producers to both address that deficit and to supply growing world demand for both these products.

At a time of industry-wide emphasis on resource efficiency and sustainable productivity growth, livestock producers, like all other businesses engaged in food production, will need to adapt to a rapidly changing environment. To deny that opportunity to those with the capacity, capability and willingness to do so, compromises not only their future sustainability, but potentially that of the broader livestock industry in the UK.

There is without doubt space for a diversity of production systems within the UK, that can synergistically exploit our broad resource base and deliver sustainable, market-based solutions that will benefit UK agriculture, consumers, and the wider economy.

However, engaging positively with those consumers and the wider community to enable that process to develop, unencumbered by the views of single issue groups, is potentially the most significant immediate challenge facing the industry.

In recognition of that, we have compiled a list of 10 key recommendations that we feel would provide the requisite evidence base and support the development of competencies necessary to underpin a sustainable intensive livestock sector in the UK.

Recommendations for further work

In this report we have attempted to identify the relationship between scale and sustainability in intensive housed livestock systems.

Whilst there are clear trends emerging both in the UK and elsewhere, particularly in the US, that support a move towards rising sustainability with scale, a clear and robust UK derived evidence base is less readily available. This continues to undermine the development of the sector and perpetuates the emotive and often confusing arguments that have characterised this debate in recent months.

The scope of this report has only allowed a relatively superficial analysis of the key issues, but has highlighted a number of areas that warrant further research and investigation to fully validate our findings and facilitate the development of sustainable intensive livestock production in the UK.

They are:

1. A detailed analysis of the economic impact of increasing scale in intensive livestock production in the UK;

2. A detailed comparative analysis of Total Resource Usage and Environmental Impact across a range of scales and systems of production in the UK, *(including the impact of substitution of alternative sources of protein for soya in intensively managed dairy cow, pig and poultry rations)*;

3. Research into the potential synergies and challenges of integrating large-scale livestock and crop production systems and the development of enabling technologies;

4. Development and communication of a robust evidence base of the current environmental and welfare performance of large-scale intensive livestock systems in the UK;

5. Development of UK-specific sustainability standards/best practice for large-scale livestock enterprises that encompass Environmental Management for Water, Air and Soil/Nutrient management – ***e.g. ISO 14001***;

6. The development of appropriately robust animal welfare metrics based on outcomes rather than more subjective system-prescriptive measures;

7. Evaluation of existing risk management tools available to intensive livestock producers and opportunities for the provision of more comprehensive and accessible financial risk management instruments;

8. Development, validation and implementation of new/existing monitoring and management technologies to facilitate the maintenance of high welfare standards and levels of environmental compliance in large-scale livestock systems;

9. Consideration of whether an assessment of a proposal's potential to deliver good welfare and allow the expression of natural behaviour should be included in the planning process; and if so, establishment in principal that any such assessment be conducted by Defra vets or similarly qualified, impartial and accountable assessors *(this would objectively validate an application and provide a counter argument to the status quo of 'virtual assessment' by those with an overtly anti large/intensive farming agenda)*;

10. Improved evidence-based communication of modern livestock production systems to all stakeholders to promote the relative attributes of a variety of systems, at the same time articulating the imperatives behind the need to change what we do as an industry.

Introduction

The concept of 'Sustainable Intensification' first proposed in the Royal Society's 2009 report 'Reaping the Benefits' and further developed by the UK government's 2011 'Foresight report – The Future of Food and Farming', has brought into sharp focus the issue of how the global food and farming industry addresses the challenge of sustainably feeding 9 billion people by the second half of this century, set against a backdrop of a shrinking land base, diminishing resources and climate change.

However, few issues in UK farming have divided opinion more starkly in recent years than large-scale intensive livestock production. The proposal in 2009 by two established UK dairy farmers to build a large US-style feedlot dairy at Nocton in Lincolnshire, which would be home to 8,100 cows housed all year round, elevated milk production to the front pages of the national media and sparked a national debate that continues to divide the industry.

In this paper we have sought to examine the arguments for and against scale in intensive livestock production using the dairy sector as the principal exemplar.

The case for intensification and increasing scale in other livestock sectors e.g. pigs and poultry, is generally better established and understood, albeit still highly contentious, as evidenced by the level of opposition to a proposed 2,500 sow state of the art pig unit at Foston in Derbyshire. Both these sectors have undergone prolonged periods of intensification and in Europe at least, there are now established and evolving environmental and welfare standards and regulations that aim to ensure the sustainability and acceptability of intensive production systems without unduly compromising the cost and competitiveness of the sector.

Dairying however remains a more challenging prospect with regard to both scale and intensification, due to its greater complexity and traditional perceptions both within the industry and the public at large, of how dairy cows should be managed.

The dairy sector has been more heavily regulated than pigs and poultry, and has historically been afforded a degree of protection from market forces in the form of quotas and prior to that the Milk Marketing Board, that the monogastric sector has had to evolve without.

This almost certainly accounts for some of the current structural differences between the sectors, e.g. why the pig and poultry businesses are generally larger, their supply chains more integrated and thus better adapted to deal with the challenges of a de-regulated market. The path of that evolution may hold some clues as to how the dairy sector can address the prospect of a world without quotas after 2015.

As it grapples with growing economic pressures and the increasing burden of regulatory compliance, the UK dairy industry is having to rapidly evaluate its options in a changing and uncertain world.

Evidence from other dairy sectors around the world that have been through that process of deregulation and free market adjustment will be increasingly relevant to the UK but their experience needs to be framed in the context of the UK marketplace and UK consumer attitudes to food production.

Many of the issues discussed also have a considerable amount in common with other livestock sectors. We trust that whilst the focus of this report is primarily on the dairy sector, it can be used to initiate a much needed debate regarding the future strategic direction of livestock production generally in the UK.

Whilst we are aware that this is a highly emotive area, there remains a clear need to evaluate all the options that exist objectively and dispassionately if these challenges are to be optimally addressed and the UK livestock sector is to remain competitive in an increasingly de-regulated and volatile market.

The economics of large-scale livestock farming

Nocton Dairies – a watershed moment?

When two British dairy farmers revealed plans in 2009 to build an 8,000 cow dairy at Nocton, they ignited a debate that has both divided opinion and brought into focus many of the issues facing the wider UK livestock sector as it faces the challenges of food production in the 21st century.

Many of the arguments in favour centred around the increasingly challenging economics of milk production in the UK that has seen a 50% decline in UK dairy farmer numbers in 10 years, national output fall to some 1.4bn litres below quota and a growing UK trade deficit in dairy products.

Opponents argued that, despite the fact that the farmers behind the proposal had an established track record of profitable large-scale milk production and their willingness to commit in excess of £40 million to the venture, such business models were fundamentally unsustainable, posed an unacceptable risk to both the environment and to animal welfare and threatened to drive established family farms out of business.

Despite at least one glaring contradiction in this argument, it gained considerable traction in the media and especially with a number of NGOs and single issue groups who subsequently joined forces to actively oppose the development.

Nocton Dairies' planning application was eventually withdrawn due to specific but irreconcilable planning issues. However, the debate around the sustainability of large-scale dairying in the UK is as relevant today as it ever was.

Whilst there are currently no live plans to build a dairy the size of Nocton in the UK, many existing dairy farmers looking to expand the scale of their operations are increasingly concerned about the opposition they will encounter.

The deterioration of the British dairy industry

The fact remains that at a time of rising global demand for dairy products, the UK continues to lose dairy farmers at a rate of as many as one a day and the rate of exodus shows little sign of levelling out. This in itself is not a uniquely British problem, and is echoed in every major milk producing country in the world, *(with the possible exception of New Zealand where dairy farm numbers have increased in each of the last 4 years[2]),* driven by a host of technological and socio-economic factors not all directly related to the economics of milk production.

2 New Zealand Dairy Statistics 2010-11 – LIC DairyNZ2011

The UK has historically been, and remains, one of the world's leading milk producers and enjoys a number of fundamental advantages over many other milk producing countries. This should support a thriving and dynamic dairy industry.

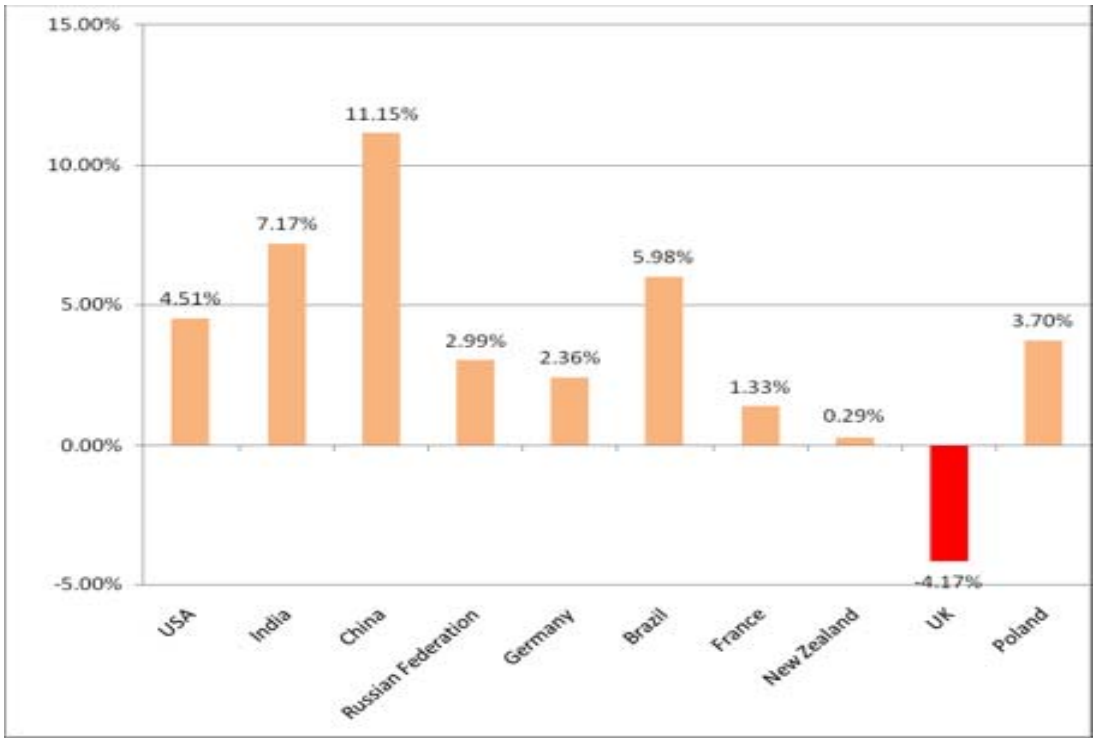

Figure 1: % change in milk production for the world's 10 largest milk producers 2006-2008. Source – DairyCo

Our climate is amongst the most benign on the planet, with regular rainfall and moderate temperatures that support excellent crop growth. We have a large domestic market of affluent consumers with a cultural heritage of relatively high levels of dairy product consumption and a well-developed infrastructure to manufacture and supply dairy products to both domestic consumers and the growing world market. Yet we still lag behind every one of our major competitors in output growth over the last decade.

Whilst other major milk producing countries have increased output in the last decade, it can be seen from the graph above that milk production in the UK has declined and despite a modest recovery since the low point of 2008, remains 600 million litres below the level of 2002/3 and 1.4 billion litres below our national quota of 14.8 billion litres[3].

[3] Defra

Meanwhile our national trade deficit in dairy products continues to grow:

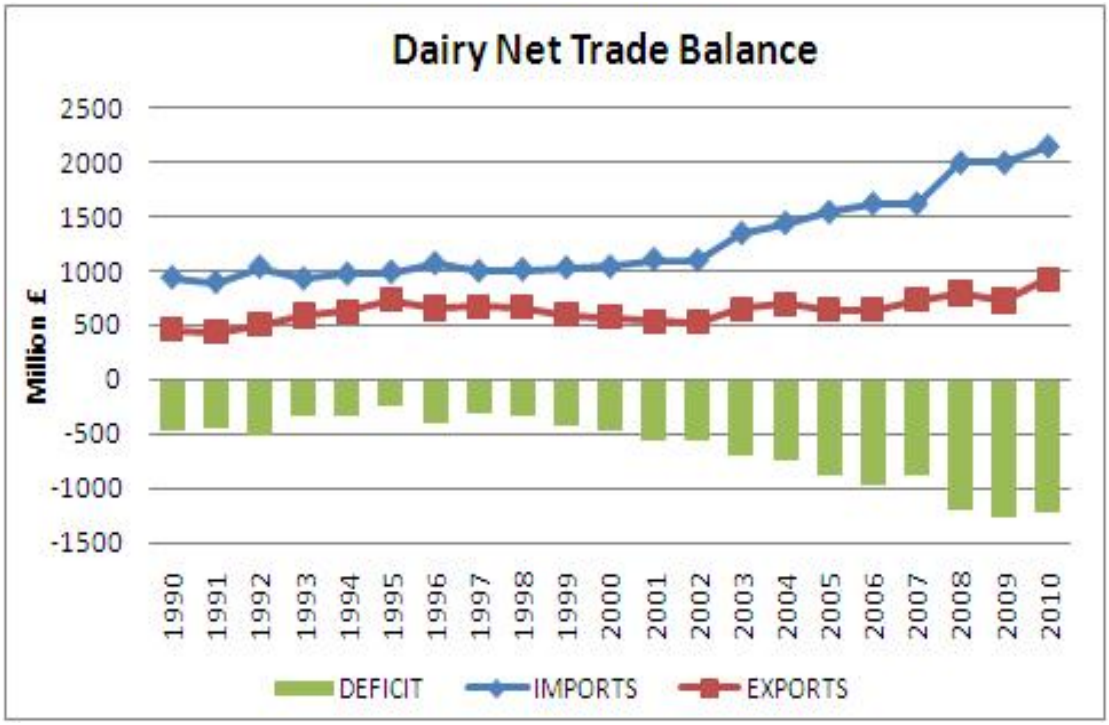

Figure 2: Evolution of the UK's trade balance in dairy products. Source – Defra via DairyCo

This increasing balance of trade deficit is set against a rising global demand for dairy products that is predicted by the UN FAO to continue into the longer term at a compound rate of around 2% annually, driven in the main by increasing wealth in developing nations, rising 'urbanisation', and a consequent transition to an increasingly animal product-based diet.

While much of the increased supply to meet this growth in demand is expected to come from within the countries where the demand arises, there will be an increased demand for dairy on the world market.

In 2009, Rabobank published a report analysing global trends in dairy markets that stated:

'The capacity of the worlds traditional lower cost exporters to meet this rising demand looks constrained and that the market will therefore likely require additional contributions from higher cost producers probably in the United States or the European Union to balance the market in the longer term.

If the world is going to encourage further production growth from the Northern Hemisphere, the market will have to cover the cost of production of at least the lower cost producers in this region. Under most credible market settings, that will entail significantly higher pricing in the international market than has been offered through most of the last decade.

Crucially, whatever the trading range, Rabobank believes that the heightened volatility evident in global dairy markets in recent years is more than just a passing phase. Moreover, while the prices of dairy , grains and oilseeds, and fertilisers are all expected to be volatile, short term correlation between them will not necessarily be high which will enhance variability in margins.

On farms, medium-term pricing will most likely generate attractive margins in much of the southern hemisphere and provide opportunities for export-led expansion in the more competitive regions of the US (and possibly parts of the EU) but generally restrict EU farmers appetite to producing additional milk for export to noncommodity product lines.

In light of market volatility and increased exposure to market forces in the Northern Hemisphere farmers should consider building businesses that can withstand greater volatility than experienced in most of the last decade[4]."

This would suggest that the UK will face increased competiton for imports over the coming years, further increasing its trade deficit in dairy products.

Additionally, the removal of EU milk quotas in 2015 poses both an opportunity and a threat to the UK dairy industry as we will become increasingly exposed to a more liberalised European and world market.

If the UK dairy sector is going to respond to the growth opportunities presented and take advantage of rising global demand, then it needs to be able to develop globally competitive, sustainable dairy farming businesses that are equipped to deal with the future challenges facing the industry rather than those it has faced historically.

Profitability of British dairy farms

In January 2012 DairyCo published a report entitled 'Profiting from efficient milk production'[5] summarising the findings of its Milkbench+ survey of 340 UK dairy farms of varying sizes and systems of production. These systems were loosely categorised into three types, 'Cows at grass', 'Composite' and 'High output' systems. The report analysed a broad range of factors that determined the profitability, or lack thereof, of these businesses, and arrived at three key conclusions:

1. Milk can be produced efficiently from any of the major systems that are currently practiced in Britain, and that efficient milk production is possible at almost any scale of production;

2. Different factors drive profit for each system and the impact that these factors have on returns varies significantly;

[4] Dairy Beyond the Global financial Crisis – Rabobank 2009
[5] Profiting From efficient milk production – Key findings from the Milkbench+ dairy benchmarking programme regarding the efficiency of dairy production in Britain – DairyCo 2012

3. The need to fit the system employed to the individual business's circumstances has never been more important.

Whilst the second and third conclusions would appear both intuitive and consistent with observable trends in both the UK and other major milk producing countries around the world, the first would seem to sit less comfortably with the broader picture of dairy sector evolution both domestically and globally. It also contradicts most producers' understanding of the economic laws governing the sector.

It is therefore worth questioning why the evidence presented by DairyCo suggests that the tried and tested formula for improved profitability – economies of scale and a drive to specialisation[6] – do not appear to apply in the UK.

In arriving at its conclusion, the DairyCo report is at risk of underplaying a fairly significant finding: that despite a fairly broad range of performance levels across all systems, and despite both low-input, predominantly grass-based systems and high-input systems appearing to be generally profitable, farmers using the more traditional 'Composite' system were on average making a loss. This level of loss appears to be similar to the profit per litre made by the high input sector, and half that of the profit per litre made by the grass-based sector.

Given that the Composite model accounts, numerically at least, for the largest share of UK dairy farms, this outcome is at odds with the positive conclusion of the report. More surprisingly, reference to this outcome can only be found in a subscript to a table in page 11 of the report, comparing relative system performance.[7]

Interestingly, these 'Composite' farms, with an average herd size of 143 cows, whilst still larger than the UK average, were less than two thirds of the size of those sampled in the more profitable 'Cows at Grass' (217 cows) and 'High Output' (234 cows) groups, which again would seem at odds with the report's key findings and hints at a more significant relationship between scale and profitability.

That hypothesis would certainly be borne out by evidence from other major milk producing countries outside Europe, tending to suggest that in a technology-driven commodity industry, there is an inevitable move over time to scale and specialisation in order to maximise efficiency and reduce costs[8].

[6] Determinants of spatial dynamics of dairy production: a review C Mosnier & C Wieck 2010 http://www.ilr1.uni-bonn.de/agpo/publ/dispap/download/dispap10_02.pdf
[7] Profiting from efficient milk production – DairyCo 2012
[8] Mosnier & Wieck 2010

DairyCo Milkbench+ conclusions in context

It is important to recognise that the conclusions drawn from the MilkBench+ data were framed within the context of the current structure of dairy herds in the UK, which may account to an extent for the failure to identify a stronger correlation between profitability and scale of production.

The DairyCo report sample consisted of dairy farms ranging in size from 70 to 700 cows as the upper limit. Whilst in UK terms this range represents large and small-scale operations and all points in between, when viewed in a global context the entire sample would be considered 'medium-sized' herds.

By European standards 70 cows is still not a small herd and viewed in a global context it would be considered a commercial scale operation in many countries. In contrast by US or Saudi Arabian standards, a 700-cow operation would be considered little more than a medium sized 'family farm' where large commercial operations are generally accepted to be in excess of 2,000 cows and in some case as large as 30,000. Even in New Zealand, 10% of herds contain over 750 cows.

The USA and New Zealand are two examples of countries with large and expanding dairy industries, which have been exposed to far more volatile market price movements than the UK has historically enjoyed. They have evolved over time to broadly standardised but fundamentally different models of production best adapted to meet the particular market and environmental challenges they face, and both show a strong trend towards increasing scale of production.

The prevailing systems adopted in these two countries are very different. The US with its more extreme continental climate and large, high-value domestic market has pursued an essentially indoor intensive model, whilst New Zealand with a much milder climate and commodity export market focus opted for a much lower cost, lower input grass-based model.

Both have proved successful in their own right. New Zealand is now the world's largest single exporter of dairy products with Fonterra, its ubiquitous farmer-owned co-operative, accounting for approximately 30% of global dairy trade[9]. The US on the other hand has historically had a greater focus on its domestic market yet has still increased output significantly over the past 60 years from a much reduced land base. From a total resource use perspective, it is one of the most efficient, if more capital intensive, dairy industries in the world[10].

The transition of the US dairy industry from an essentially low-input pastoral model at the end of the second world war to a large-scale intensive feedlot based model today, has enabled US dairy farmers to produce the same quantity of milk today from 10% of the land and a quarter of the cows required 60 years ago.

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9 The key elements of success and failure in the NZ Dairy industry – Agribusiness Research& Education Network, Massey University 2008

10 The environmental impact of dairy production: 1944 compared with 2007 J. L. Capper*, R. A. Cady† and D. E. Bauman J ANIM SCI June 2009 vol. 87 no. 6 2160-2167

Economies of scale in housed dairy systems

Whilst both low input grazing-based dairy farming systems and high input intensive housed systems can operate efficiently at scales well in excess of the average UK herd size, of the two, the intensive housed model naturally lends itself more to truly large-scale production.

Grass-based dairies require a corresponding increase in the size of the grazing platform for every cow added to the herd. And the logistical challenges of moving large groups of cows back and forth over increasing distances to grass effectively sets the point of maximum operational efficiency at much lower cow numbers than feedlot dairies.

This issue was examined in a paper by David Beca from MD Red Sky Agricultural PTY, Australia, in 2007[11]:

"Pasture-based livestock businesses are particularly complex businesses to manage. Both ruminant livestock production and high quality pasture production are governed by a number of curvilinear relationships. These relationships include outcomes where the addition of inputs that can initially result in increased outputs, can subsequently result in decreased outputs....

The result of these factors is that there is a loss of comparative efficiency with larger {grazing} farms, especially those with more than 800-900 cows. This loss of efficiency is likely to erode any benefits from economies of scale.

Farms with fewer than 150 cows are disadvantaged as a result of the proportion of 'fixed' expenses that are unrelated to land area or cow numbers, plus the cost to have at least one capable manager in a dairy business. In addition the value of capital infrastructure (housing and dairy plant in particular) disadvantages these businesses. As a result of the comparative disadvantages of either small or large farms, the most economic size is between 200 and 700 cows."

Because feedlot dairies do not require pasture for production, land immediately adjacent to the dairy no longer becomes the limiting factor in dairy expansion. The number of cows that can be managed on a single site is essentially governed by the capacity of the milking parlour.

Large modern rotary milking parlours capable of processing a cow every 6 seconds, enable 4,000 cows to be milked 3 times in a 24 hour period *(allowing for wash down period between milkings).* Two parlours located side by side, as can be found at Rosendale Dairy in Wisconsin *(and as initially proposed by Nocton Dairies)* would enable a herd of over 8,000 cows to be managed on a single site.

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[11] 'Connections' 2007, Australian Agricultural and Resource Economics Society (AARES) and The Faculty of Agriculture and Food Systems, The University of Melbourne: "Are there economies of scale in Dairy Farming and if so, what is the most economic size?" http://www.agrifood.info/connections/2007/Beca2.pdf

Image 1: One of two 80 point rotary milking parlours that milk 8,000 cows three times a day at Milk Source LLC's Rosendale Dairy at Pickett, Wisconsin

At this scale, significant cost of production efficiencies are achieved across a broad range of commercial and operational areas such as feed and other input purchasing, fixed asset and labour utilisation and the cost of construction of the fixed infrastructure required to house, milk, manage and feed large numbers of cows.

The potential to gain operational efficiencies from scale is brought home in the example of Fair Oaks Farms in Indiana USA *(see Case Study 1 – Appendix 1)*. Their 32,000 dairy cows are managed in 10 units of 3,200 cows on 10,000ha of irrigated cropland.

With a rolling herd average across all units in excess of 11,500 litres per cow per year, Fair Oaks Farms is one of the best performing dairy farming businesses anywhere in the world and sustains high levels of production, welfare and environmental sustainability through an adherence to a professionally developed and monitored set of management protocols, and an exceptional standard of animal husbandry. Through these, they manage to maintain a long run cost of production 25-30% below the US industry average.

Large herds allow cows to be grouped according to yield or stage of lactation without compromising operational efficiency, which in turn allows optimal feeding and management strategies to be employed for issues such as heat detection, breeding and dry cow management.

At this scale, dairies can also afford to employ highly trained specialists in key roles within the dairy, and allocate specific tasks to individuals further driving technical efficiencies and reducing the cost of production per litre.

UK experience

Given that there are no single site operations of this size currently operating in the UK and that none of the dozen or so herds with over 1,000 cows is included in the Milkbench+ report, the conclusion that there is little relationship between scale and cost of production, particularly in intensive systems, could be challenged.

Anecdotal evidence from these larger producers in the UK would tend to suggest that significant economies of scale can be achieved, particularly once they pass the 1,000-1,500 cow mark. These are due in the main to:

- Changes in management practices necessary to effectively manage herds of this size;
- Savings in logistical costs achieved by producing whole tanker loads of milk (or multiples thereof) each day, thereby reducing considerably the cost of collection, more efficient asset utilisation and the spreading of fixed costs over a larger number of litres; and
- Significant discounts on inputs due to the lower transaction costs associated with bulk volume purchases.

Additionally, a number of milk processors in the UK are known to have entered into bespoke pricing arrangements with larger dairies, offering significant premiums to secure large volumes of a year-round level supply of milk from a single source, thereby further increasing the margin achievable over a lower unitary cost base.

Therefore, the argument can be made that scale economies should exist, but as yet there is insufficient data available in the UK to underpin this point. In the meantime, if we examine readily-available data relating to large-scale housed milk production in the US, we can see some very clear trends emerging.

Figures from the USDA Economic research service[12] suggest that average costs of production of milk fell sharply as herd sizes increased.

"Large farms with at least 1,000 milk cows had 15% lower dairy enterprise costs in 2005 than farms with 500-999 cows, and 25-35% less than farms with 200-499 and 100-199 cows.

Overhead costs comprise the major cost advantage held by larger dairy enterprises, as these operations are able to use capital and labour far more intensively than smaller operations.

Although most family dairy farms do not pay themselves a cash wage for their labour, that labour still has an opportunity cost—they forego other money-earning activities when they work on the farm. An estimate of this opportunity cost must

[12] Profits, Costs and the Changing Structure of Dairy Farming- USDA Economic Research Service – Report No. 47 September 2007

therefore be included in a measure of overhead and full economic costs even though the operation does not pay an explicit labour expense.

With the largest dairy enterprises providing returns that substantially exceed total costs (including capital recovery and the value of operators' time), those businesses have attracted investment and are expanding rapidly. Since the returns to small dairy enterprises often do not cover all of their costs, many more small enterprises are leaving dairy farming than are entering."

In 2009 Roberto Mosheim of the USDA and Professor CA Knox Lovell of the University of Georgia published a paper in the American Journal of Agricultural Economics entitled 'Scale economies and inefficiency in US dairy farms', attempting to quantify the extent of scale efficiencies achieved on US dairy farms.

Their analysis used a data set for 619 dairy farms drawn from the 2000 Agricultural Resource Management Survey, a national survey of US dairy producers, to estimate scale economies in such a way as not to confuse them with economic inefficiency or other influences in the cost-output relationship.

Their conclusions were clear:

"The title of this article mentions both scale and efficiency, but are they equally important? We do not think so. We argue that efficiency and its patterns are interesting and important, and they influence the patterns of scale economies, but scale economies are far more crucial.

Economies of scale drive structural change in dairy farming; hence, the model must specify different types of inefficiency correctly. Previous findings (and assertions) use models plagued by various types of specification error, perhaps the most serious being the failure to incorporate properly (or to incorporate at all) technical and allocated inefficiencies. At the very least, the model we present here comes closest to accounting for these problems in estimating scale economies in U.S. dairy farming.

Our substantive finding is that this more precise model supports a conclusion that returns to scale are larger at all levels of output than previously believed.[13]"

On this evidence there would appear little doubt that, as with other manufacturing businesses, large dairy farms are able to achieve significant cost advantages over smaller operations, and those cost advantages are a powerful force for consolidation. In the US, over the past 10 years, the dairy industry has seen a significant concentration of production into the hands of fewer, larger farms.

The USDA's Overview of the United States Dairy Industry 2010[14] states that:

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[13] Scale Economies and Inefficiency of U.S. Dairy Farms –Roberto Mosheim, C A Knox Lovell American - Journal of Agricultural Economics (2009)

[14] Overview of the United states Dairy Industry – USDA NASS September2010

"*The dairy industry in the United States has undergone significant structural change over the past eight years. Total milk cow operations have declined significantly, while the number of large operations has increased.*

There were 65,000 milk cow operations in 2009 compared with 97,460 in 2001, a decline of 33%. Despite the large decrease in milk cow operations during this time period, both milk production and milk cow numbers have been on the rise.

Milk production increased 15%, from 165,332 million pounds in 2001 to 189,320 million pounds in 2009. Milk cow inventory showed a smaller increase of 1%, from 9.10 million head in 2001 to 9.20 million head in 2009.

Although the overall number of milk cow operations has declined since 2001, the number of operations with 500 or more head of milk cows has increased. Since 2001, the number of operations with 500 or more head increased by 20%, from 2,795 to 3,350 in 2009.

The largest size group, places with 2,000 or more head, showed the greatest percentage change from 2001, increasing from 325 places in 2001 to 740 in 2009, a gain of 128%.

While larger operations were growing in number, smaller operations declined in number. Places with less than 500 head went from 94,665 in 2001 to 61,650 in 2009, a decline of over 33,000 operations, or 35%.

The share of milk production accounted for by large operations has steadily increased. Operations with 500 or more head accounted for nearly 60% of all milk produced in 2009, up from 39% in 2001. Production on farms with 2,000 or more head has increased from only 13% in 2001 to 31% of total milk production in 2009.

Smaller operations continue to produce a smaller share of production. Places with less than 500 head accounted for nearly 41% of milk production in 2009, down from 61% in 2001."

Represented graphically the figures speak for themselves. Essentially 3.4% of US dairy farms currently account for approximately 60% of US milk production.

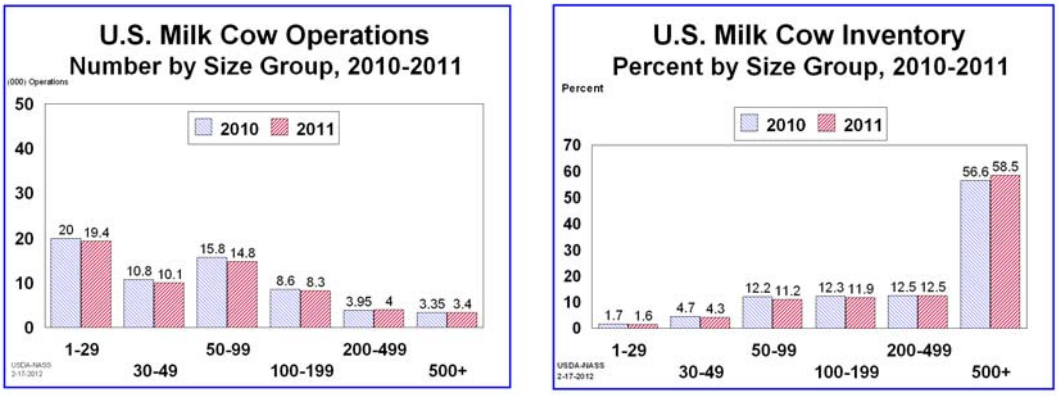

Figure 3: Evolution of scale of production of milk in the US from USDA NASS website

Risk and resilience at scale in large-scale dairying

From this evidence it would seem there is a definite correlation between profitability and scale in housed systems. Personal experience gained from a Nuffield Scholarship in 2008/9 looking at the drivers of success in large-scale US dairying left one of this report's authors in no doubt that well-managed large-scale housed dairies are undoubtedly capable of delivering superior financial, environmental and animal welfare performance.

However two of the major perceived weaknesses of large-scale housed dairy systems are their high capital cost and vulnerability to fluctuations in the cost of purchased feed, which often accounts for a significant proportion (c.50%) of their total cost of production.

The reality is that larger US dairies, despite having high levels of capital investment and buying in a significant proportion of their feed, are consistently operating at the bottom end of the cost of production spectrum and are consequently better able to deal with the often savage volatility of milk prices in that country.

This resilience is borne out by the way in which the US industry has recovered from the price crash in 2009 that saw US farmgate milk prices drop from over $20 per cwt to less than $11 in the space of nine months.

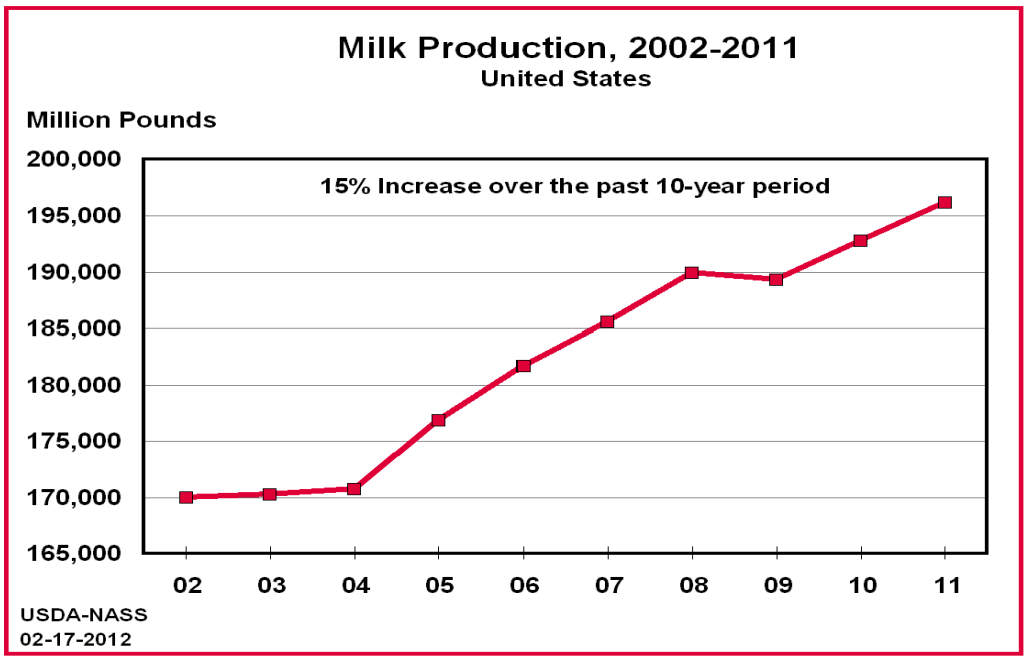

Figure 4: US dairy industry over past 10 years. Source – USDA

Despite a marginal decline in milk output over that period when the vast majority of US dairy farms were losing money, the industry rallied and has recovered more quickly than many observers expected.

This can in part be explained by the way in which large dairies manage price and commodity risk. Far from leaving themselves exposed to fluctuating milk and feed prices, many larger operators hedge input and output prices over increasingly longer time horizons, allowing them to better manage the spread between feed costs and milk price, thus insulating themselves from market volatility.

The most effective example of the worth of this strategy is Milk Source LLC, a business run by three young dairy farmers in Wisconsin that has sustained a prodigious growth rate over the past 10 years and was one of the few dairy businesses that was able to significantly expand production between 2008 and 2010 *(see Appendix 1 – Case Study 2)*.

It is important to recognise that the market for financial risk instruments in dairy commodities is currently better established in the US than in Europe, driven by historical demand and the predominance of the commodity processing sector. However as global markets continue to converge, the emergence of trading platforms such as Fonterra's Global Dairy Trade[15] and other similar trading exchanges will facilitate the development of a more liquid and accessible market in dairy instruments than previously possible. This will certainly underpin the development of sustainable large-scale dairying in Europe.

Conclusions

The lack of data from the relatively small number of genuinely larger scale UK dairies challenges the reliability of any conclusion drawn from the current dataset regarding economies of scale, particularly with regard to intensive housed systems.

Much of the DairyCo data is aggregated across a spectrum of different production systems, which further distorts the picture. This is particularly accentuated by the fact that the point at which one would expect intensive housed systems in the UK to start to demonstrate scale economies, *(i.e. above 700 cows),* is already beyond the point at which diseconomies of scale start to impact on the efficiency of grazing operations.[16]

Furthermore, it is critical to remember that the economic viability of any business is based not only on its ability to generate a sustainable margin per unit of output, but also by the ability of that business to generate a viable absolute return for the owner.

Despite this lack of data, data from the US where intensively housed dairy systems predominate, shows that there is an indisputable link between increasing scale and reducing cost of production, which is clearly supported by

[15] http://www.globaldairytrade.info
[16] http://www.agrifood.info/connections/2007/Beca2.pdf

the on-going concentration of US milk production into the hands of a relatively small number of large-scale producers.

Provided that input cost/output price risk can be managed effectively, then a business continually operating at a lower unitary margin, but generating a disproportionately higher level of output, will ultimately be more viable in absolute terms than one generating a higher margin at a much lower level of output.

It is therefore logical to assume that where scale economies can be achieved and resource constraints and regulations permit, optimum business size will be determined by the point at which absolute risk-weighted return for the owner is maximised rather than margin per unit of output. Indeed, a strategy predicated on the latter would tend to imply potentially significant marginal revenue foregone.

There are significant risks associated with large-scale intensive milk production but mechanisms to manage those risks exist and, in practice, underpin the economic sustainability of these farms as fundamentally as the high level of technical and operational management skill required to run them efficiently.

The environmental and social issues associated with housed dairy production systems are discussed in detail in the subsequent sections of this report but from a purely economic perspective the relationship between scale and economic sustainability in intensive dairying is clear.

The Social and Welfare challenges of large-scale indoor dairies

Defining the issue

Protestors against the development of large-scale farms term them 'mega' or 'super' farms. These terms suggest scale and numbers of animals as the issue, but as efforts to define how big 'too big' is has yielded no tangible answer, the issue appears more complex.

As well as people local to proposed developments raising concerns around impact on their quality of life, animal welfare groups have been at the forefront of campaigning. Some members of the farming industry itself, including a number of farmers, have also expressed apprehension. The concerns raised are complex, from threats to public health to impact on local quality of life, from environmental damage to the economic impact on other producers.

The campaigning has mainly taken the form of attacks on planning applications for large-scale farm developments, although a general PR war has raged in the media and a rash of reports and mini campaigns have been launched by a loose coalition of groups concerned with not just animal welfare but also the natural environment, traditional rural life and organic or extensive farming systems.

It is two and a half years since a proposal for an 8,000-cow dairy farm in Lincolnshire was lodged with the planning authorities and the whole debate about large-scale farming developments kicked off.

It is now clear that we are dealing with a complicated range of subjects that have the potential for significant social impact, including:

- Impact on local individuals' quality of life, including: environmental damage to air, water and habitats; traffic; noise; flies; smell
- The proliferation of low value jobs, mostly using immigrant labour
- Impact on animal welfare

These anxieties – as well as others concerning environmental impact and green-house gas emissions – appear to be grounded in varying degrees in public unfamiliarity with modern food production, concern about the industry as a whole being brought into disrepute, and a fear that established ways of life will be lost and traditional farms will be pushed out of business.

A question of scale

If size really is the issue behind these concerns, no critics of these systems have yet been able to define, publicly at least, the thresholds at which the size of a farm or number of animals becomes unacceptable. Indeed, the chief executive of Compassion in World Farming (CIWF) – a campaign group against large-scale dairy farming – states in his blog[17]:

"… we see the trend toward larger-scale industrialised farming as a real concern. When it comes to animal well-being, scale per se may not be the issue; however, it often indicates a serious underlying threat to animal welfare. Large farms can also pose health risks and, in some cases, have negative effects on the environment."

This position is backed up by other responses from NGOs when pressed to answer the question: "How big is too big" – that it's not an issue of scale in itself, but of a system that threatens to move food production "in the wrong direction". The World Society for the Protection of Animals (WSPA) has recently stated via social media that their view is a 'mega dairy' is: *"..larger than average with little or no access to pasture."*

However, size often seems to be the aspect that catches attention and ignites concern. Social media sites often report 'a new mega farm, with XXXX animals', whether it's dairy, pigs or broilers.

Much was made of Nocton's 8,000 cows, then the revised 3,770 cows in the resubmitted plans, and the physical area the buildings would occupy. The Foston pig development plans to have 2,500 sows – certainly not the largest pig farm in the country – but it's possibly too large a number for those unaccustomed to farming to grasp, especially when it is grossed up to include the number of offspring the sows will have at any one time – 25,000.

The campaign against a recent application for a broiler farm in Shropshire emphasised the 330,000 birds the farm plans to rear at a time. The campaign against a recent application to expand a dairy farm near Welshpool claimed "It's too big and it's too near". For many members of the public who grew up with the image of small mixed farming, developments on this type of scale simply cannot be imagined.

Objections to large-scale farming have increasingly focused on the uncompetitive advantages they have with their economies of scale, and the associated risk that they will put other, smaller dairy farmers out of business. It is true that for a milk buyer, collecting large amounts of milk from one source is more cost effective. The concern is that if purchasing milk from a new large unit displaces milk from a number of smaller farms for a higher value contract, leaving the smaller farmers on a lower value deal, they may not be able to continue in dairy farming.

[17] http://www.acompassionateworld.org/2011/01/is-a-big-farm-a-bad-farm/

Despite these worries relating to size, some recent surprise results found among DairyCo's quarterly consumer tracking research have identified that more than half of consumers questioned don't have a view on the size at which a dairy farm becomes 'too large'[18].

Despite this, one farm in Wales with 1,000 cows on a New Zealand-style system[19] is often in the trade news because of its scale, but always in a positive light. Similarly, producers running smaller year-round housed herds rarely attract attention and are not targeted openly by campaigners.

Hence it can probably be concluded that while size sparks the debate, the system of farming then becomes the more emotive issue.

…or of system?

As indicated previously, system is just as emotive as scale – or maybe even more so. There is a general lack of understanding about how indoor herds live, and to emphasise the 'unnaturalness' of these systems (taking advantage of the dairy industry's continuing reluctance to talk about them) and create a call to action, they are frequently presented as not having yet entered the UK – hence WSPA's rallying cry:

"Britain's dairy industry is at a crossroads. Under pressure to take cows out of fields and put them into US-style mega dairies or factory farms, we are about to see our countryside, environment and milk forever changed. You can help stop this by taking a few seconds to add your name to the campaign."

This is despite hundreds of dairy farmers apparently successfully managing tens of thousands of dairy cows in indoor-based systems in the UK already. The 2012 National Mastitis Survey indicates that although the participants are a self-selected groups, there is an increasing trend towards housing: *"… in 2012 an increasing proportion of milking cows (16% in 2009 and 22% in 2012) are being kept indoors … This indicates larger herds are more likely to permanently house their milkers or at least their high yielders."*[20]

Comparisons drawn by campaign groups between indoor and pasture-based systems are often stark and extreme. For example, CIWF asked supporters to do the following:[21]

[18] AHDB/DairyCo on-line survey YouGov Plc
[19] http://www.ddc-wales.co.uk/client_files/gelli_aur_rhys_williams.pdf
[20] MSD Animal Health National Mastitis Survey 2012 via Farmers Guardian
[21] http://www.ciwf.org.uk/farm_animals/cows/dairy_cows/vote_now_where_do_you_want_our_milk_to_come_from/default.aspx

"Dairy farming is at a crossroads, with indoor 'zero-grazing' on the rise. Please vote in our poll and tell us what sort of future you want to see for Europe's dairy cows – A or B."

Image 2: CIWF campaign presenting extreme differences in dairy systems

Protestors against large-scale indoor developments have focused on welfare issues, and use emotive and misleading language to describe indoor systems, such as 'battery' and 'factory', to conjure up images of animals in dirty, crowded cages, fully confined or kept in the dark. Many of these words have become common parlance in connection with large-scale dairy farms, and also have transferred over to larger scale applications for pig and poultry units too.

Image 3: 'Word cloud' of emotive terminology used against 'factory farming' systems

There was frequent use of such emotive and misleading terminology around the Nocton Dairies' application. For example an IPSOS Mori poll[22] conducted by WSPA used the following statement within the survey:

"There is a proposal for a new dairy farm in the UK, which would produce milk from around eight thousand cows in large indoor dairy sheds. The cows would spend most of the time indoors, only being able to graze outdoors when they are not able to produce milk."

However, when the survey results, were used within an Early Day Motion[23], this had been rephrased to *"factory milk from battery cows"*.

These words have stuck, and it's not uncommon to see the use of such terminology on social media sites as another campaign group lays out its case against a large-scale development.

Another interesting finding recently emerged from DairyCo's quarterly consumer tracking research – that less than 10% associate the word 'battery' with animals kept indoors, and more than half relate it to animals in cages[24]. As cows – in indoor systems or not – are not caged in the UK, the use of the word in this context is clearly misleading.

It could also be argued that the use of 'battery' meaning 'intensive' in relation to indoor systems is borderline too. Dairy cows within an indoor system have just as much room, and frequently more, than cows housed only for the winter period. The forage for the cows is usually grown no more intensively than on any other dairy farm, with similar inputs, and diets still incorporate significant quantities of forage.

Therefore, the main difference in intensity of the system is that the animals do not physically walk to the fields to graze the forage in summer months; instead it is brought to them through mechanisation. Furthermore, permanent housing means a greater degree of automation is required to handle manure, which instead of being spread on fields by the cows themselves, must be collected then spread through mechanical means.

Displacement of family farms

A common criticism of large scale intensive farms is that they drive traditional 'family farms' out of business, thus changing our communities and our countryside for the worse. Certainly a cursory glance at the evolution of the US dairy industry, where 55% of US milk comes from the 3% of US dairy farms with over 500 cows, might seem to support the argument that large can push out small.

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[22] http://www.ipsos-mori.com/Assets/Docs/Polls/WSPA_dairy_Topline_140610.pdf
[23] http://www.parliament.uk/edm/2010-12/942
[24] [24] AHDB/DairyCo on-line survey YouGov Plc

However the decline in producer numbers in the US over the last 10 years, as a percentage of the total, has been no more marked than in the UK or any other EU country, where few if any 'mega dairies' currently exist.

It is worth noting at this point that 'Scale' itself is a relative and context-specific concept. Data from the International Farm Comparison Network (IFCN) would suggest that the average size of all dairy herds around the world currently stands at three cows, with 75% of the world's dairy farmers being classified as 'household' milk producers. It's unthinkable to suggest that the European dairy industry could be remotely sustainable at this scale, yet the inevitable transition from household dairying to what we would recognize as 'family farms', in the developing world, will have potentially far greater social consequences than the evolution of a relatively small cohort of genuinely large-scale dairy farms in Europe.

Closer to home, in the Netherlands where the average herd size is c.90 cows, there is currently a proposal before the Dutch government to limit dairy herd expansion to 500 head (*including youngstock*); a level long since surpassed by many UK dairy farms and exceeded by orders of magnitude in countries such as the US and Saudi Arabia, suggesting that what constitutes 'acceptable scale' is more often than not determined by perceived cultural norms rather than any rational or evidence-based assessment.

Opponents of large-scale dairy farms often try to paint a picture in the minds of consumers of corporate behemoths bulldozing hapless family farms out of the way in their relentless pursuit of profit at any cost. The reality however appears to be somewhat different.

Even the largest dairy farms in the US are still essentially family farms. They may have evolved corporate structures to facilitate the management of their businesses and employ more staff than a traditional family farm, but invariably the name above the door is actively involved in the day to day running of the farm and not a 'faceless suit' sat in an office hundreds or even thousands of miles away.

Successful farmers, like successful small business owners in other industries, are entrepreneurs who are, by nature, opportunists. Which therefore begs the question: is the rise of large-scale dairying a cause or merely an effect of wider demographic changes in the industry? Are those producers, best placed to expand production, driving their less competitive neighbours out of business or simply taking advantage of opportunities created by those leaving the industry as a consequence of a far broader range of socio-economic factors?

The reality is likely to be a combination of both, however this is not unique to dairying. Indeed it is a trend that is well established, not only in other sectors of agriculture, but across the wider economy. Therefore one could argue that to unilaterally impose arbitrary limits on scale, where little if any evidence-based justification for such limits exists, will only undermine the longer-term competitiveness of the industry; and for the incumbents, who have often

invested many years, if not generations-worth of time and capital in building sustainable and competitive businesses, such restrictions could be considered restraint of trade.

Local concerns over quality of life

As with any potentially intrusive development, local communities will want to know what impact the proposal will have on their quality of life and their surroundings. Most of these issues are dealt with under planning law and the Environmental Impact Assessment, and can be summarised as:

- Water – surface and ground water and water resources, to look at whether the proposal will create flooding issues or reduce the quality or quantity of water available in the area
- Air Quality and Amenity – whether the proposal will release any pathogens or pollutants to the air, be it from the farm itself or any anaerobic digestion or other operation, which could affect human, animal or plant life; whether the farm will cause an increase in fly or pest populations and how the farm plans to control this
- Smell – whether the farm itself or any waste operations, including the spreading of slurry or digestate, could cause nuisance or loss of amenity; applications frequently now ask for odour mapping and spreading agreements
- Acoustics – whether the development will cause noise nuisance at any time of the day or night to any nearby property
- Traffic and Transport – whether the development will significantly increase traffic movements and risk of accidents, or whether it will reduce safety generally
- Visual impact – whether the development will be visible from various vantage points and whether that constitutes a blight on the landscape or is out of character with the surroundings; photo montages are increasingly used to show how the development would look in the context of the existing surroundings.
- Lighting – whether the farm's lighting will change the 'night-time' landscape and cause light pollution.

There is no need to go into these in detail, as they are technical issues and failure to satisfy the authorities on any of these may well result in a recommendation for refusal. However, these are important aspects to be aware of because they are valid grounds for objection that are frequently used against planning applications, and are also arguments used in PR campaigns.

One important point to note is that there is now a track record of local campaign groups becoming organised and teaming up with national lobbying and campaign groups to share a common goal of stopping large-scale farming developments. The local groups are mainly concerned about the impacts mentioned above, but they share the aim of national or international objector groups and can feed in critical local knowledge to the campaigns.

Equally, the larger groups can supply essential funding and manpower to local operations. Examples of this have been seen with the 8,000-then-3,770 cow dairy application at Nocton Dairies (CAFFO[25]), the 2,500 pig farm application at Foston (Foston Community Forum), the 1,000-cow dairy expansion at Leighton Farm in Welshpool (CALFe[26]) and the application for 330,000 broilers at Bletchley (Bletchley Broiling Point[27]).

However, it is interesting to note a number of quiet expansions taking place around the UK, with little or no attention. The key difference appears to be the presence of a local campaign group of concerned residents. With no local group, the development often stays below the 'radar' and any national campaign groups lack the critical local contacts to gain traction for the campaign.

The question of animal welfare

One of the reasons it is important to be aware of valid grounds for refusing planning applications is because it is now well known that animal welfare is not considered within planning law. This means that while an objector may be motivated by concerns over welfare, an objection to the planning authorities on that basis will not be included in weighing up the strength of the application.

Despite this, it can be considered that the vast majority of objections in high profile applications such as Nocton Dairies or the Foston pig proposal in Derbyshire are prompted by welfare, as they are largely stimulated by animal welfare groups.

People for the Ethical Treatment of Animals (PETA) maintain it was responsible for 6,000[28] of the 14,000 objections received by the district council reviewing the Nocton Dairies proposal, and more than 5,000[29] were claimed by Compassion in World Farming supporters.

This was largely through the production of a template objection letter and vigorous campaigning through social media, events and advertising. Vegetarian International Voice for Animals also created a template objection letter[30] for its supporters to use. An online petition with 50,000 signatures submitted to the council by campaign group 38 Degrees[31] contained strong wording on welfare:

"…These farms would make a big contribution to climate change and undermine more responsible, sustainable cattle farms in Lincolnshire and the rest of the UK.

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[25] http://www.caffo.co.uk/
[26] http://www.support-calfe.org.uk/
[27] http://www.facebook.com/BletchleyBroilingPoint
[28] http://blog.peta.org.uk/2011/02/victory-for-cows-nocton-dairies-withdraws-cow-prison-application-in-lincolnshire/
[29] http://www.ciwf.org.uk/news/beef_and_dairy_farming/cows_belong_in_fields_campaign_success.aspx
[30] http://www.viva.org.uk/campaigner/planning-application.html
[31] http://www.38degrees.org.uk/page/s/factoryfarm

Keeping cows inside almost all year is cruel and there is evidence that cows kept in factory farms suffer as a result."

The Soil Association – the UK's leading organic certification body – which has been responsible for leading the campaign against the Foston pig farm proposal with its Not in My Banger campaign[32], cites three welfare aims for pigs – a ban on tail docking, outdoor access, and a ban on farrowing crates.

During the campaign against Nocton Dairies, supermarkets were asked for their views about whether they would buy milk for their customers from large-scale indoor dairies. While The Independent reported that supermarkets would blacklist such milk[33], the words used were less clear. In fact, the Dairy Industry Newsletter pointed out that most supermarkets are already sourcing from the largest farms in the country, most of which are indoors-based[34]. Despite that, this does show the retailers will keep a keen watch on public opinion and therefore a perceived lack of public support for such systems could translate into farmers having fewer market options for such milk.

Overall, it can be deduced that welfare and general discomfort with animals being kept indoors are overriding concerns for the majority of those who want to stop the development of large-scale farming. So the question remains as to whether there are genuine welfare concerns over large-scale dairy units and/or mainly indoor-based systems.

The UK is perceived by many to have some of the highest animal welfare standards in Europe, and certainly appears to be in the vanguard when adopting EU legislation changes, for example the ban on sow stalls[35] and the move to enriched cages for battery hens[36].

British dairy farming is governed by a range of welfare legislation and codes of practice:

- The Welfare of Farmed Animals (England) Regulations 2007[37]
- Defra Code of Recommendations for the Welfare of Livestock: Cattle[38]
- Red Tractor Farm Assurance: Assured Dairy Farms[39]

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[32] http://www.soilassociation.org/notinmybanger
[33] http://www.independent.co.uk/life-style/food-and-drink/news/supermarkets-turn-noses-up-at-megadairy-milk-2137056.html
[34] http://dl.dropbox.com/u/45053136/Dairy%20Industry%20Newsletter.pdf
[35] http://www.farmersguardian.com/home/livestock/eu-sow-stall-ban-heading-for-farce-new-figures-indicate/46557.article
[36] http://www.guardian.co.uk/environment/2011/aug/31/farmers-flout-battery-hen-ban
[37] http://www.legislation.gov.uk/uksi/2007/2078/contents/made
[38] http://www.crosscompliance.org.uk/cms/assets/Uploads/PDFs/Cattle-Welfare-Code-2003.pdf
[39] http://www.redtractor.org.uk/site/REDT/Templates/GeneralStandards.aspx?pageid=32&cc=GB

A source of information widely used by objectors to large-scale indoor farm proposals is a comprehensive report on the welfare of the dairy cow, a 2009 report from The European Food Safety Authority's Panel (EFSA) on Animal Health and Welfare, which reviewed a wide range of research on the effects of farming systems on dairy cow welfare and disease[40]. It concluded that the overall need of a cow is to:

"maintain bodily and mental integrity while growing and during adult life. In order to do this, cows have a series of needs that are relevant to the housing and management conditions imposed upon them by humans. A general need of a cow is to have sufficient control of her environment and some ability to choose what to do and when."

It went on to describe the following key points about a cow's requirements:

- *Cattle need to rest for about 12 hours a day; adequate rest is important to prevent fatigue and to maintain normal functions*
- *Foraging behaviour accounts for a large proportion (up to 80%) of the daily activity of cows …[they] therefore need permanent access to a sufficient quantity of material to enable proper investigation and manipulation activities. Cows are highly motivated to work for access to foraging material like straw.*
- *Cows have a natural tendency to explore their environment and they show a fair amount of curiosity.*
- *Cows need social contact with other cows or heifers on a regular basis.*

The EFSA report identified some increased risk of lameness and mastitis from cows housed indoors all the time (as it calls 'zero-grazed'). However, it added:

"…zero-grazing systems differ from pasture-based systems in many respects...It is difficult to determine which of these factors may be responsible for any difference in welfare. Furthermore, there is always the possibility that some modification of indoor housing systems (e.g. using a different type of ventilation or flooring) would raise the welfare of cows in zero-grazing systems to a similar or higher level than found at pasture. For these reasons, any results concerning the effect of grazing on the welfare of cattle must be interpreted with care. It should not to be assumed that providing cows with access to pasture will automatically improve their welfare, or that a high level of animal welfare cannot be achieved in zero-grazing systems (Rushen et al., 2008)."

It highlighted the relative susceptibility of cows to a variety of ailments, depending on whether they are at pasture or whether they are housed. It found that *"…cows kept on pasture are healthier in general"* and reported a number of studies in different countries that found lactating cows without access to pasture suffered from a higher incidence of a variety of health problems.

[40] www.efsa.europa.eu/en/scdocs/scdoc/1143r.htm

Hock and knee injuries were also more common when cows had no or limited access to pasture[41]. However, it also said:

"Cattle at pasture are not all free of welfare problems. Cattle at pasture can be exposed to inclement weather, increased parasite load, flies and gad-flies, inadequate energy intake, toxic plants and high competition for feed if stocking rates are too high. …When the herbage quality is low in digestibility and protein quality, cattle are known to lose more than 10% of their weight (Ritter and Sorrenson, 1985). Cows can lose body condition and weight especially after calving when kept on pasture, which can be a cause for concern (Fontanelli et al., 2005)."

Therefore the issues are not clear cut and the report, which is objective in its conclusions, found there were risks associated with all types of system, large and indoor herds included, but the welfare outcomes depended largely on the level of management in each herd and the mitigation of those risks.

This has not prevented the report being selectively quoted by those campaigning against large-scale developments. Furthermore, the research covers a wide range of European systems (including some that would be regarded as very old-fashioned in the UK, such as tie-stall byres), and does not look at the latest incarnations of large-scale indoor dairy farming systems in the UK. It is probably safe to say that the efforts made to mitigate any negative effects of housing of large-scale herds are in recent dairy farm design are therefore not included and do not form any part of the recommendations.

The Fourth Freedom

The government's advisory body, The Farm Animal Welfare Committee (formerly Council), defined guidelines many years ago for the ideal state of an animal to ensure its physical and mental welfare[42]:

1. Freedom from Hunger and Thirst – by ready access to fresh water and a diet to maintain full health and vigour.
2. Freedom from Discomfort – by providing an appropriate environment including shelter and a comfortable resting area.
3. Freedom from Pain, Injury or Disease – by prevention or rapid diagnosis and treatment.
4. Freedom to Express Normal Behaviour - by providing sufficient space, proper facilities and company of the animal's own kind.
5. Freedom from Fear and Distress – by ensuring conditions and treatment which avoid mental suffering.

The Fourth Freedom – the Freedom to Express Normal Behaviour – is the most contentious as welfare groups maintain that if an animal cannot graze then it cannot express normal behaviour.

[41] Haskell et al., 2006, Rutherford et al., 2008
[42] http://www.defra.gov.uk/fawc/about/five-freedoms/

While the Nocton Dairies application was still live, the British Society of Animal Science published a brief[43] looking at the challenges and advantages of housed cows, which echoed the EFSA findings that there can be advantages to both housing and pasture systems, but that it was largely down to management.

Specifically addressing the issue of the fourth freedom, the article stated:

"…there is concern continuously-housing cows means their normal behaviour is compromised. Scientific evidence suggests the behaviour of cattle housed indoors may be different from that of those housed outdoors, but that there are no behavioural differences between continuously housed cattle and those that are merely over-wintered. Solving problems with one aspect of animal behaviour may create problems with another. For example, grazing may be perceived as being more 'natural', but it may also deprive the animal of shade and create periods of hunger, discomfort and stress in hot, dry weather when grass growth is restricted by lack of water. Given the choice, in summer cows prefer to be fed indoors rather than graze, especially in daytime when temperature and humidity are at their highest. This might be interpreted as an expression of a preference for shade."

Recent research carried out at Harper Adams on cows' expression of choice shows that it is inconclusive whether cows would actually choose to go outside if given the option[44]. It is anticipated that in the spring when the doors are first opened the cows may want to spend some time outside exploring but as a cow has a requirement to spend up to 12 hours a day resting, the type of bedding on offer in the housing has a significant impact[45]. This is not an area that has been examined yet – and could have a major impact if the choice of bedding available is less comfortable than lying in a field. Similarly, more recent research from Harper Adams suggests that method of rearing of the dairy heifer also plays a big part.

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[43] http://www.bsas.org.uk/downloads/BSAS_housingdairy_briefs.pdf

[44] Charlton, G., Rutter, S. M., East, M., and Sinclair, L. A. 2010. Factors affecting dairy cow preference to be indoors or at pasture. In: Proceedings of the British Society of Animal Science and the Agricultural Research Forum, Belfast, UK, 12-14 April 2010. No. 94. http://www.bsas.org.uk/downloads/annlproc/pdf2010/pdf2010.pdf
Charlton, G., Rutter, S. M., East, M., and Sinclair, L. A. 2010. The effect of TMR on dairy cow preference to be indoors or at pasture. In: Proceedings of the 44th Congress of the International Society of Applied Ethology (ISAE), Uppsala, Sweden, 4-7 August 2010. Page 68. http://www.applied-ethology.org/isaemeetings_files/2010%20ISAE%20in%20Uppsala,%20Sweden.pdf

[45] Cook, N.B., T.B. Bennett, and K.V. Nordlund. 2004. Effect of free stall surface on daily activity patterns in dairy cows, with relevance to lameness prevalence. J. Dairy Sci. 87:2912-2922.
Grant, R. 2004. Taking advantage of natural behaviour improves dairy cow performance.
Munskgaard, L., M.B. Jensen, L.J. Pedersen, S.W. Hansen, and L. Matthews. 2005. Quantifying behavioural priorities: effects of time constraints on behaviour of dairy cows. Appl. Anim. Behav. Sci. 92:3-14.

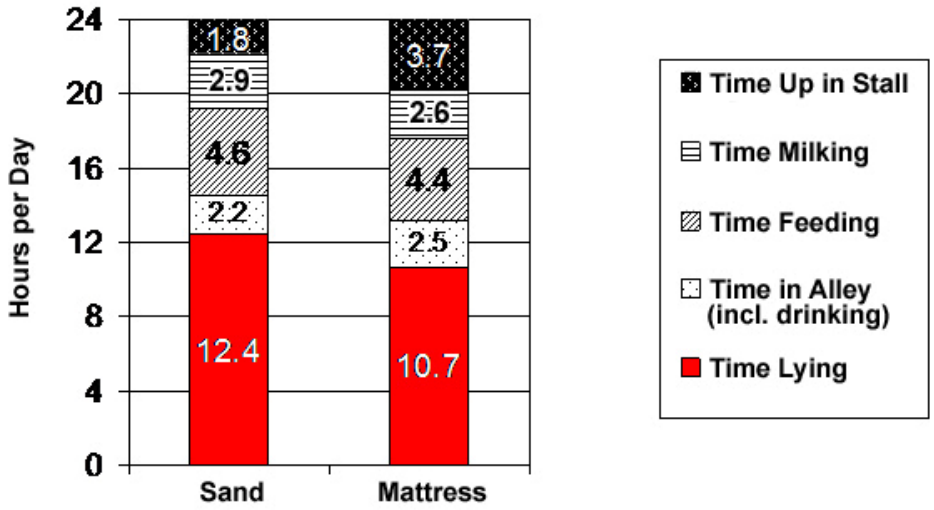

Figure 5: Effect of free stall surface on daily activity patterns in dairy cows. Source – Journal of Dairy Science

It is safe to say that further work is needed on the Fourth Freedom to really quantify what natural behaviour means. The cow as we in the UK know it, has been domesticated as long as cats and dogs, which means that practically any range of natural behaviour could be argued.

For example, there has been much modification of the behaviour of household pets to suit changing human lifestyles. In fact, people for the Ethical Treatment of Animals (PETA) advises owners of cats to keep their pets indoors permanently to reduce risk of harm or even death[46], yet PETA actively campaigns against housed cattle. This proves how pivotal the area of natural behaviour really is in this whole issue of the acceptability of large-scale indoor farming developments.

Assessment of the risks of scale and system

The furore over the Nocton Dairies proposal prompted the government to request an opinion from FAWC on the issues around large-scale or indoor-based dairy herds. It responded in 2010 in a letter[47] to agriculture minister Jim Paice, identifying various pros and cons to both housing and scale. But overall, it concluded that as long as management was adapted to counteract possible drawbacks of large indoor systems, there were benefits on offer and cows could experience a satisfactory level of welfare.

However, the letter also highlighted a lack of research on some aspects of modern indoor-based large-scale systems; the uncertainty over the Fourth Freedom was identified, as were issues concerning greenhouse gas emissions and group size.

The letter outlined the need for more research in some areas and concluded with a salutary message about consumer acceptability:

[46] http://www.peta.org/living/companion-animals/indoor-cats.aspx
[47] http://www.fawc.org.uk/pdf/cows-welfare-letter.pdf

"… it is our view that their objections to highly intensive farming practices will continue unless significant steps are taken to ensure that consumers become adequately and appropriately 'informed' about animal welfare issues."

The use of the word 'satisfactory' was criticised by animal welfare groups and some members of the public, who felt that this was not good enough. This possibly compounds the potential for terminology to confuse the issue.

The view that welfare need not suffer – and in fact could be enhanced – on large-scale indoor units was echoed in an article in the Veterinary Record[48] from Nottingham University's leading dairy cattle vets Martin Green and Jon Huxley. It stated that:

"The application for the UK's first 'super dairy' can be seen as a rational proposal from an industry attempting to counter this prolonged period of poor returns. While many have been shocked by its scale, the idea that unit size per se is a welfare issue is ill-informed."

This prompted a supportive response in the Veterinary Record by leading UK cattle vet Dick Sibley[49], and further backing from the dairy cattle veterinary profession was expressed by British Cattle Veterinary president John Fishwick[50], who said that good welfare relied on good stockmanship and husbandry, regardless of herd size.

Indeed, one common criticism of large-scale indoor farms has been the treatment of animals like machines with resulting poor welfare. However, there is an interesting trend in staffing levels on larger farms. A sample of seven large-scale indoor-based dairy farmers in the UK averaging over 1,000 cows each, gave figures of 100 or fewer cows per member of staff, with the average at 80[51]. This is noticeably lower than estimated industry averages of 120-150 on smaller farms. It would seem that rather than larger farms economising on labour, efficiencies brought about through the reduction of other overheads and of variable costs allow investment in more and increasingly specialised staff, for example vet, foot trimmers and nutritionists.

Hence it would seem that obtaining economies of scale is one of the routes to investing in greater staff numbers and expertise with the aim of delivering ever-better welfare, as it is perceived that this is where the profitability of the herd can be most improved.

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[48] http://dl.dropbox.com/u/45053136/712.full.pdf

[49] http://dl.dropbox.com/u/45053136/Life%20worth%20Living%20Vet%20Record%20797.1.full.pdf

[50] http://www.vetsonline.com/actualites/detail/36673-revues-1/vets-defend-mega-dairy-s-commitment-to-animal-welfare.html

[51] Authors' own survey

Other concerns with housing

Three times a day milking has sometimes been used as an argument against large-scale, indoor dairy systems. However, three times a day milking is not particular to these systems, but tends to be more common in them because cows are close to the milking parlour and easy to get in and out. In research using robotic milking systems where cows choose when and how often they are milked, around three times a day was the natural choice.

The EFSA report looked at milking interval and also concluded that three times a day milking was preferable to twice a day milking in high yielding cows when the twice a day milking couldn't take place at equal 12-hour intervals.

"More frequent evacuation of the udder diminishes the risk of mastitis, although total milking time per day is longer and thus also the mechanical impact of the milking machine on the udder. In practice, however, the balance between the two effects seems to be advantageous with higher milking frequency (Svennersten-Sjaunja et al., 2000), at least if the milking equipment is well adjusted."

It should also be noted that in indoor units, waiting time is often minimal. With cows taking around 8 minutes to be milked, the aim is often to have them out and back to their feed and beds within the hour. This adds up to less than three hours in a day for milking. In pasture-based systems, it is common that cows can take 2-3 hours per milking to come in, wait and return to pasture after milking. This adds up to 4-6 hours a day walking or standing unproductively, even if milking only twice a day.

Another concern expressed about large-scale dairy farming is the transmission of communicable diseases, particularly those that result in culling. In large-scale indoor herds, there are pros and cons.

With Bovine TB, (bTB), there is an incidence of 1 in 1000 average of false positive tests so with large numbers of cows on large-scale farms at the farm, there is a realistic chance that bTB restriction measures will be imposed at some point, whether there is any disease present or not. Again, because of the incidences of false positives, there is a reasonable chance that a large herd could get caught in a long series of 60-day testing with herd movement restrictions. The biggest issue in these circumstances would be managing calves that couldn't be moved off the farm.

However, if cows were housed permanently, risk of exposure to bTB would be considerably reduced. Two large-scale indoor-based farmers in the UK have recently had positive tests following years of being clear. This was following a request from their milk purchaser that they graze some cows as a response to public concern over indoor systems. They complied and both farms tested positive at the next test.

The potential for a disease such as Foot and Mouth Disease (FMD) or other notifiable disease to strike is a scenario that must be considered. If, for example,

there is a FMD outbreak in Britain, then there will be an immediate standstill on all animal movements and the contingency for accommodating more calves, as with bTB, would be implemented.

While the exposure of an indoor herd to pathogens is theoretically lower, should a large-scale farm develop a lesion, arrangements would have to be made to dispose of large quantities of milk until the case was proven or ruled out. In the event of a FMD case being confirmed on a large-scale farm, then current regulation is that all animals must be slaughtered. With the growth of herd sizes and the presence now of around 20 or more herds with more than 1,000 cows in the country, it would be timely to investigate whether contingency plans, such as vaccination, may be considered as an option.

Staff and careers

Large-scale dairies should, in theory, offer more opportunities for skilled job creation than smaller family farms, where key roles are invariably reserved for family members. The structure of a large-scale unit means differentiation of roles and stratification of management are essential, but also offer a genuine career path for new entrants and motivation for staff – something which has been greatly lacking in attracting new entrants to the industry. Overcoming the antisocial nature of working hours would be one major benefit alone.

Furthermore, scale of operation would allow the provision of employee benefit schemes (pensions, healthcare etc), allowing a better quality of life for individual employees. Large-scale dairies are also more likely to invest in formalised CPD structures and staff training.

Communication

Farmers, generally, have not been renowned for their communication with local communities. Indeed, communication probably hasn't been seen as particularly necessary until recently, as the potential negative impacts of large-scale farming have been publicised.

It is interesting to note that among seven of the UK's largest dairy farmers, five proactively produce a newsletter, host open days or engage with the local parish council[52]. It is likely that as farms get bigger, farmers will need to engage with neighbours and communities so that they can better understand their plans, express concerns when they arise so they can be quickly resolved, and act as a way of building mutual trust and understanding. If this is in place by the time a large-scale indoor farming application is lodged, the chances of objections will be much lower, and of success, much higher, if national groups cannot commandeer a local power base for their activities.

[52] Authors' own survey

Conclusions

That there is public resistance to large-scale farming developments is clear. To date, no high profile planning application for a single new large-scale farming unit has been approved in the UK. All have either fallen down on technical grounds or are still ploughing through ever increasing and changing hurdles. A quick survey[53] of the applications that are quietly gaining approval against those that encounter problems or fail reveals a more complex matrix of socially-led criteria that suggest whether an application will encounter issues or not.

Figure 6: Factors suggesting why some livestock developments are more controversial than others

Factor	Least Resistance	Most Resistance
Scale	Under 1,000 animals	Over 1,000 animals
Precedent	Already in existence – expansion only	New greenfield development
Enterprise type	Typical to that area/familiarity among communities and planners	Atypical in that area/unfamiliar to communities/planners
System	Involves outdoor access/ perceived freedom of movement	Permanent housing
System	In line with common perceptions of system for that species	Perceived as a novel system for that species
Proximity to neighbours	Distant, with no sensitive groups nearby	Close/bordering, with schools, hospitals, retirement homes etc
Local communities	Largely rural, long standing, strong association with local agribusinesses	Large percentage of incomers, affluent, less connection to local agribusinesses
Applicant	Long history in the area	New to area/absentee farmer
Applicant	Has establish communications routes and engagement with communities	No existing routes of communication or engagement with communities

Ironically, while EFSA highlights the potential for higher welfare in grass-based systems, evidence shows that modern large scale systems in the UK hold the potential for delivering very high welfare because they are built around the need of the animal.

But welfare is not a consideration under planning and is therefore, ironically, more subject to campaigning by charities and single interest groups as there is

[53] By this report's authors

no regulatory body involved to 'rule' on the planning application in the same way as the Environment Agency or SEPA would give an opinion on the environmental aspects of the plan.

Local impact can mostly be dealt with through measuring and quantifying aspects such as light, noise, smell, traffic etc. However, that does not eliminate the fear that many have of the unimaginable scale of these developments.

Overall, it is the novelty of these developments that make them easy material for objectors to work with. This was brought to light in a quote from a WSPA spokesperson, who, in a Farmers Weekly interview[54], said:

"WSPA was looking for a campaign that would show it could be just as effective at home as it was abroad. Nocton fitted the bill perfectly. We were looking for a cause to raise our profile with our UK supporters. Nocton appeared out of nowhere and fitted everything we stood against. We were completely opportunist."

Creating significant adverse publicity through well-orchestrated campaigns serves to place even more pressure on regulators and specialists, who are also largely unfamiliar with the type of developments being proposed. It would only be human to take a highly precautionary stance in the face of such overwhelming public noise.

But until the welfare facts are communicated and the public are brought up to speed with the other imperatives facing our food production systems, the emotive issue of animals being kept indoors and away from their 'natural environment' is likely to continue to create a barrier for the introduction of these systems.

[54] http://www.fwi.co.uk/Articles/24/02/2011/125674/Stopping-the-39super-dairy39-the-inside-story.htm

Intensive Livestock, Scale and the Environment

Emotion v Evidence

The debate about large-scale animal agriculture and its impact on the environment is one of the most contentious and emotionally charged of all environmental issues.

Proponents of large-scale livestock production argue that it is the most resource efficient and thereby the most environmentally benign way to meet the growing world population's seemingly insatiable appetite for animal products. Opponents argue that large-scale intensive livestock production is resource inefficient, highly damaging to the environment and presents an unacceptable public health risk.

As with all such arguments the reality is often to be found somewhere between the two seemingly irreconcilable positions.

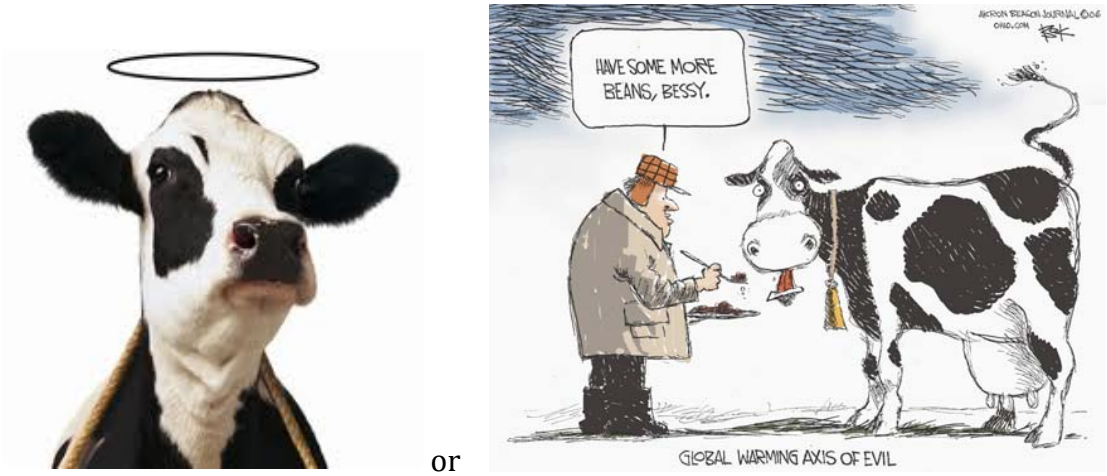

Image 4: There is little consensus in the debate over large-scale dairy farming

As with the issues around animal welfare, when discussing the environmental sustainability of housed dairy systems, one needs to be conscious of whether the issues are scale or system related. At an individual cow level the there is little to differentiate an animal in a herd of 50 from one in a herd 5,000 cows. But often the risks, the optimum mitigation strategies and the potential benefits at a business level are invariably linked to both the system of production and the scale of the operation.

Clearly the failure of a manure storage facility on a single 5,000 cow or 30,000 pig operation would have far greater environmental impact than multiple failures on much smaller units, however this hazard needs to be assessed against the potential for those failures to occur, the prevention and mitigation measures in place to ensure that they don't, and the overall level of resource efficiency and environmental impact of the day to day operation of the business.

It should also be recognised that while it is right to be concerned about the impact of a large-scale environmental incident, the size of a farm does not increase the likelihood of a pollution incident occurring. The Environment Agency handled over 9,000 water pollution incidents in 2010, many of which were from existing small scale farmers, as well as water companies and industrial plants.

Livestock's long shadow?

In 2006, The UN FAO published a report entitled 'Livestock's long shadow – environmental issues and options'[55] that highlighted the significant impact that animal agriculture has had and continues to have on the environment

Image 5: Livestock's Long Shadow, published 2006 by FAO

Its conclusions were that animal agriculture accounted for 18% of all anthropogenic greenhouse gas emissions (in CO2 equivalence), was responsible for 8% of the world's freshwater usage and contributed significantly to environmental degradation, stating that the livestock sector was: *"…probably the largest sectoral source of water pollution"* and that *"…70% of previously forested land in the Amazon is occupied by pastures, and feed crops account for much of the remainder"*.

This report rapidly became the 'go to' text for the anti-large livestock farming lobby, citing it as *prima facie* evidence of the contribution of the livestock industry's contribution to environmental damage. However what was often overlooked in the analysis of this report was that by far the largest component of this environmental footprint was attributable to land use change, particularly in developing countries.

Consequently there were considerable regional variations in the environmental impact of livestock production. In developed countries, where land use change was not considered to be a significant factor, higher productivity achieved through intensification of production, more efficient resource use and improved technical performance invariably led to a much reduced environmental footprint when measured at a unit of output level.

The effect of intensification of production on greenhouse gas emissions, particularly from the dairy sector, are discussed separately in this report but in terms of overall resource use there is clear evidence that intensification of livestock production can significantly reduce its environmental impact.

[55] Livestock's long shadow- environmental issues & options UN FAO 2006 http://www.fao.org/docrep/010/a0701e/a0701e00.HTM

According to Capper et al 2009[56] total resource usage by the US dairy industry per unit of output has declined significantly over the past 60 years. Their paper "The environmental impact of dairy production: 1944 compared with 2007" concluded:

"*A common perception is that pasture-based, low-input dairy systems characteristic of the 1940s were more conducive to environmental stewardship than modern milk production systems. The objective of this study was to compare the environmental impact of modern (2007) US dairy production with historical production practices as exemplified by the US dairy system in 1944.*

A deterministic model based on the metabolism and nutrient requirements of the dairy herd was used to estimate resource inputs and waste outputs per billion kg of milk. Both the modern and historical production systems were modelled using characteristic management practices, herd population dynamics, and production data from US dairy farms.

Modern dairy practices require considerably fewer resources than dairying in 1944 with 21% of animals, 23% of feedstuffs, 35% of the water, and only 10% of the land required to produce the same 1 billion kg of milk.

Waste outputs were similarly reduced, with modern dairy systems producing 24% of the manure, 43% of CH4 , and 56% of N2O per billion kg of milk compared with equivalent milk from historical dairying. The carbon footprint per billion kilograms of milk produced in 2007 was 37% of equivalent milk production in 1944.

To fulfil the increasing requirements of the US population for dairy products, it is essential to adopt management practices and technologies that improve productive efficiency, allowing milk production to be increased while reducing resource use and mitigating environmental impact."

Much of the improvement in performance can be attributed to advances in animal and plant genetics. However given that to fully exploit this improved genetic potential requires the adoption of modern management practices, then viewed holistically, the evolution of milk production in the US over the reference period, from an essentially pasture-based model in 1944 to an almost exclusively intensively-housed model, has had a profoundly positive impact on the environmental footprint and resource requirement of milk production.

CAFOs and specific risks to the environment

Viewed holistically at an industry scale, the majority of available evidence points to a direct link between intensification and resource efficiency in livestock production.

[56] **The environmental impact of dairy production: 1944 compared with 2007** J. L. Capper, R. A. Cady and D. E. Bauman J ANIM SCI 2009, 87:2160-2167 http://jas.fass.org/content/87/6/2160

However as economic forces rationalise the livestock industry into fewer larger production units, the emphasis on environmental risk effectively shifts away from per unit resource usage to the potentially increased environmental risk posed by single concentrated point sources of pollution. The term CAFO or 'Concentrated Animal Feeding Operation' defined by the US environmental protection agency as:

"*Agricultural operations where animals are kept and raised in confined situations. CAFOs congregate animals, feed, manure and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures, fields, or on rangeland."*

This is quantified in terms of animal number as any operation with over 700 dairy cows or 2,500 adult/finisher pigs, 30,000 laying hens or 125,000 broiler chickens. These are threshold levels above which permits are required to ensure compliance with environmental regulations particularly relating to discharges to the environment[57].

But CAFO has become the generic term for large intensive livestock units in the US. Consequently it is increasingly used pejoratively by the environmental and animal welfare movement as a symbol all that is wrong with modern intensive livestock production.

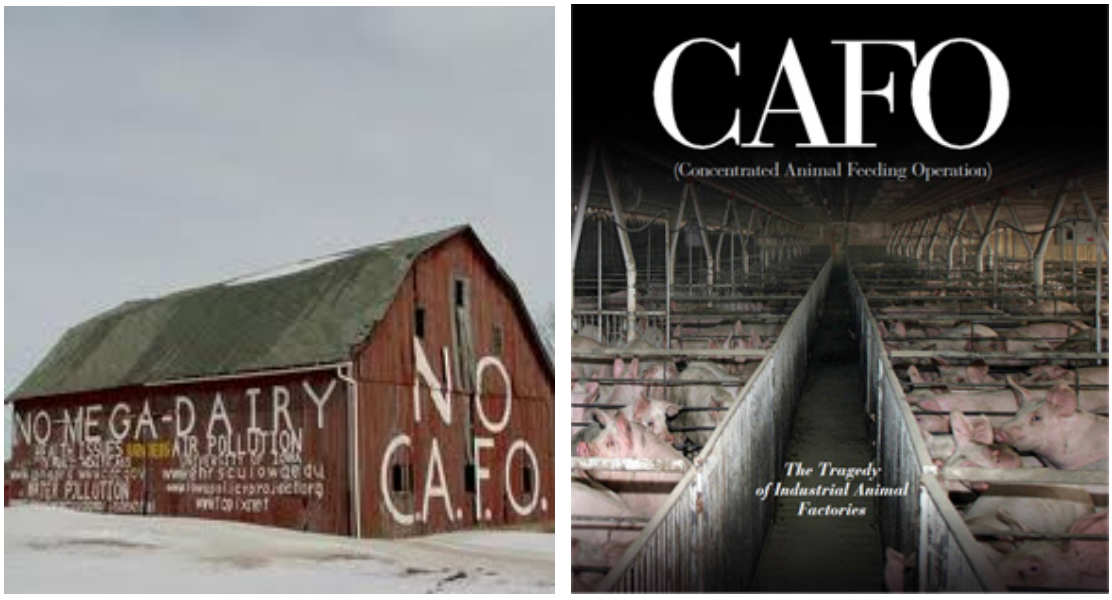

Image 6: the term 'CAFO', while technical, has negative connotations

The USA effectively pioneered the development of large-scale animal agriculture and has a much longer history than most other countries of dealing with the challenges that the evolution of this sector has presented. Therefore it is not surprising that as the sector has evolved over time there have been, as part of the learning process, numerous well documented incidences of environmental pollution arising from less than optimal management of large numbers of livestock in highly concentrated facilities.

[57] http://www.epa.gov/region7/water/cafo/index.htm

However these experiences have yielded a far better understanding of what constitutes best practice in the management of CAFOs, and regulation has evolved over time to ensure that those practices and comprehensive environmental impact assessments are a prerequisite of both the permitting process and ongoing management of large-scale intensive livestock facilities[58].

Jim Ostrom of Milk Source LLC, who operates five Dairy CAFOs collectively milking approximately 20,000 cows in Wisconsin, summarised this in an interview regarding environmental safeguards that are in place for his 8,000 cow Rosendale dairy in Fond Du Lac county, the largest in the state.

'The farm is the first in Wisconsin to have to file an environmental impact statement. The dairy will have to install around 80 groundwater monitors where it plans to spread manure. Critics say it should be about 900, citing manure-tainted wells near Green Bay – but that's three counties away, amid 41,000 cows on smaller farms that handle manure by traditional methods.

Rosendale, by contrast, is watched by hostile critics with the Department of Natural Resources on speed-dial. The partners, said Ostrom, all have children they're hoping will inherit the business. "We owe it to them not to be imbeciles.[59]*"*

Image 7: the Green Tier programme logo

The state of Wisconsin Department of Natural Resources has been particularly proactive in working with all industry, not just agriculture, to reconcile the requirements of businesses with the need to safeguard the environment. The Green Tier programme http://dnr.wi.gov/topic/GreenTier is a voluntary assurance standard built around ISO 14001 Environmental Management Standards that requires the planning implementation and continuous review/action of a set of management standards designed to ensure the environmental sustainability of the business going forward.

Compliance with the environmental standard is independently audited and requires a not inconsiderable amount of administrative and management time on behalf of the business. Consequently it is unlikely to be taken up by many traditional scale family farming operations due to the disproportionately high cost in terms of time and financial commitment relative to their income.

However for larger operations where environmental compliance is increasingly heavily scrutinised, the independent validation that an internationally recognised standard brings provides a greater degree of reassurance for all stakeholders that the business in question is operating in an environmentally sustainable way.

[58] http://cfpub.epa.gov/npdes/afo/aforule.cfm
[59] http://www.jsonline.com/news/opinion/82436072.html

Borlaug and Townshend, a tale of two farming systems

Far from the monocultural image that objectors like to portray, large-scale dairy farming has the potential to return farming practice to tried and tested traditional concepts, for example the Norfolk four course rotation, which combines livestock and arable for optimum benefit.

The rotation, attributed to the 18th century Norfolk landowner and agricultural reformer Charles 'Turnip' Townshend was, until the advent of Norman Borlaug's 'Green revolution' in the latter part of the 20th century, the foundation of agriculture in the UK. The concept of combining livestock with root crops, cereals and legumes provided a virtually closed loop system that drove increases in agricultural productivity to effectively underpin the UK's emergence as the leading industrial and military power of the 18th and 19th centuries.

Global population growth in the 20th century necessitated another quantum leap in productivity, delivered by Norman Borlaug with the development of dwarf cereal varieties and the subsequent intensification of crop production that this allowed.

In the UK, the combination of these new technologies, CAP price support and low cost fertiliser underpinned by cheap oil, drove a process of intensification and rapidly increasing scale in arable production, particularly in the East of the country, that was incongruous with the prevailing model of traditional mixed farming. Consequently over six decades we have witnessed a migration of particularly grazing livestock from the East to the West of the UK to make way for ever larger arable farms.

As we move into the 21st century we face a changing set of challenges and an effective reversal of many of the forces that shaped the UK agricultural landscape in the last half century. Rising energy and nutrient prices, the removal of direct price support and the emergence of novel pests and diseases are starting to challenge the long term sustainability of an arable system based around winter wheat and winter oilseed rape.

The rapid spread of herbicide-resistant blackgrass alone threatens the viability of this rotation due to the limited window of control opportunity and rapidly diminishing arsenal of effective chemical control measures.

Similarly the importation of increasingly expensive nutrients to grow crops that are subsequently incorporated into livestock rations and fed to animals hundreds of miles away, with no corresponding return of those nutrients in the form of manure, would seem to be, from a resource efficiency perspective at least, a less than optimum strategy. Furthermore, this is at a time when global demand for finite plant nutrients is growing at an unprecedented level and the concept of 'peak phosphorus' proposed as a future limitation of agricultural productivity growth[60].

[60] http://www.foreignpolicy.com/articles/2010/04/20/peak_phosphorus

Figure 7: Evolution of world price of phosphate fertilser1960 -2007

Manure applications to grassland in the UK are in essence controlled by Nitrate Vulnerable Zone regulations and therefore it is Nitrogen content that determines the rate at which manure is often applied, particularly in areas of high stocking density.

This however is not necessarily the most efficient use of manure nutrients due to the fact that whilst animal manures are a good source of both nitrogen (N) and phosphorus (P) for agricultural crops, they have an imbalance in their N to P ratio, so that if they are applied to meet crop N needs, then P is over-applied.[61]

For many years, manures have been applied to meet crop N needs or simply to dispose of manure within maximum allowable application rates, which has resulted in the accumulation of Phosphate in some intensively managed grassland at levels far beyond its agronomic optimum and often to the point where it is lost to groundwater through leaching or run-off. Such a process is both an inefficient use of a finite resource as well as a potential source of environmental degradation.

In many countries including the US and parts of the EU, regulations have been developed to limit P losses from manures and soils high in P by moving manure nutrient management from an N basis to a P basis.

This is especially relevant when one considers that the UK's net phosphorus balance, i.e. the net surplus of Phosphorus application relative to crop offtake, is amongst the highest in the EU.

[61] Impact of Changing From Nitrogen- to PhosphorusBased Manure Nutrient Management Plans Rory Maguire, Assistant Professor, Crop and Soil Environmental Sciences, Virginia Tech http://pubs.ext.vt.edu/442/442-310/442-310_pdf.pdf

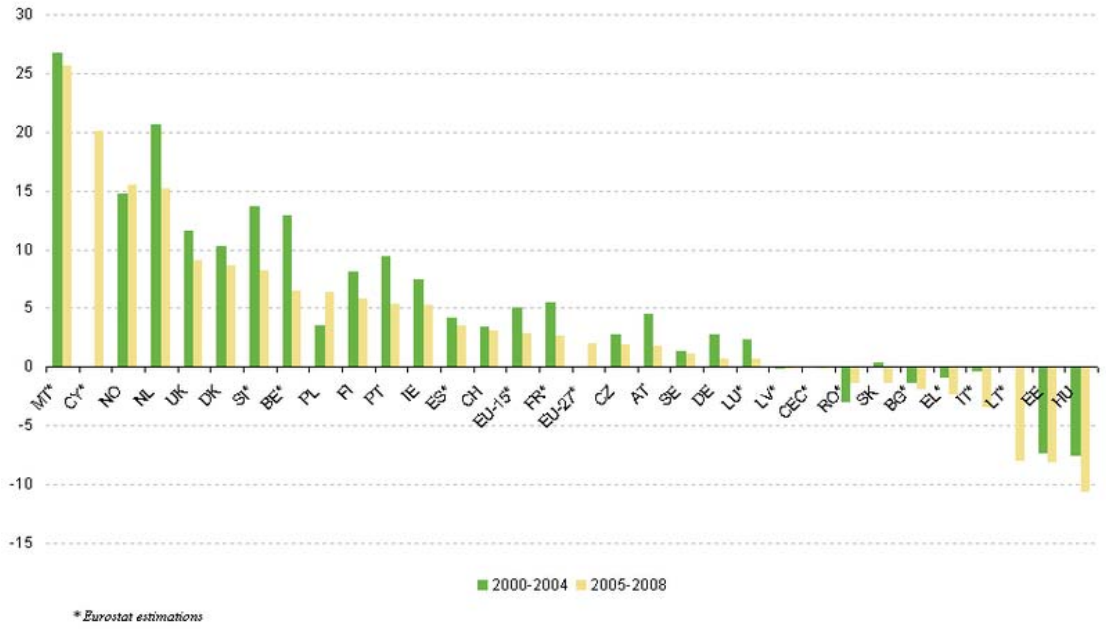

Figure 8: Graph showing Net phosphorus balance for all EU countries 2000- 2008

The potential introduction in the UK of controls on phosphate applications, that already exist in Ireland and other EU states to comply with the EU Water Framework directive, may force a rethink of manure management and change the focus from purely nitrogen to phosphorus loading as the limiting factor for manure application to agricultural land[62].

Back to the future

The redistribution of livestock production within arable areas of the UK may provide a potential solution to some of these new sustainability challenges facing UK agriculture. The integration of pig and poultry with arable cropping is well understood and numerous examples of intensive and extensive systems exist within the UK. Dairy however, due to the requirement to change cropping patterns to incorporate forage crops, poses a different set of challenges but equally offers some unique benefits.

Incorporating crops such as maize or lucerne into winter sown arable rotation provides a viable spring cropping wholecrop and 3-4 year leguminous forage crop that would broaden arable rotations, reducing pest and disease pressure, and allowing a wider range of weed control strategies to be used.

When one considers that many arable crops, particularly roots, require significant Phosphate application, then the potential synergies between large-scale livestock and large-scale crop production systems start to become increasingly attractive *(see Appendix 1 – Case Study 3).*

[62] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Phosphorus_balance_in_agriculture

Add to this the benefit of nitrogen fixation and soil structure improvements offered by the deep rooted legume lucerne (alfalfa), and the savings in nutrient costs and potential increase in soil organic matter achieved through the utilisation of manure and/or digestate, and the potential synergies begin to build.

Access to land to grow high quality forage crops and spread the substantial quantities of manure generated by large herds of housed cows is another potentially major benefit of locating feedlot dairies in arable areas as is the increased proximity to potential sources of arable crop processing by-products.

Many large-scale pig producers in the UK and the continent have already seen the significant benefits – both agronomic and financial – that regular applications of manure in place of inorganic fertiliser can deliver.

JSR Farms in East Yorkshire, one of the UK's largest pig and arable farming businesses, reported net benefits of £235,000 from utilising the manure from 3,500 sows plus 35,000 progeny across 3,500 ha of arable land in 2010[63].

These comprised a saving of £135,000 *(£195,000 nutrient value less £60,000 of spreading costs)* on fertiliser purchases plus a further £100,000 in increased yields over crops grown on land using purchased inorganic fertiliser alone.

Additionally there is a significant potential environmental benefit in terms of the carbon offset from reduced synthetic Nitrogen fertiliser usage. Fertiliser manufacturer Yara estimates the average embedded carbon footprint of Ammonium Nitrate produced in Europe in 2010 to be 7.8kgCO_2e per kg of N[64].

On that basis the carbon offset associated with the substitution of manure for nitrogen fertiliser at a NMax of 175 KgN/ha manure derived nitrogen *(to comply with current NVZ regulations for arable land)* equates to 1.365t CO_2e per ha.

Even if one applies a lower Nitrogen use efficiency rate for manure nitrogen *(i.e. 50% of inorganic fertiliser N)* and current EU best practice carbon footprint for Ammonium Nitrate of 4kg CO_2e/KgN, then the net saving still amounts to a considerable 350Kg CO_2e per ha per annum.

Assuming the N content of cow slurry to be 3 Kg N / m3 and that a dairy cow produces 25m^3 slurry per annum[65], then using the same 175 kg NMax application rate assumes an implied stocking rate of 2.33 cows per arable hectare. On that basis the manure from a 3,000 cow dairy unit applied to around 1,250ha of arable crops would deliver a Carbon saving of at least 450 tonnes CO_2e per annum in reduced nitrogen usage.

[63] http://www.terrapinn.com/2012/agri/data/ph.pdf
[64] http://www.yara.com/doc/29293_2010_Carbon%20footprint%20of%20AN%20-%20Method%20of%20calculation.pdf
[65] http://www.defra.gov.uk/publications/files/rb209-fertiliser-manual-110412.pdf

Despite many arable farmers' concerns over accuracy and timeliness of application and potential crop and soil damage, modern high capacity application technology enables slurry or digestate to be applied with far greater precision over a longer application window without compromising crop performance or damaging soils.

Image 8: Application of slurry to arable crops using modern low impact equipment

JSR Farms have successfully used Yara sensor variable application technology to tailor slurry applications according to crop needs, improving the accuracy of application and minimising nutrient losses.

Redistribution of livestock as a means of reducing environmental impact

The distribution of large dairies at a relatively low density across an essentially stockless arable landscape would further reduce the potential environmental impact at a catchment or landscape level, particularly compared to areas of very high livestock density, albeit on smaller units in traditional dairying areas.

Whilst many critics of large intensive livestock systems point to the potential risk of environmental pollution, the risk to groundwater from manure application is predominantly related to stocking rate and the consequent rate and timing of manure application.

One could therefore argue that 5,000 cows on a single, purpose built dairy with state of the art manure management systems and infrastructure in place to contain all effluent and 5,000ha of crop land available to spread manure, represents a far lower risk to the environment than 50 units of 100 cows concentrated in a smaller overall area of grassland.

However when one considers that the ultimate reason for Nocton Dairies' withdrawal of its planning application was because of unanswered questions regarding the potential risk to groundwater, it is clear that both understanding and clear guidelines around environmental management of large livestock units in the UK are lacking. Consequently, this has reduced confidence among regulatory authorities to grant planning permission for such units.

There is therefore a clear need for the industry to work with regulators and other relevant stakeholders to develop a clear, robust and evidence-based framework for the objective assessment of such applications in the future.

Large, intensive, housed livestock units do have an obligation to ensure, *ex-ante*, that their activities will not compromise the environmental integrity of food production. But equally, if this can be demonstrated and adequately managed, then regulators need to take a balanced and holistic view of the economic and environmental benefits that such proposals can offer.

The current adherence to the precautionary principal on the basis of insufficient evidence of lack of confidence in existing systems is a major hurdle that needs to be overcome if this issue is to be resolved.

Anaerobic digestion

Anaerobic Digestion (AD) is a technology that has a potentially significant role to play in the environmental management of large-scale livestock production in the UK.

The economic case for AD on large-scale livestock units is increasingly compelling. An established feed-in tariff structure provides long term security of income for energy generated from Biogas mitigating the risk inherent in the considerable investment required to install the technology. Additionally a well-established Biogas industry in Europe means that technology risks are minimised through the availability of range of systems and operational experience to suit an individual farm's needs.

Whilst manure alone has a relatively low gas output, when combined with energy crops or other feedstocks, the technology has the potential to deliver a valuable income stream, and provide an excellent hedge against rising energy prices, whilst reducing methane emissions and odours from manure.

Image 9: Anaerobic digestion

In a paper written in 2000 entitled 'Anaerobic Digestion: Holistic Bioprocessing Of Animal Manures', Ann Wilkie of the University of Florida Dept of Soil and Water sciences concluded:

"Anaerobic digestion, under controlled conditions, offers a holistic treatment solution that controls odors [sic], produces usable energy, minimises environmental impact from waste emissions, and maximises fertilizer and water recovery and reuse.[66]*"*

This was based on observations that AD was increasingly being installed on large livestock units in the US, primarily to minimise manure odour risks associated with large-scale livestock production systems. Anaerobic digestion can reduce manure odours by 80-95% compared with unprocessed manure, due to the almost total destruction of odour-causing volatile compounds in the digestion process.

The technology is now considered a 'hygiene factor' for new large-scale dairies in the US and an essential part of their license to operate within the 'zero discharge' obligations of increasingly exacting CAFO regulations and environmental permitting processes.

This proved to be of particular value to Kenn Buelow of Holsum Dairies in Wisconsin when applying, in 2006, to build the second of his two dairies that currently accommodate a total of 7,800 cows.

To support his case, he approached local residents to ask for a testimonial backing up his claims for environmental compliance – with regard to odour emissions – from the first 3,300 cow dairy…which they readily provided. In a letter to the Town of Gibson Board regarding Holsum Dairy, a 3,300 herd dairy operation, the Town of Rantoul, in Calumet County, Wisconsin said:

"The digester setup, which has been constructed at this site, has virtually eliminated all manure odors [sic].... Taking into consideration the number of animals at this site, the aroma is better than one would expect from a 100-cow operation without a digester."

Holsum Dairies was duly granted a permit to build a 4,250 head facility three miles from the first dairy, creating an 8,000 cow business which was the first dairy farm to comply with the State of Wisconsin's 'Green Tier' Environmental management standard, and is now acknowledged to be one of the most sustainable and environmentally compliant dairy farming businesses in the US (*see Appendix1 – Case Study 4).*

[66] Anaerobic Digestion:Holistic Bioprocessing Of Animal Manures Ann C. Wilkie Soil and Water Science Department University of Florida, 2000 http://molecol.ifas.ufl.edu/images/wilkie1.pdf

Carbon emissions

The dairy industry particularly has come under attack in the past for its contribution to greenhouse gas emissions. Activists and reporters have claimed that the carbon equivalent emissions from ruminant livestock are far more significant than from other sources and that the only option is to kill cows to save the planet.

Yet at the same time, we need to produce more food. Global population is growing exponentially. By 2030 we will, if predications are correct, have 9 billion mouths to feed. Against this backdrop there are many other challenges. Climate change will affect agricultural production and water availability. Energy shortages and limited fossil fuel resources will result in increased pressure for bio-energy, using limited land area. The only way around this will be to produce more food from fewer resources – so called sustainable intensification.

These buzzwords are becoming more commonplace. It is now widely acknowledged that the mantra of 'more from less' will become the driving force in world food production. But if we set the carbon agenda against that of food production, where does that leave us? Can milk production be justified in the future, particularly in the developed world, and will there be pressure on milk production systems and even where milk is produced?

The reality is that the UK has a world-class dairy industry that is well placed to reduce carbon emissions and meet the increased demand for food.

The recent UN FAO report 'Greenhouse Gas Emissions from the Dairy Sector' showed that global milk production, processing and transportation contribute just 2.7% to the world's total man-made greenhouse gas emissions, and just 4% when emissions relating to meat production from dairy-related cattle are included. The global average GHG emissions per kg of milk and related milk products are estimated at 2.4kg CO_2 equivalent.

What is interesting, however, is that this figure is much lower for milk produced in efficient milk-producing countries such as the USA and Western Europe. These countries, with more intensive and larger scale milk production systems, have a carbon footprint averaging 1.5 kg of CO_2 per kg of milk produced.

The UK results are even better. DairyCo data (2011), collected by The E-CO2 Project, shows a national average of 1.3kg of CO_2 per kg of milk produced *(echoed by the Food Climate Research Network)*, and some of the most efficient producers were achieving results of less than 0.8kg. What this means is that we are producing milk with a carbon footprint of less than half the global average, with our most efficient producers doing so at a third of the rate.

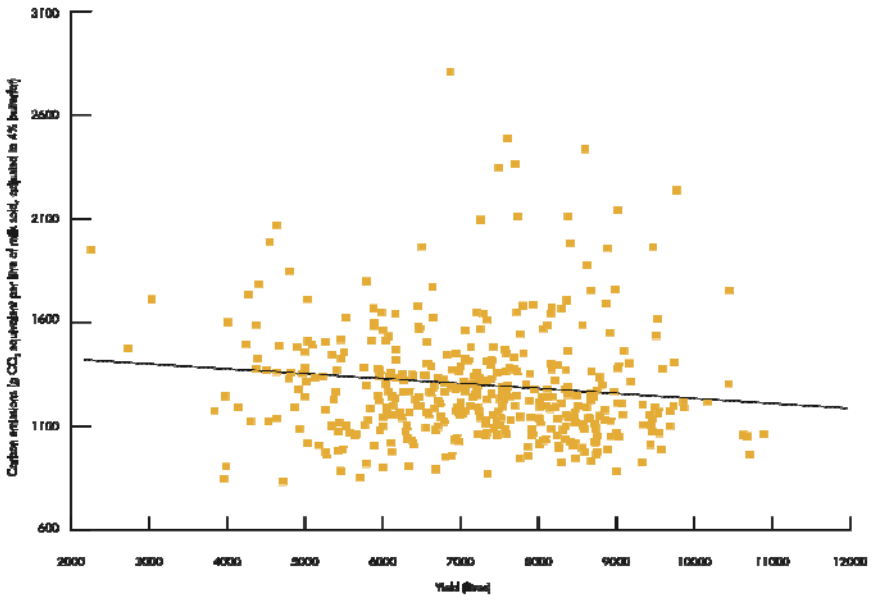

Figure 9: Comparison of average yield vs. CO_2e emissions/ litre. Source – DairyCo, 2011

That's all very well, but it doesn't particularly point to a sustainability advantage associated with larger intensive production systems, such as housed cows. Yet further analysis of the data shows that as average yield per cow rises, average CO_2e emissions fall *(see Figure 11)* as a result of the maintenance element of methane emissions being spread over a larger number of litres.

Further analysis of data shows that efficiency measures such as feed rate and replacement rate also show a direct correlation, in that the higher a herd's feed rate and replacement rate, the higher the associated CO_2e emissions/litre. This is illustrated on the following graphs:

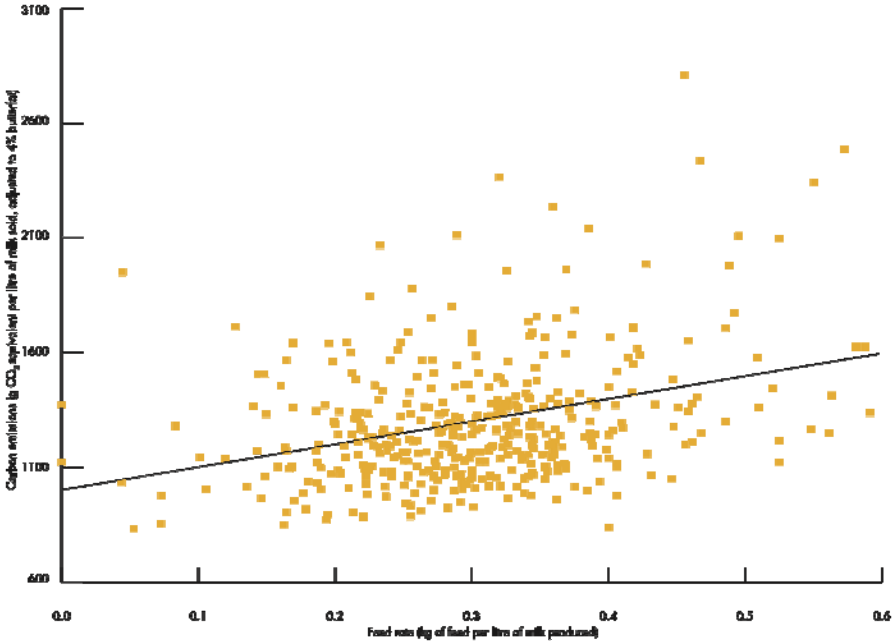

Figure 10: Comparison of average feed rate vs. CO_2e emissions/ litre. Source – DairyCo, 2011

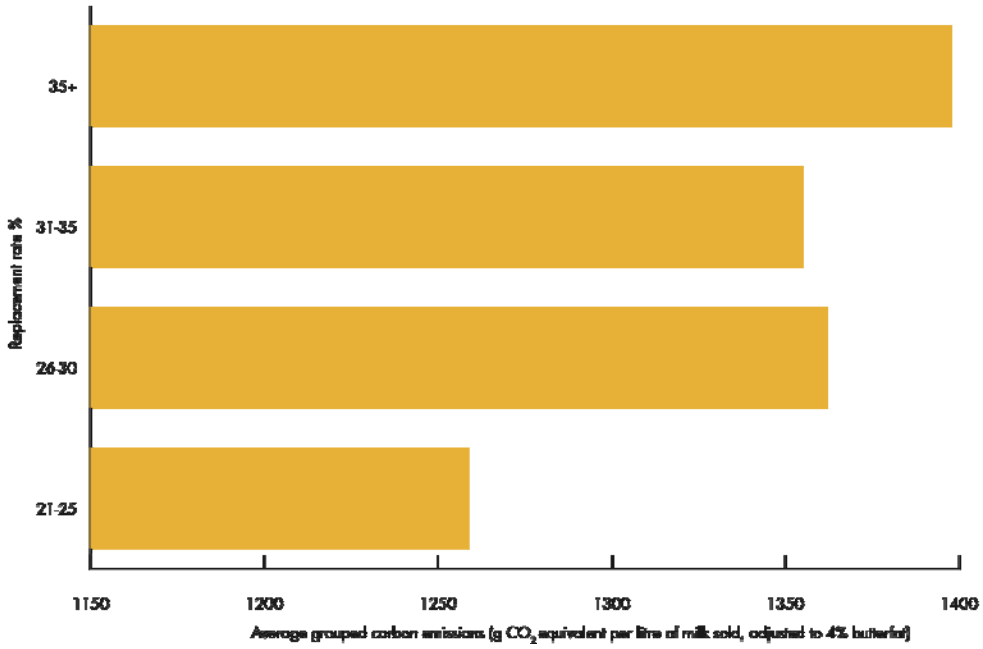

Figure 11: Comparison of average yield vs. CO_2e emissions/ litre. Source – DairyCo, 2011

Overall this makes it clear that efficient production – systems that maximise output and minimise inputs – are the best solution to low carbon footprints from milk.

Does herd size have an impact? Well the graph below suggests that there is no clear correlation between herd size and carbon footprints.

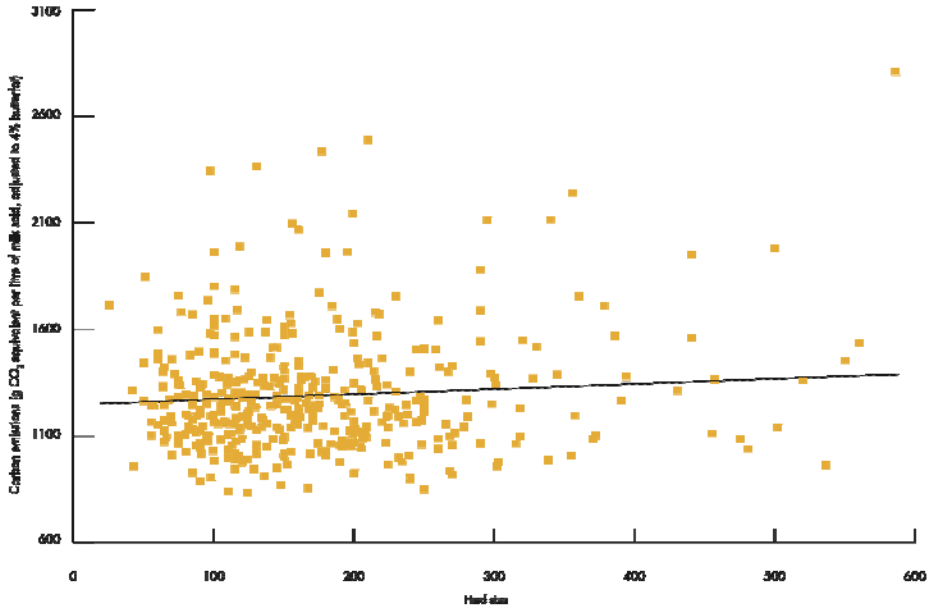

Figure 12: Comparison of herd size vs. CO_2e emissions/ litre. Source – DairyCo, 2011

In practice many of the most efficient herds in the country, and those with the lowest carbon emissions, are the large, well-managed, intensive production systems that achieve high health and welfare and exceptional production performance.

The split of CO_2e emissions is shown below, and the largest contributors are enteric emissions from rumen fermentation *(40%)* and concentrate feed use *(26%).* Yet when correlated with CO_2e emissions, no one factor accounted most for the variations between farms and there is no strong trend between production system and CO_2e emissions, so large herds don't necessarily score highly here, although many are very efficient and would have lower average CO_2e emissions.

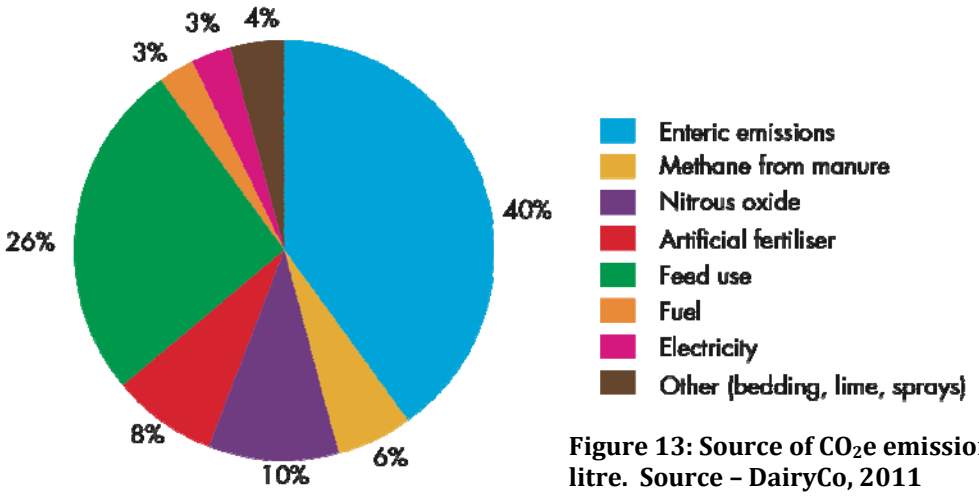

Figure 13: Source of CO_2e emissions/ litre. Source – DairyCo, 2011

Conclusions

Despite the considerable amount of negative publicity around large-scale intensive housed livestock production, there is a mounting body of evidence that not only can these systems operate in an environmentally safe and sustainable way at scale, but the environmental management systems and technology that can be economically deployed on larger scale units can deliver highly sustainable production systems that minimise the environmental impact of their operations and maximise resource use efficiency.

Whilst large-scale livestock operations may historically have been allowed to be built and operated at a sub-optimal level of environmental compliance, those days are very much in the past.

The standards of construction and environmental impact assessment, monitoring and management that are a pre-requisite of the planning/permitting process today, ensure that virtually all of the mistakes of the past cannot and will not be repeated.

Regulatory scrutiny of large-scale units particularly in the UK, where environmental regulations are amongst the most exacting in the world, will only add to the already significantly enhanced environmental safeguards that are established best management practice.

The rising price of fertiliser and current and increasingly rigorous environmental regulation, particularly around issues relating to air and water quality have forced a rethink of how manure is valued and managed. New and emerging technologies will enable that value to be fully realised, effectively reversing the status of manure from potential liability to valuable asset.

Those same economic and environmental pressures will potentially open up new opportunities for the increased integration of large-scale livestock production with large-scale crop production systems to synergistically enhance the long term sustainability and profitability of both.

There is however a clear need for the development of UK specific environmental management systems for large-scale livestock farms that will allow proposals to be more objectively assessed and to deliver the requisite level of confidence in the standard of environmental management of such units for all stakeholders.

Regarding carbon emissions, overall, the conclusion is that efficiency is key – efficient production is the most effective way of delivering low carbon emissions per unit of output, regardless of production system. Farmers should therefore focus on increasing output (within the constraints of their chosen production system), making best use of slurry, improving feed efficiency, reducing replacement rates and using energy efficiently.

This fits perfectly with the 'more for less' message. If we can increase cow yields by 2% per year for a decade and take average yields from 7,000 to more than 8,000 litres per cow, then our carbon figure per litre would fall by more than 20%.

Whilst it is hard, if not impossible, to discourage production in countries with the highest carbon outputs per litres of milk (such as India, Africa and Asia), the reality is that they are not well placed to meet the demand of hungry populations.

The climate in these areas does not suit high-yielding dairy cows, and power and transport infrastructures are inferior. If we are to have a truly sustainable global dairy industry then production in well-developed countries such as the UK, with climates that suit high output dairy production should prevail.

Large, housed UK herds, with a strong focus on efficient production and herd health and welfare, will be carbon efficient – possibly among the most carbon efficient in the world. And the UK dairy sector needs to be encouraged – at all sizes and in all production approaches – because it has a critical role to play on the world stage in terms of sustainable milk production.

Discussion

There are undoubtedly numerous and significant risks that accompany rising scale and intensification of livestock production. The considerable initial capital investment and the on-going cost of compliance with an ever increasing raft of environmental and animal welfare regulation, coupled with the political minefield that is stakeholder engagement, clearly acts as a deterrent to all but the most single minded entrepreneurs.

The UK however is not immune to the relentless process of innovation and economic rationalisation that is transforming agriculture around the world, as the global industry addresses the challenge of sustainably feeding a rapidly growing population.

As an industry we need to look beyond an historic inward focus on both our market and traditional methods of farming if our livestock industry is to remain competitive in a future with less market regulation and greater exposure to commercial and environmental risks.

True Sustainability has three pillars: Economic, Social and Environmental, each with its own unique set of challenges, but all of which must be addressed in concert before an individual business or indeed an entire industry sector can claim to be genuinely sustainable.

In the short term economic viability and risk management are the most immediate and major drivers of business success and it is clear that in a deregulated market there are clear links between scale and profitability in intensive livestock systems.

Where such businesses have emerged elsewhere in the world they have had to address the social and environmental challenges that accompany this change in scale of production.

Invariably there have been lessons learned from this process, not all of them positive. But there is an increasing body of evidence that not only can large-scale intensive livestock production systems meet their social, welfare and environmental obligations, but the management systems that have evolved to do so and the technology that such businesses can afford to employ can yield significant additional and synergistic sustainability benefits beyond the reach of many smaller businesses.

As an industry we are already witnessing an inexorable trend towards increasing scale of production. If one assumes that this process is an evolutionary one then the question becomes how far and how fast should that process be allowed to progress?

Fifty years ago a herd of 50 cows would have been considered large. Today herds of 500+ cows are commonplace and accepted in the UK. This would certainly have shocked or even appalled previous generations, yet it is simply the evolution of an industry. Why therefore should a sustainable and well managed herd of 5,000 cows be any less acceptable in the future or indeed the present?

Which gives rise to the vexed question of displacement of traditional family farms; one of the more emotive arguments used to undermine the case for large-scale production systems. This is, however, a rather regressive argument, given the clear evolving trend across all sectors of UK and indeed global agriculture to larger scales of production driven by a host of socio-economic and technological factors. Dairy farming is not immune from those.

Few UK dairy farmers exiting the industry cite competition from larger dairy farms as a significant reason for quitting milk production and it could be argued that given that UK production is so significantly below quota, then there is plenty of room for new entrants or expansion of those businesses with the capacity and capability grow. A similar argument could be applied to both the pig and poultry sectors.

Despite assertions from the anti-large farming lobby that large dairies are institutionally funded corporate behemoths, this is simply not the case. They are invariably family businesses that have grown organically from a more traditionally recognisable scale; often as a consequence of better than average technical and financial performance coupled with a desire to grow and a mindset that can adapt to the changing management demands of larger scale production; not least the transition from managing cows to managing people.

In the US where over 60% of the nation's milk comes from farms of over 500 cows and 35% from farms of over 2,000 cows, even the largest businesses are predominantly family owned. They have developed corporate structures to facilitate day to day management but more often than not, the owner is actively involved in the day to day running of the business and is not a 'faceless suit' in an office hundreds or even thousands of miles away.

The fact that these producers have, to a man, profited from efficient milk production and consequently expanded production as opportunities arose, to better exploit their technical and commercial ability underlines an old cliché that 'good small businesses do not stay small for long', particularly in a competitive industry that clearly favours scale of production.

One must therefore ask the question: Are these businesses profitable because they are large or are they large because they are fundamentally profitable? And if the latter is the case, are they not best placed to sustainably drive the industry forward in an era of increasing global competition?

The UK's varied climate, market and broad resource base would indeed tend to suggest that in the post quota era, there will continue to be opportunities for different systems of production to succeed. However one can readily envisage a continued polarization of the sector towards both high and low input systems.

Efficient grass-based milk production, something that due to the limitations of climate is not achievable in the majority of US and many European states, will always be competitive in the UK and will limit the extent to which large-scale intensive production systems might impact on the UK dairy sector. There is no doubt that grazed grass is the cheapest way to produce milk, particularly in areas of relatively abundant rainfall and long growing seasons, as is the case in much of the west of the UK.

A low cost grazing model is without doubt an appropriate production system in such a situation. However there is no reason why that cannot coexist with larger scale more intensive systems that sustainably and profitably utilise a completely different set of resources, such as arable crops and co-products, complementing existing crop production systems and maintaining a diversified yet profitable production base within the UK dairy industry.

Whilst the market will ultimately dictate the economic sustainability of such businesses, they will however need to be able to clearly demonstrate both their environmental and social sustainability '*ex-ante*' if they are to be granted the requisite permits to begin construction or expansion.

This in turn will require a robust evidence base and established best practice measures to provide the necessary reassurance to regulators, planners and the growing legion of other stakeholders that are invariably drawn into the permitting process.

In 2015 EU milk quotas will be removed, ushering in a new era of milk production in Europe. This will bring challenges and opportunities for all European producers. Those countries with forward looking, fundamentally sustainable dairy sectors will be far better placed to exploit those opportunities and far less vulnerable to external competition in their domestic markets.

Which brings us full circle back to Nocton Dairies. In light of this paper, it appears the farm could have delivered a highly innovative and sustainable business model with the potential to transform the way we view both livestock and crop production in the UK. One cannot help but wonder whether history will judge it to have been merely an expensive gamble or a missed opportunity.

Appendix 1 – Case studies

Case study 1 – Fair Oaks Farms

'No one makes money from sick or stressed cows' *Gary Corbett, CEO of Fair Oaks Farms in 2008.*

Fair Oaks Farms (www.fofarms.com) in Indiana, milks 30,000 cows on 10 units arrayed across 10,000ha of irrigated crop land. The business is one of the largest in the US and represents intensive dairy farming on a truly industrial scale. However the owners understand better than anyone the fundamental link between animal health and welfare and commercial sustainability.

Fair Oaks business model is therefore built around ensuring that every one of their 30,000 cows' needs are optimally met and that standards of animal comfort and husbandry are as high as any in the industry. The farm sells approximately 12,000 litres of milk per cow per year to the liquid retail sector. This is achieved without the use of Bovine Somatotrophin (rBST). Their low cull rate means that the business is able to sell surplus heifers each year, or potentially expand their operation without buying in replacements; a good indication of a well-managed, healthy herd.

Consequently Fair Oaks is one of the most efficient dairy farming businesses in the United States and operates at a long run cost of production 25-30% below the US industry average. Their environmental track record is equally impressive, operating to the most exacting, 'zero discharge' regulations in the industry and capitalising on the value of energy derived from the anaerobic digestion of manure.

In the spring of 2012 the farm began converting a fleet of trucks to run on biomethane derived from their own AD plants. The trucks operated by Ruan Transport Corp, deliver 1.25 million litres of milk from the farm to processing plants across the South East of the US every day, saving fuel costs and offsetting carbon emissions in the process. This is one of many examples within this business of how commercial and environmental sustainability can by delivered synergistically at scale[67].

Fair Oaks Farms are proud of what they have achieved, so proud that they have built a dedicated visitor centre and conduct daily farm tours to promote what they do to the general public, which has proved extremely popular.

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67 http://www.progressivedairy.com/index.php?option=com_content&view=article&id=7927:fair-oaks-pioneers-model-for-expansion-of-biomethane-use&catid=77:manure&Itemid=121

They now welcome around half a million visitors a year to the farm to see cows in their working environment and learn about the business of modern dairy farming. Not only has this proved to be a very successful PR venture and has dispelled many of the myths around how modern large dairies operate but also generates a significant revenue stream for the business.

In early 2012 Fair Oaks farms announced plans to extend this model to the pig industry in a joint venture with Belstra Milling Co to develop a 2,500 sow commercial pig unit complete with visitor centre that would dovetail with the existing Fair Oaks Dairy Adventure[68].

The objective of the project is to demonstrate, as they have with the dairy visitor centre, that commercial, large-scale intensive livestock production is sustainable on all levels and that far from compromising animal welfare or environmental impact, the financial performance and sustainability of the business is dependent on ensuring that the highest standards are achieved and maintained across all aspects of the business.

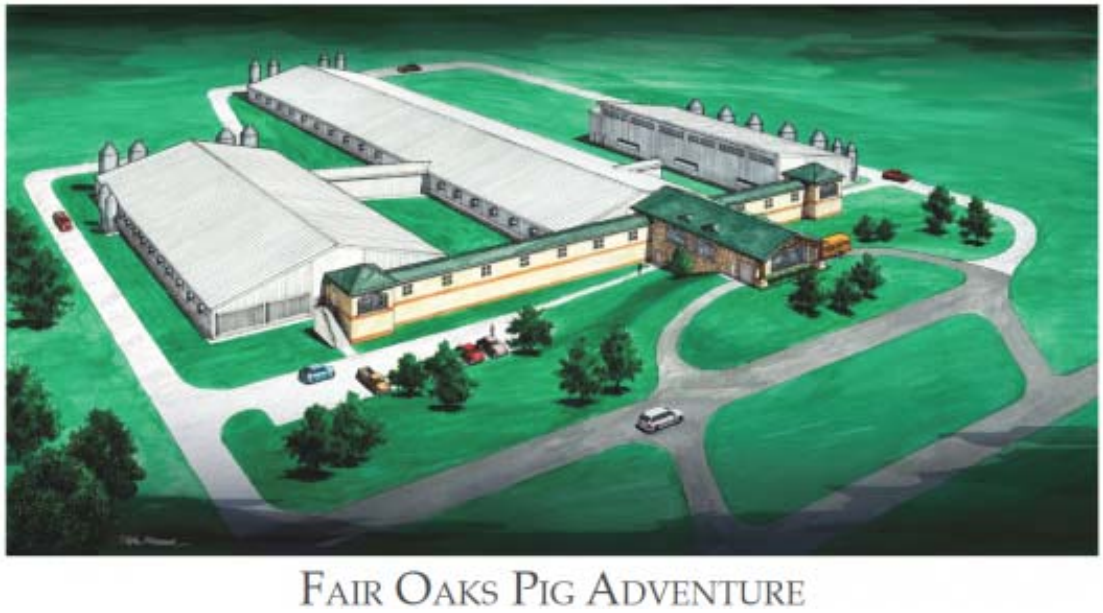

Image 10: Artist's impression of Fair Oaks Farms / Belstra Milling Co's proposed 2,500 sow breeder unit and visitor centre due to open in early 2013

68 http://www.feedstuffs.com/ME2/dirmod.asp?sid=F4D1A9DFCD974EAD8CD5205E15C1CB42&nm=&type=news&mod=News&mid=A3D60400B4204079A76C4B1B129CB433&tier=3&nid=8C7D20CB5BBE47A59DF499A9452E1276

Case study 2 – Milk Source LLC

Milk Source, www.milksource.com was founded by Jim Ostrom and Jon Vosters in 1994 when the two partners purchased the Vosters family dairy farm, then comprising 150 cows. They subsequently embarked on a period of aggressive expansion to supply the growing demand for milk in the Mid-west and taking advantage of low cost loans available through the US farm credit system to purchase what they considered to be undervalued agricultural land.

Image 11: Jim Ostrom

As land and milk prices rose they increasingly leveraged their assets to expand the business, acquiring more land and more cows each year.

Ostrom understood that to sustain this expansion he needed to borrow money and thus had to ensure he could service his debt. Knowing how much cash he required to service borrowings and drive the business's growth agenda, Milk Source's philosophy is to hedge its position on both feed inputs and milk sales over as long a time horizon as it can secure its target margin over cost of production.

Whilst in doing this the business might forego potential revenue at times of high milk price, or more accurately periods where the spread between milk price and feed price are high, this disciplined approach to risk management has ensured a steady free cash flow after debt servicing, that drives the business's growth.

John Vosters (dairy operations) and the third partner Todd Willer (field operations) are responsible for ensuring the dairies operate at consistently high level of technical performance while Ostrom is responsible for overall financial management and business expansion.

And it appears to be working. In October 2008, just as the global banking crisis was starting to bite, the company was milking nearly 12,000 cows on three sites. They had just completed construction of the first phase of Rosendale dairy, an 8,000 cow facility in Fond du Lac county and were about to begin stocking it with 4,000 cows.

In the subsequent three years, Milk Source has completed the development at Rosendale to its current 8,000 cow capacity and in the spring of 2012 commenced operations on another 4,000 cow greenfield dairy at Grand Marsh.

They are currently building another 4,000 cow dairy at Richfield that is scheduled to come on stream in the spring of 2013.

Image 12: The tanker loading dock at Milksource's 8,000 cow Rosendale dairy in Wisconsin

This growth, whilst remarkable enough in its own right, is even more extraordinary when one considers that it was financed using borrowed money during a banking liquidity crisis and a global downturn in milk prices. It clearly under-lines the critical importance of professional risk management in sustainable large-scale dairying.

Image 13: The proposed Richfield Dairy

Jim Ostrom's vision is to build a business of 40,000 cows within a two hour flight of his base in central Wisconsin by the end of the decade. His track record to date would tend to suggest that these are not empty words.

Case study 3 – Three Mile Canyon Farms

Image 14: Aerial view of Three mile Canyon showing the irrigation layout

Located on the south bank of the Columbia River near Boardman in Oregon, Three Mile Canyon farms is an excellent example of how large-scale intensive livestock production can be integrated with arable and vegetable crop production to deliver a commercially and environmentally sustainable business model.

Belonging to RD Offutt Co, the largest potato grower in the US, the farm comprises 35,000ha of land, of which approximately 16,000ha is cropped under centre pivot irrigation, making it one of, if not the largest irrigated farms in the US. The principle cash crops are 2,000ha potatoes 600ha of onions and 1000 ha of vegetables.

It is also home to 22,000 dairy cows plus youngstock, on three dairies, two of which are managed under a joint venture agreement with a major Midwestern dairy farming business, the third is leased to an independent dairy operator. Forage for the cows in the form of corn silage and alfalfa along with wheat and soybeans are grown effectively as break crops within the vegetable rotation.

The manure from the cows is processed through an anaerobic digester to produce biogas to that in turn generates the majority of the farm's energy needs.

The resulting digestate is separated into liquid and solid fractions, the liquid being used to 'fertigate' crops via the farm's irrigation system while the solid is combined with green waste compost produced on site from municipal green waste to provide a solid fertiliser/soil conditioner that is applied to the farm's sandy soils to increase nutrient and organic matter levels.

Potato and Vegetable by-products are recycled back through the cows providing a truly closed loop production system. The integration of the dairies into the large-scale arable and vegetable production system has resulted in a considerable reduction in purchased fertiliser use and facilitates the dairy's compliance with its Zero Discharge CAFO permit obligations

Image 15: Aerial view showing two of the three 7,500 cow dairies, heifer feedlot, green waste composting facility and some of the 200 centre pivot irrigators that provide water and nutrients to 16,000 ha of cropland at Three Mile Canyon Farms

The farm has developed an environmental management plan which is woven into a broader Corporate and Social Responsibility framework[69] to ensure that all resources including the 135,000,000m^3 of irrigation water it abstracts annually from the Columbia River are managed responsibly and efficiently.

The irrigation system comprises 246 centre pivot irrigators that are centrally monitored and controlled by computer via a 100sq mile Wi-Fi network to ensure optimum water and nutrient application rates and to detect any mechanical faults or leaks that would impair system performance and lead to a loss of water and potential issues of soil erosion and nutrient loss.

[69] http://www.threemilecanyonfarms.com/pdfs/2005_corporate_social_responsibility_report.pdf

Whilst breathtaking in scale and level of investment, the business model is a very simple one and is essentially a modern recreation of the Norfolk four-course rotation, a centuries-old farming system developed in the United Kingdom, combining livestock, grain and root crops and legumes to create a diversified resource efficient and resilient farming model.

Three Mile Canyon Farm's scale has effectively combined modern technology and management practice with the fundamental sustainability of a traditional mixed farming system to deliver a commercially viable, resource efficient large-scale farming business well adapted to meeting the challenges of sustainable food production in the 21st century.

Image 16: the use of modern technology is integral to efficient management

Case study 4 – Holsum Dairies

"We want our dairy to be an example of agriculture contributing positively to the community. We have developed strong links in our community, economically, environmentally and socially." *Kenn Buelow DVM, Holsum Dairies, LLC*

Holsum Dairies at Chilton in Wisconsin milks 8,000 cows across two sites that were constructed in 2001 and 2006 respectively. The business run by vet turned dairy farmer Kenn Buelow was the first dairy farm in the state to receive accreditation under the Green Tier programme.

Image 17: Aerial View of Holsum Irish Dairy, Chilton, WI

Compliance with the Green Tier programme was considered by Buelow to be a fundamental component of the business's Corporate and Social responsibility agenda and key to their gaining stakeholder acceptance as one of the first large dairies to be built in a state that has traditionally been the stronghold of traditional US family dairying.

The compliance process required considerable investment of time and resource to achieve and Buelow agreed that as such it is likely to be out of reach of all but the largest operations. However, given that these businesses pose the greatest potential risk to the environment in the event of a breach of environmental safeguards then it is certainly a worthwhile investment, and represents the environmentally responsible mindset of a business with sustainability at its core.

Holsum Dairies is a good example of innovation and sustainability in large-scale dairying. Buelow, a native of Wisconsin, was a practicing vet for 20 years running a large herd management group in New Mexico, the state with the largest average herd size in the US.

In the late 1990s he recognised the increasing economic and environmental challenges facing large-scale dairying in the South West of the US particularly around future water and feed security, and began to look to his native mid-west for opportunities for develop a sustainable large-scale dairy business.

With the financial backing of a large family-owned trust fund that had been a client of his in New Mexico, Buelow secured a 75 acre site in Calumet county Wisconsin to build a 3,600 cow dairy.

The business model was a simple one; to sustainably produce quality milk at the lowest possible financial and environmental cost per litre. This would be achieved by focusing management activity on the core value drivers for the business, outsourcing of non-core activities, exploiting the potential value of waste streams and effectively managing risk.

The trust would act as sole financier to the business, providing both debt and equity at commercial rates, avoiding the need for bank finance in the capital structure of the business and all the issues that that would entail. The investors had confidence in Kenn's ability to manage a large dairy business and thus the counterparty risk to them was considerably reduced.

The proposed model separated infrastructure and operations, with the business divided into two separate corporate entities: a property company that would own the site and the dairy infrastructure; and an operating company that would own the cows and be responsible for all dairying operations.

Holsum Irish Dairy, was built on Irish Road, Hilbert, Wisconsin in 2001 for 3,600 Holstein cows housed for 365 days a year in free-stalls (cubicles) and milked though a single 72-point rotary milking parlour, operating 24 hours a day on a 3-shift system.

Milk is sold locally to a cheese manufacturer supplying cheese to the pizza market. Supplying a commodity market enables the business to accurately hedge the value of its milk sales as the contracted milk price is linked by a transparent mechanism to the value of cheese and cheese derivatives traded on the Chicago Mercantile Exchange (CME).

The only land that the business owns is the 75 acres that the dairy buildings, feed pads and digestate lagoons stand on. All non-core operations i.e. forage production, harvesting, calf and heifer rearing, milk haulage and manure spreading, are outsourced to local farmers and contractors.

This approach significantly reduced the amount of capital required to establish the business as it avoided the substantial outlay required to purchase land for forage production. The rationale behind this was that, provided input price risks were adequately managed, the core dairying activity offered a significantly higher return on investment than holding land did. The trust had a sufficiently diversified investment portfolio to carry the managed risk associated with outsourcing of feed production.

The success of this strategy was contingent on the establishment and maintenance of strong relationships with local farmers and contractors with clear pricing mechanisms for contracted crops that allow all parties to hedge their positions, as required, in a fair and transparent way.

Consequently Kenn developed a pricing mechanism that links the price paid for corn (maize) silage and alfalfa (lucerne) haylage to the market value of dry corn and soybeans respectively, which the contracted growers would otherwise grow.

Image 18: significant stocks of feed are required for the dairy

Additionally the contracts are conditional on growers taking, pro-rata to their contracted area, all the manure from the dairy in the form of separated digestate with 50% of the value of nutrients (N, P&K) in the digestate available in the first year offset against the price Holsum pays for forage.

Holsum organises all harvesting operations through local contractors to better manage harvest logistics and the quality of work done and to further reduce costs for all parties.

The forage contracts are structured in such a way that a typical grower earns 10% more in net profit terms supplying Holsum Dairies than he otherwise would growing corn and soybeans for the general market. This arrangement works extremely well in practice, with 40 growers contracted in 2008 and demand for the digestate so high that Kenn was in negotiation with suppliers to increase the value of the offset to 75% of available nutrient value for 2009, to reflect its increasing value as a fertiliser.

All manure is processed through an anaerobic digester to produce Biogas which in turn is burned in an onsite Combined Heat and Power (CHP) plant to generate electricity and hot water.

All electricity generated is sold to the local grid, in order to obtain maximum carbon credits, and any requirement for the dairy is purchased back at commercial rates. The recovered heat is used to maintain digester vessel temperature, provide hot water for the dairy and heat the floors of the free-stall buildings in winter via an underground heat matrix. This prevents slurry freezing to the concrete in the very cold winter temperatures common in this part of North East Wisconsin.

Image 19: the CHP plant at Holsum Elm Dairy

The digested slurry or 'digestate' is separated and the solid fraction retained as free-stall bedding, effecting a saving of more than $150,000 a year over the cost of buying and recycling sand. Having passed through both the cows and the anaerobic digester, the solids are by this stage pretty much inert and therefore provide a comfortable and hygienic bedding medium.

Using digested manure solids (DMS) as free-stall bedding requires careful management, but does avoid many of the costs and logistical challenges of using sand, particularly when anaerobic digestion is an integral part of the manure handling process, without compromising cow comfort. Work at Cornell University has shown that somatic cell counts and mastitis incidence in well managed systems using DMS are statistically no different to sand based systems and in some cases improvements in environmental hygiene were reported.

This would be supported by the experience at Holsum dairies, but Kenn pointed out that regular stall grooming and topping up with fresh material every other day was essential to maintain a healthy environment. This is not a problem given the volume of solids generated. In fact for Kenn, it also provides a significant source of revenue for the business, as he is able to sell 30 truckloads of separated solids a week, at $15 a tonne, to other dairy farmers to use as bedding.

Image 20: Separation of solids from digestate stream

This income stream effectively covers the salary cost of the two unit managers employed to look after the day to day running of the business.

The separated liquid fraction is stored in a sequence of settling lagoons, and used as fertiliser for forage crops. The combination of solid separation and post separation settling, essentially removes the majority of the phosphorous bearing particles from the manure stream.

This is a major benefit as phosphorous rather than nitrogen is the determining factor that limits the quantity of manure that can be applied to land in many states in the US. Low P levels in the resulting liquid fraction allow larger quantities of N&K to be applied to crops as digestate, reducing fertiliser costs for the growers and minimising the amount of land required to dispose of the dairies' liquid waste stream.

Exporting manure solids, regular dredging of the settlement lagoons and the subsequent spreading of high-P solids to land with a requirement for phosphorous allows Holsum Dairies to better exploit the nutrient value of their manure without compromising environmental legislation.

Image 21: Separated digestate solids are reused as bedding

Kenn sets a very high standard in all areas of his business and environmental management is a key performance area for him, given the level of scrutiny large dairies are under in this respect. Holsum Dairies has set new standards for environmental compliance within the dairy industry.

In 2006 the business built a second unit, Holsum Elm Dairy (below), three miles away from the original site. This unit was for 4,200 cows milked through an 80 point rotary and whilst it incorporated a number of minor design improvements was essentially a larger version of the original design. Milking began in November 2006 and by June 2007 the unit was operating at full capacity.

Meticulous attention to detail at every level has allowed Kenn to achieve and maintain remarkably low operating costs through a period of rapid business expansion. In the 12 months to October 2008 his average cost of production across both units was $12.40 per cwt, the equivalent of approximately 16.5ppl at the prevailing exchange rate. Over the same period his average receipts were $21 per cwt. As one of the lowest cost operators in the industry, Holsum dairies was better prepared than most to weather the 2009 slump in milk prices and one of the first to return to full profitability once the market recovered.

Holsum Dairies is by any measure a sustainable business. Under the stewardship of Kenn Buelow it has managed to combine class leading technical, financial and environmental performance to produce a large-scale intensive dairy farming model that integrates seamlessly with the existing crop production and processing businesses in the area to optimise the value of their respective co-product/ waste streams.

The integration of AD has further reduced the environmental signature of the business whilst offsetting energy costs and generating a potentially significant additional revenue stream.

The environmental management infrastructure and strategy employed on this farm that ensures that it complies with the US EPA's zero discharge requirements however would be difficult if not impossible to deliver economically on a smaller farm.

In 2011 Holsum dairies was the inaugural winner of the award for Outstanding Dairy Farm Sustainability[70] in the US Dairy Sustainability wards run by the Innovation Centre for US Dairy http://www.usdairy.com/, a cross-industry programme to foster and develop a sustainable Dairy sector for the US. The judges were fairly clear in their reasons for making the award:

"The leadership of this dairy in developing and implementing sustainable practice is a testament to what is possible in dairy agriculture" *Cathy Stepp, secretary, Wisconsin Department of Natural Resources.*

"Holsum Dairies serve as a shining example to other farmers and farm operators in the state and region regarding sustainable farming practices" *Ben Brancel, secretary, Wisconsin Department of Agriculture, Trade and Consumer Protection.*

Holsum Dairies represents what can and is being achieved by a new generation of large dairies in the USA. Their focus on all aspects of business sustainability and successful integration with other local farming businesses, offers a potentially replicable template for sustainable large-scale dairying the UK.

[70] http://www.usdairy.com/Public%20Communication%20Tools/Holsum.pdf

Appendix 2 – The Authors

David Alvis
Managing Director – Winstone Agribusiness Consulting

David set up Winstone Agribusiness Consulting in 2010 following his Nuffield Scholarship looking into the drivers of success in large-scale dairying. Through this company he co-manages the Sustainable Agriculture & Food Innovation Platform for the Technology Strategy Board, a £90m 5-year investment programme, funded by the UK government, to stimulate innovation and new technology development in UK agriculture.

David is a dairy farmer's son from Somerset, with a BSc in Agriculture, an MBA from Cranfield School of Management and over 20 years' experience in commercial, consultancy and farm management roles across the UK Agri-food sector. He is a passionate advocate of progressive sustainable farming and is involved in a number of industry initiatives including Dairy 2020, The Govt Office for Science Food Research Partnership and the Green Food Project. In 2010 he was awarded a fellowship of the Royal Agricultural College 100 Club for a paper entitled 'The Scale Imperative?.. Challenges and opportunities for UK dairying'.

Amy Jackson
Owner/Managing Director – Oxtale Public Relations

Amy has a Master's degree in Farm Business Management plus 28 years' experience in agriculture including 15 in public relations; this includes working on farms in the UK and Canada, for agricultural and mainstream (UK top 5) communications agencies, nearly four years as head of communications at the Milk Development Council, and experience in the cattle breeding and auctioneering businesses. She has extensive contacts within the industry including the NFU, AHDB and Defra, as well as in the broadcast, mainstream press and farming media, and is passionate about the future of the farming industry.

In 2012 Amy was awarded a Nuffield Farming Scholarship, which she will use to research the removal of barriers to large-scale dairy farming.

John Allen
Managing Partner – Kite Consulting

John has worked within agriculture his whole life and has almost three decades experience of consultancy. John works across the UK and the EU as well as having undertaken projects in the US and Eastern Europe.

John's areas of expertise include strategic planning, carbon reduction project management, marketing, supply chain management, change management and people management, and he works with some of the UK's leading farmers as well as major food and dairy processors and retailers.