Animal farming

The story behind the Livestock Industry

Colin Whittemore

Wageningen Academic Publishers

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Preface

Three things immediately impact an animal's everyday life. Is its genetic make-up fit for purpose? Are nutritional needs being met? Is the management providing a proper level of husbandry?

The animal itself may have no immediate interest in the wider trading context within which the farmer – the carer – exists, but nonetheless this impinges hugely upon the life of all farm animals. There is no avoiding the external forces which influence animal life on the farm, such as environmental issues and the global economy. Nonetheless, domesticated livestock are a functional part of profit-making businesses the main present purpose of which is to feed people.

From the perspective of European and United Kingdom animal farming this book deals with all of these issues, and in doing so places animal farming into the forefront of a controversial time line. Where are we now? How did we get here? Where are we going with this? It has been the failings in understanding the past and planning for the future that have led to so many of the misfortunes that have beset the animals on our farms.

The modern world has many experts in the little patches of life, but fewer who attempt to stitch together the fabric of a big picture; economics, science, history. But unless the whole is considered, then the component parts can not be properly understood. Somebody has to try.

Dedication

This book is for Chris, my wife, who shares with animals a mutual understanding and love. It also acknowledges Jan Kielanowski, insistent teller of truths, Christopher Wathes, fellow campaigner for honest science, and Frank Elsley who saw me right.

Author

Colin Whittemore is a Fellow of the Royal Society of Edinburgh, past President of the British Society of Animal Science and Emeritus Professor of Agriculture and Rural Economy at The University of Edinburgh – a place with a long history of both enlightenment and dissent.

The first of Colin Whittemore's two-hundred research papers was a study of animal behaviour and welfare – an abiding concern throughout his career. Later commitments were to animal nutrition and the understanding of growth and lactation. At Edinburgh, he was successively Head of; Animal Production Advisory and Development, The Department of Agriculture, and The Institute of Ecology and Resource Management. He has served (amongst others) on the Boards of The Roslin Research Institute, the Scottish Agricultural College and the Hill Farming Research Organisation, and he has chaired Technical Quality Assurance Committees determining production standards for animal farming. He has had lifelong interests in Economics, Rural Social History, Mathematical Modelling and the Communication of Science and Technology. Raised on a family livestock farm, he left school at the age of fifteen, gaining a University place only after attending Agricultural College and night classes. He was first appointed to the staff at the University of Edinburgh in 1970, and subsequently gained a number of higher degrees and professorships. He has been awarded the RASE Gold Medal for research had published five advanced academic texts and four popular social history titles. He acted for many years as an international consultant for a major livestock exporting business. In addition to the extended family, his recreations are writing, skiing and horses.

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Chapter 1. Domestication; a disturbance of nature

Keeping animals on farms – domesticating them – is a matter of livestock control. Control of where and how the animal lives, what it eats and who it breeds with. The purpose of this is to disrupt the natural equilibrium of life.

In nature, life's cycles are balanced so that no element within a stable ecology gains dominance. Before cattle, pigs, poultry and sheep were domesticated, the world was *not* overrun with aurochs, boar, jungle fowl, or mouflon. Populations waxed and waned, but overall they were held in an evolving steady state.

Domestication wilfully tipped the equality of birth and death out of equilibrium. The production of offspring, eggs and milk by domestic livestock far, far exceeds any requirement to achieve merely their replacement rate. In consequence, the animals need special management, extra feeding and better care.

There is very good reason for this. The surplus production is used by human-beings for food – the highest quality of food that can be got. That is the purpose of animal farming.

Farmers have three elements to their responsibilities for the animals they keep: Breeding, Feeding and Management. Breeding concerns genetic and reproductive manipulation. Feeding is not just about nutrient requirements, it is also about foods and eating. Management is first about animal husbandry – welfare by another name. But management is also about marketing and growing the business; about making money to re-invest in the farm, to make animal farming better – for the animals, for the people.

Chapter notes

For those with a predilection for numbers, data drawn primarily from EUROSTAT – Agricultural Production, tells that the European Union livestock sector is dominated by pig and poultry production (that is, the most intensively farmed species). The European Union produces annually; 23 million tonnes of carcass meat from pigs, 12 million tonnes from poultry, 7.5 million tonnes from bovines, and 0.7 million tonnes from sheep. In addition, there is 150 million tonnes of liquid milk and 7 million tonnes of eggs.

United Kingdom+Ireland produce about 7% of the pig meat, 15% of the poultry meat, 19% of bovine meat, 53% of sheep meat, 15% of the milk and 10% of the eggs. Germany and Spain dominate the pig sector, France and United Kingdom+Ireland the bovine, while more than half the sheep meat in the European Union comes from United Kingdom+Ireland. Poultry meat, eggs and milk production are more evenly distributed amongst the European Union countries.

Present per capita annual consumption of animal products in the European Union is high; 40 kg of pig meat, 20 kg poultry meat, 12 kg bovine meat, 2 kg sheep and goat meat, 65 kg milk and 35 kg milk products, and 12 kg of eggs. In EU, current intakes are substantially above (at least twice) those required for satisfactory nutritional purposes alone. The consumption of animal products must therefore be considered, at least in part, in terms of eating for pleasure rather than for necessity.

Chapter 2. Animals as servants of man

Not all that long ago, ten thousand years maybe, farming started. Some of the plants and animals previously gathered and hunted from the wild became domesticated. The animals would have found domestication quite a good idea; the people living in the agrarian communities that looked after them had not yet latched onto the idea of exploiting them for profit. For *that* notion we have The Enlightenments of the 1700s and the Industrial Revolution to thank. The Industrial Revolution, with the huge impact that it had upon agrarian life, struck the United Kingdom half a century or more earlier than Continental Europe. For this reason many of the dramatic changes that effected domestic livestock (not always for the better) in the eighteen and nineteen hundreds tended to happen first in Britain.

Before the mid seventeen hundreds, livestock were not a particularly important part of the farming scene. For the ordinary people in Northern Europe, and most everywhere else for that matter, meat, eggs and milk were relatively scarce – cereals, greens and roots were the staple foods. In the long cold hungry months, feeding the animals often became competitive with feeding the children. Farm animals were not first in line for limited resources.

Then there was the problem of containment. Crops growing on cultivated strips were open to ravage by marauding cattle, sheep and pigs, not to mention goats. Fields – areas of cropped land contained within boundaries – were not so common. Those enclosures that now define today's man-made landscapes were not ubiquitous then. For domesticated animals the options were to be herded or to be housed. There are many parts of the world (and some parts of Europe) where this remains the case – foraging swine, goats, sheep and cattle all needing to be accompanied by a herd and his dog. The fence and the herd combined managed successfully to keep the wild predators from out of the stock and the stock from out of the crops. When not under the direct charge of a human, the animals were kept in pens, or chained, or both. Pigs in sties, hens in coops, cattle in stalls, sheep in folds.

For the time-being then, farm animals were not the prime consideration for most farmers. Even the sheep with its hugely valuable wool only represented a small part of ordinary farm output. It was the grain crops that concentrated the mind of the common people tilling the land. Cereal grains were what kept the wolf from the door and the children alive.

With the exception of draught oxen, which were pivotal to powering the whole economy, there was a perception that food animals were a hindrance to good husbandry, not a help; they were a luxury, not an essential. By the year seventeen hundred however, domesticated sheep, goats and cattle had become useful sources of food as well as continuing their role as providers of power, and of wool and hide for clothing. Pigs and poultry performed special duties as recycling depositories for domestic waste and low grade cereal grains; turning them into edible flesh, cooking fats, eggs and soil fertiliser.

Perhaps the most crucial factor in animals' utility however was that they ate grass (which humans do not). Some of the tilled strips were seeded down to grass to give the soil a rest from growing cereals. More significant was that just about everywhere that was not tilled – so long as it was not bog, moor or woodland – was growing natural grass that was just sitting there, waiting to be eaten. Much of the grasslands were used as common grazings; the poorer lowland pastures, flood plains, uplands, scrub. Cattle and sheep just love to eat lots of grass, while goats are happy to browse the scrub.

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Before the rural idyll was so rudely disrupted in the mid seventeen hundreds, the every-day countryside would find itself populated with dwellings; rough cottages, sometimes in groups set around a bigger house, sometimes scattered freely throughout the hinterland. In much of northern Europe, the cultivatable ground would be arranged into strips or rigs, running side-by-side with a shallow depression between (furrows) to help drainage. Each family in the community would be responsible for one or more strips. They would have the tilling and cropping rights for one whole growing season at least. Meagre dues, commensurate with the poor levels of productivity prevailing, were paid to the land's title-holder.

Mostly the land would be growing grains – the staff of life; wheat, oats, barley, rye – with some summer vegetables and winter greens such as kale and cabbage. Up the valley sides, or along-side the river, might be the common grazings, shared amongst the community. Here the few animals owned by each family would be gathered together into a larger flock or herd – the goats, the cattle and the sheep.

In the summer, milk could be stolen from cows suckling calves for making into cheese and butter which, if fortune smiled, might be kept through some part at least of the winter before going rancid. In autumn, with the calves and lambs grown strong since their springtime birth, there would be slaughtering and feasting. Only a limited few breeding females and stock males could be kept over-winter on scarce resources. What wasn't eaten forthwith was salted (if there was salt), or dried to hang through until the family fell victim to the hard times of winter.

In years of good harvest, some of the spring-born beasts might be kept chained in a stall for feeding on into autumn and beyond (four legs and a beating heart being the best storage preservative of all). Cattle breeds were small and chunky; maturing early and thereby fattening (literally) quickly. The pigs and hens were kept nearby the dwellings; convenient for being fed household and stack-yard wastes. Hens would lay sixty or more eggs through summer. Some would be settled under broody hens for chicks to hatch. Not all of these (and very few of the males) were needed for next year so were eaten fresh (chicken flesh does not dry as well as beef, nor salt as well as pork). The presence of bacon in the house was a bonus, but best from the pig was the fat; lard being far superior to any other fat for cooking and baking. In the warmer climates of southern Europe the pattern differed and breeds of pig

and cattle that were large and lean (rather than small and fat) prevailed. Winter seasonality was not so great an issue, and olive trees provided the oil.

In the eyes of many today, this landscape would be seen as an agrarian paradise where the human population lived in balance with its environment. However, difficulties began to arise with the development of the philosophical concept that somehow it was the right of the next generation to live better than the last; to have *more*. This seemed to be co-incidental (or maybe caused by) the industrial revolution – the actuality of machine manufacture. The people involved in these activities were not agrarian, they were urban. People and landscape were no longer in balance. The land had to feed more people than those who just lived on (off) it. This, as far as the farm animals were concerned, was the origin of their troubles because it heralded the coming of the enclosures.

Since the beginning of farming, the contract between man and land, and between man and animal, had seemed fully sustainable. It has been argued that the boar that became the pig, the fowl that became the chicken, the early indigenous cattle that became the oxen, the mouflon that became the sheep, and indeed the wolf that became the sheepdog, all entered somewhat willingly into the contract. For them it was rather a good bargain; servitude for shelter. There might even be some degree of doubt as to who was domesticating who!

This attractive, but rather loosely evidenced, thesis rather suggests that farm livestock come as willingly to the fold as a cat or dog might come to the household door. However, if animal farming is to be fully understood then it might be best to accept that the behaviour of farmed livestock can often be rather *un*-domesticated! Pigs bite, cattle use their horns, and all species will be happy to escape if they possibly can and seek their fortune in the wild. The classical work of David Wood-Gush in the 1980s showed how well capable domesticated livestock are of 'going native'. The consequence of this is that seminal to the farming of livestock is the necessity of some way or other to keep them contained – captive.

For more than nine-and-a-half thousand years things seemed to work out quite satisfactorily. But after the industrial revolution it was not just the balance between people and land that was disturbed, the balance between people and animal was lost at same time.

With the need to feed an ever-growing population whose life was not spent working for its own food, the old ways were no longer fit for purpose. It only took a few successive years of poor summers and cold winters for the rural population to come to the realisation that the farming paradigm was needing to shift.

The pattern of rural life which had served so well for so long was failing. Not just failing the needs of a new sort of society that did not live in the country, but also failing the needs of the countryside community itself. Conditions were ripe for revolution.

It took less than a hundred years through the seventeen hundreds for the shape of farming to be transformed. Indeed, for a thing called a 'farm' to be made. It was tumultuous, but it was necessary.

The coming of 'farms' would not be a good thing if you were a farm animal. The problem with a farm is that it is *not* a natural community. Its (unnatural) balance needs man's constant attention to maintain it. If left, it will not stay a farm. It is not in harmony with its place. To survive, a farm must strive against nature; it is an unstable ecological niche. Not the sort of place in which an animal might choose to be. If, back ten thousand years ago, there had been farms as they are known today, one might surmise that the about-to-be-domesticated animals might have thought better of it.

The purpose of the new sort of farm was to be productive. To produce stuff to sell to people in towns; a machine to make more food; more, better, cheaper. Farms would be good at that, and that is why they came to be. Marx pointed out that the basis of capitalism was to set the workers to manufacture goods worth substantially more than was paid for their labour; the surplus being the foundation of profit. Animals on farms would identify with that!

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Like most revolutions that stand time's test, the first farming revolution had its cause in many different disturbing forces, all of which came together at the same time. In the countryside times were hard. Things were going awry that needed fixing; and as good fortune would have it, the very fixes were ready to hand – the brains, the will, the money. The enlightenment of thinking brought objective pragmatism to decision-making while the industrial revolution brought money. But with that there also had to be the technology – the knowledge – to deliver the change; and that was there too. The primary disturbing force however was the imperative to feed the ever-increasing industrial work force.

The first and biggest step was the passing of laws to enable enclosure of lands and the creation of fields with physical boundaries – fences, walls, tree-lines, hedges, drainage ditches. Of course, people were already settled on all the best land. Families had for generations cultivated their plots in 'open fields' and also had rights to expansive areas of common grazings – independent families with 'ownerships' and 'tenancies' in their own names.

In Continental Europe, farms were less drastically rationalised than was the case in Britain – many remaining as smaller holdings. While in Britain, the land ownership structures favoured the creation of larger farms, many of which were offered as long-term tenancies. These differences have had fundamental influences on the disparate ways the people of Europe and Britain have come to view their agrarian communities. When large farms were made out of smaller plots and common grazings, the necessary consequences in Britain was that a good proportion of the people settled onto the land had to be removed. Got rid of, cleared out. Many were ready to go, already beaten into compliant submission. Their families were destitute, the roofs of their homes were falling in, their rents not paid, their winter food stores were empty. In Continental Europe however, farms stayed smaller and the land remained evenly populated to a much greater extent.

It so happened that for those thrown off their lands there were places they could go to; economic migration to places that seemed better. Some actually were. If the journey overseas could be survived, the colonies owned by northern European nations offered a new life. Work and sustenance was also promised closer to home, by industry and the towns that the industrial revolution had spawned. A few families stayed behind on the land to work as labourers – hired hands on the very ground that so recently before they had called their own.

The flight from out of the countryside and into the towns fuelled itself. Industry and manufacturing was looking for labour. The new urban population needed feeding from the lands which, being enclosed into well-ordered farms, now had the means to do it. To be more productive. Many fewer people to produce enough to feed both the rural and the urban populations. The purpose of the countryside was no longer just to feed those who worked upon it. It was a business, a rural factory, producing products; products to sell – for money.

If the farm *generated* money, it also *needed* money. *Before*, the economic inputs were land and labour. *After*, there is added a third input – capital. Farms developed an appetite for money. To create ever more output they had to be supplied with ever more input. The crank had been turned, the engine fired into life – the spiral of increasing input to generate increasing output had begun. The agrarian economy had become like the manufacturing economy; survival would come only from the incessant treadmill of never-ending cycles of growth.

Farmers found themselves not so much custodians of the land and of the animals upon it, as custodians of family businesses. The farmer had become an important person in the community. Not one amongst equals, tilling a strip and feeding the family, but an employer. A person who commanded a work-force to fetch and to carry, to go and to come. Others carried out the tasks that he had decreed.

The farming family and the animal husbandman had used to be one and the same. No longer. There was the farmer, the boss, and there were the workers; labourers, horsemen, dairymaids, swineherds, shepherds, goatherds, cattlemen. The herd looks to the animals. The farmer looks to the business. The farmer tells the herds what to do. The farmer hires those that do as they are told and fires those that do not. The person caring for the animal is no longer the one making the decisions about the way that animal is cared for.

Compassion and respect for an animal that is to be killed for its meat, or kept for the milk or eggs it produces, comes readily to those who themselves tend the animals first-hand. For the decision-maker with a business to run, compassion and respect are a distant incumbrance. Before the industrial and farming revolutions, the man (or boy) who killed a beast was the same as fed that beast and looked after its welfare. It is profoundly more difficult to attend to the welfare of an animal that leaves the farm as a commodity – something that has been sold merely for money. The animal may travel many miles to its slaughter. The slaughter-man is not the farmer's boy. Responsibility has been off-loaded. Compassion is

the loser. The animal no longer dies at the hands of its friend while pre-occupied with its food-trough, unknowing, in a trice. It dies in a special strange place at the hands of a special strange man who does not even know it has a name.

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The facets that comprised a 'farm' at the beginning of the eighteen hundreds were much the same as what is still recognisable as a 'farm' today.

A farm yard – a steading. A house for the farmer and his family. Adjacent, farm buildings for storage of crops and all the paraphernalia of arable farming. The first agricultural machines, ploughs, cultivators, sowers, reapers, threshers.

There are also buildings purpose-built for the animals. Cowsheds, for the ordered confinement of dairy cows kept for the milk they produce. Courts for holding cattle being fattened for beef. Stone sties with indoor houses and outdoor runs for the pigs. Wooden sheds for the laying hens.

Outside of the farmyard are fields. Fields with controlled ways in and out – gates to open and to shut. Some fields are cleared for cropping, protected from grazing livestock by ditches and fences. Others actually contain livestock, with grasses sown for eating *in situ*. Around the fields are woodlands for livestock shelter, as well as for timber.

Whilst the farm structure enabled the massive surge in productivity that followed the agricultural revolution, it was the technology that drove it. Livestock were central to these innovations. Whereas a hundred years earlier animals might have been peripheral to the food-producing endeavour, now they were central. Farms had not just enclosed the tillable acres, the common grazing had been roped-in as well – the production unit *included* the grasslands. Grass leys were planted *within* the rotation of cereal crops. These were used for animals' summer grazing and winter keep.

By eating the grass, the livestock in turn made manure to feed back to next year's grain crop. Root crops were included into the rotation – potatoes, turnips and swedes. These, especially the turnips, provided extra animal fodder to supplement the dried hay when the cold weather arrived and the grass had stopped growing. Livestock could now be securely over-wintered. Cattle for meat could be grown to larger sizes. The carrying capacity of an acre of ground leapt up and animal numbers increased geometrically. Dairy herds could be big enough to have the specific purposes of producing butter and cheese for sale as well as liquid milk. Sheep could be kept safe in fields, to be shorn for their wool and the lambs slaughtered for meat. With overwintering a reality, the michaelmas feasts became history. Farms could feed the town year-round.

In a word, a successful farm needed its animals. Animals to produce goods for sale and animals to ensure high yields of the all-essential wheat, oat and potato crops.

Into the towns poured livestock products; lamb, beef, pork, bacon, eggs, butter, cheese, milk, wool, leather. The towns grew. Industry grew. The need for food grew. Output from farms increased to keep up. The animals were made to be more productive. More piglets, more eggs, more milk, faster meat growth.

Things were fine, for a while. Then, inevitably the farms could not keep up with industrial population growth. The whole purpose of industry was to manufacture goods for sale – to sell to countries which did not yet have a manufacturing industrial economy. These countries had agrarian communities which produced food and they were ready to export it. In exchange for manufactured goods, foreign farm products poured into the industrialised countries.

Industrialised nation's (particularly Britain and Northern Europe) home farms did not only have more mouths to feed, they had competition! What's more, the competing, imported, food was cheaper than that which could be produced at home. The golden age was over! Costs would have to come down by putting up the rate of production and increasing efficiency.

But what about that contract? The one mankind made with the animals when they agreed to become domesticated? It had elided into something different. Man and farm animal were no longer working in harmony. Man was dominant. Animal was enslaved under the yoke of working ever harder, being ever more efficient.

The means to keep on increasing output from farm livestock was ready to hand. They could be fed better, husbanded more diligently, bred specially for purpose. Some cow types could be specialised into producing milk, others to be best at beef. Pigs could be bred to grow fat faster; hens to lay more eggs. Because they were bred for it, fed for it, managed for it, greater animal productivity was assured. Breeding for higher rates of production would be the gauleiter of the second farming revolution.

The scene was set.

Welcome to animal farm.

Chapter notes

The British Agricultural History Society and its associated publications may be of interest to those wishing to read further into the historical matters raised in this chapter. Changes over time can also be usefully tracked by studying landscape use maps readily found in libraries.

For a feel of the times, and of innovative thinking by farmers through the years, browsing the proceedings of Agricultural Societies is rewarding; especially in the archives of the Royal Agricultural Society of England, The Highland and Agricultural Society, and the Farmers' Club.

In 1992 William Morrow published Stephen Budiansky's 'The Covenant of the Wild' which proposed, controversially, that domestication was as much an animal as a human choice. However, the natural capability of 'domestic' animals to continue to be able to survive in the 'wild' may be judged from (amongst others) the earlier publication of Stolba and Wood-Gush, 1989. *Animal Science* 48: 419.

Chapter 3. Animal breeding; improvement by trial and error

Before the 1700s the different regions of Europe had their own varieties of cattle, sheep, pigs and goats. This was prior to the enlightened thinking which brought about the rather bright idea that one could select particular individuals from out of a varied population of animals and fix for a particular 'type'; like milkiness, or muscularity. Often, areas would specialise in a particular livestock product, such as beef, or goat milk, or wool, such as might suit a particular landscape and climate. The livestock of the area would, naturally, reflect their special ability to deliver that individuality of product. The animals would be named locally, often according to appearance, such as 'Curleycoat', 'Longwool', 'Shorthorn', 'Longhorn', 'Red', 'Sandy', and so on. More often, though, names attributed would be those pertaining to the region itself; Friesian, Charollais, Limousin, Holstein, Texel...or even just the 'Land race'. If there was sufficient commonality amongst a particular named group of animals, then this could be called a breed. Purchasers of a 'breed' would have a reasonable expectation of what they would get; what it would look like and what it would best produce.

Accelerating change in the genetic make-up of domestic animals by 'controlled selection' is often attributed to the English livestock breeders of the eighteenth century. They were by no means alone in this, nor were their targets universally accepted as being the correct ones. Nonetheless, the English experience serves well as a specific (and probably the best) example.

Soon after the middle seventeen hundreds, some progressive livestock farmers formed into groups to knock out a grand idea. It was about how animals could be selected for the particular characters that would make their farms more money. The grand idea was so grand that Charles Darwin acquired it for his treatise 'On the origin of species'. Foremost amongst such farmers were a bunch from Leicestershire who gathered around Robert Bakewell of Dishley Grange.

In Bakewell's judgement 'success' was measured by saleability – a financial judgement. In Darwin's judgement 'success' was measured by survivability – a biological judgement. The principles are not difficult to grasp. First, decide what the character is that is wanted. Maybe, say, *bigness*. Then take note of the known-forever fact that a big father and a big mother will likely have a big child.

So by positive selection of parents, a particular character can be pulled in any chosen direction. While this was unsurprising, what *was* surprising was how quickly such changes could be made to happen; noticeable differences – money-spinning differences – within only four or five animal generations (ten years). This difference in rate of change between natural selection and controlled selection is due in part to 'focus'. Controlled selection focussed on few characters to the exclusion of the many others.

A couple of other common-sense observations helped along the early years of man-driven controlled selection. First, because a chosen male can get himself around a harem of twenty or so females, concentrating selection effort amongst the males moves things along fastest. Second there is the matter of trying to sort out whether the character shown by a father is, or is not, likely to be also shown by the children. This is much more likely to happen in the cases of the highly heritable characters (like the colour of his coat-hair) than for others which are more under environmental influences (like his daughter's yield of milk). Interestingly, characters like size, fatness, shape and rate of growth are about half way along the heritability scale, so improvements can be made quite rapidly. More rapidly for these sorts of traits than for milk yield or litter size, for example.

But on such matters it can be easy to be led astray! The best way to judge what characters a sire's children are likely to inherit is indeed to observe the children themselves, not their father. It is simple to make the father grow fast; just feed him lots of cereal! But that does not mean that he will pass on to his offspring genes expressing an ability to grow fast eating grass! 'By their fruits you shall know them'. And that is what Bakewell did; finding the best males by checking out the next generation. 'Progeny testing', required a little more patience, but it was a much surer way forward to making correct sire selection.

If it was all so obvious, why then had livestock improvement by selection not happened before? Well, maybe it did, or maybe it didn't need to. People were happy with the differences that God had already provided in their animals; and what God had made should not be messed with. But come the mid seventeen hundreds, perceptions had moved on; people were more enlightened. Anyway, there was money in improving animal productivity. Surely it would be acceptable to nudge God's grand designs along in the direction of a bit of profit – parable of the talents and all of that.

The eighteenth century farmer-breeders went about their improvement programmes with a will and did financially well out of it (which was the whole idea). They improved the wool on one breed to make a wool sheep, another sheep breed was selected for early maturity, so it was especially good for meat. For beef, the biggest, fattest, cattle were chosen to breed from. Cart-horse breeding ended up with the large and powerful Shire horse.

The heritage of those early pioneers lives on; alive and well to this day. But in some cases it has become 're-interpreted'. The underpinning technology of the eighteenth century was to measure productive traits in the offspring and then select only the *proven* best fathers. Pedigree breeding has sometimes forgotten that tenet, and also lost focus on what should be selected for (and against).

It was at this time that began the creation of livestock *breeds*. Everybody is familiar, or thinks they are, with what a *breed* is; in dogs, in cats, horses, cattle, sheep, hens. But a breed is no more than whatever some people choose to say that it is. And they may also change

their minds as they go along! Most 'pure' breeds are not at all pure – they are historical (and recent) mixtures with other 'breeds'. Some of these 'mixings-up' are open and admitted; others more covert!

Usually, breeds are understood to be families of animals with particular characteristics which, because they are within families, are repeated from one generation to the next. A breed is defined by its breeding 'true to type' (horns, coat colour, size, shape, character, and so on), and by its showing particular 'qualities' (meat, milk, wool, prolificacy, etc.). Livestock (and pet) breeds are not natural, they are a human construct. As such they do not change by evolution, they change by human manipulation. Breed manipulation is big business; driven not by any altruistic desire to better the lot of the animals concerned, but to make money.

In 1804, Charles Colling used inbreeding to fix the special type he was looking for by weaving the most intricate of incestuous webs that led to a famous bull called Comet. Comet's father, named Favourite, mates his own mother to produce a daughter. Favourite then mates that daughter to produce Comet. The family groups that followed-on from Comet came to be the basis of the Shorthorn breed. A cow was a Shorthorn only if it was registered in the herd book which showed the detail of its parentages (its *pedigree*, usually for at least five generations). Pedigree breeders took pains to describe the physical (type) attributes that defined the breed as different from any other; these being up-dated (changed) on a regular basis. Perfection in type was set in the annual show ring. It was a matter of the judgement of the judge (always himself a prominent breeder). There is more than pride at stake in the show-ring – championships mean money.

Rather similarly, Hugh Watson Esq., who farmed in the early part of the 1800s at Keillor in Angus, Scotland, mated together some native Angus doddies with native Aberdonian hummlies (both words mean 'without horns') to make the world renowned Aberdeen-Angus breed. The primogenitor of the breed was 'Old Grannie'. She was the perfect type with all the required characteristics for the new breed. Her offspring were bred with each other so that every Aberdeen-Angus carries her blood. She is said to have had 29 calves, whose pedigree entries would have suited Mr Watson handsomely. She died aged 35, the story goes, of being 'struck by lightening'. (Which is sad, 'though often the *attribution* of a calf to a particular grandparent can be just as valuable as the grandparent!)

George Coates published the first herd book (for Shorthorns) in 1822. Even today, a particular animal belongs to a particular breed only because the 'breeders' agree that it does, and its pedigree is written down somewhere. Over the years, particular named breeds have changed colour, size, hornedness, height, shape, temperament, weight, musculature, most everything. The decisions about what is good or not good about any particular animal which might be considered to have breeding potential lies with the elite breeders – for each breed a select few of privileged cognoscenti.

These breed society cartels ruled livestock improvement – to their considerable financial advantage – until the breeding revolution that took place after the 1939-1946 World

War. After that, poultry breeds became nothing more than what the new wave of poultry geneticists chose to put (best-kept-secrets) into their nucleus stocks. A breed of poultry is now the name of the company that sells them. The same applies to most commercial pigs, while cattle (dairy and beef) are slowly going the same way.

Since the middle of the twentieth century, dairy cattle breeding has been transformed by a vast amount of commercially valuable information being available internationally about each and every bull, while artificial insemination means that farmers have a huge variety of choice and the ability to buy their 'bull' one mating at a time. The same (hugely beneficial) simultaneous reduction in expense and increase in proven (commercial) value has occurred in the poultry and pig industries where few large breeding companies dominate the sales of hybrid stock world-wide.

The sheep industry stalwartly hangs onto a number of the old traditions however; amongst them the livestock market, the show-ring, and the elite pedigree breeder. These traditions are now almost universally rejected on the continent, and remain only in the United Kingdom and amongst sheep breeders. They were however equally common throughout Europe before the advent of the modern science of genetics in the 1960s.

Pure-bred rams regularly fetch prices well in excess of their (unproven) worth. Price is greatly dependent upon what was paid for the animal's father (mostly) and mother. Monies paid for these 'Grandparent generation' animals can be astronomic. Let us say a meat sheep at slaughter sells for £80. Its father will likely have cost £800, and its grandfather £8,000.

In many such cases, value is not about proven qualities, it is about the looks of the animal in the ring, the cost of its parents and the reputation of its breeder. There is a gasp when a famous breeder sells a fine specimen for tens of thousands of pounds (it's a sheep for goodness sakes!). But the big payer will get his money back; the person he bought from will buy from him in similarly big numbers next year!

Price ratchets up 'value'. Real money feeds into the system not through the high prices at Grandparent level, but through the 'commercial' producers paying elevated prices to take home a ram to mate with their ewes to produce lambs for meat.

Providing that the merry-go-round keeps on going around, the elite breeders will continue to make their elite profits, and the commercial farmers buying from them will continue to throw coins into the market ring for little benefit to themselves.

Things might be different if breeding animals were rigorously proofed. If a potential sire were tested and proven to have a record of imparting to his offspring a measured advantage in some characteristic of value (growth rate, meatiness, temperament, etc.), then the financial benefit of using that animal as a sire can be exactly costed. Classical genetics is the science of math and probabilities! With knowledge of the number of offspring that he could father in his lifetime, the proper value of the beast can be calculated – with precision! All the required techniques are already ready to hand!

At bottom, for the commercial producer it is not the pedigree of the ram that is used that will mostly effect the price he gets for his meat lambs, it is the breed. The substantive shifts in efficiency of production, level of output and quality of product (not always positive) have resulted from the change from the Suffolk breed of sheep to the Texel as the preferred meat sire. Similar has been witnessed for other species: the ousting of the Dairy Shorthorn by the Friesian, the substitution of the Scandinavian Landrace pig for the Saddleback, and the mass eviction of the Hereford beef breed by the continental Charolais and Limousin.

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Modern statistical techniques have brought mathematics to bear on the probability of an animal actually being as good as he seems to be. Artificial insemination has allowed a good sire to get around not twenty females, but two hundred or even two thousand. 'Molecular genetics' is allowing the detection, selection and even insertion of the wanted genes (or groups of genes) themselves – thereby greatly increasing rates and accuracies of improvements. Few genes with major effects relate only to a small number of traits like congenital disorders and some specific diseases. Most traits are the result of combinations of many genes with small effects. However, where a significant proportion are found in identifiable groups, segments of the genome can be identified as having specific effects. Finding these in order to facilitate their concentration into the next generation can be done by combination of modern genomics and traditional observation of the performances of relatives. Such breeding procedures are in present use for Poultry, Pigs and Dairy cows.

In the beginning though, most important of all was money. Money to fund breeding projects. Money from Governments to encourage agriculture forward to making a better job of feeding their populations in the nineteen-fifties and sixties.

Government support of Animal Improvement through Breeding became a huge success story in all the countries of Europe. Denmark set up a national network of progeny testing stations for pigs. The Netherlands re-organised its dairy cattle breeding in the 1950s. In Britain, the Animal Breeding Research Organisation even had its very own Research Institute with a brand-new building put up for it in 1963. Livestock breeders throughout the advanced agricultural nations (especially northern Europe and North America) made improved animals which were both more productive and more efficient. They had to be fed for it, certainly. But if they were, improved breeds of dairy cows were soon giving three times the gallonage of milk. Improved pigs grew twice as fast and used half the feed. Laying hens doubled their egg production. Chickens grew so fast on so little food that poultry meat flew from being a rare and expensive luxury, enjoyed only by the well-to-do, to being the most common meat available to all at knock-down prices.

Practice with Science had delivered!

Through the past half-century, 42-day live-weight of birds under similar conditions of feeding and management has been increased by selection of improved genotypes from a

little over 1.0 kg to around 2.5 kg. Over the same period the efficiency of conversion of food to bird live weight has been reduced from around 2.2:1 to around 1.5:1. Equally important, today's breeding programmes are now balancing selection for production traits with selection for welfare traits such as strength of bird health and robustness of constitution.

Two, quite different, tactics can be employed. One is cross-breeding – two different nucleus 'breeds' crossed to get the first Filial ('F1') hybrid effect. This gives strength and a robust constitution to the first-cross generation. It worked to the benefit of both farmer and farmed animal in the case of pigs, poultry and sheep. The effect does not carry through however into the second generation. 'F1' types have to keep being re-made each and every generation. They are, by definition, a *first* cross. Second crosses (F2) are both (1) highly variable and (2) lose much of the hybrid benefit.

The other tactic is pure-breeding. The selection of specific chosen traits and their progressive improvement generation upon generation. One could of course do both – select in the pure, parent, breeds, for specific characteristics, then cross to get an 'F1'. This is common for pigs and poultry (and somewhat for sheep and beef) but not so much for dairy cows.

As ever, however, when dealing with animals, the predictably glorious tumbled to the unpredictably not quite so glorious. Things went rather seriously wrong. Two could have been foreseen, one could not.

There is an evident short-cut which has a most ancient warning-sign posted in big red letters at its door; *ignore at peril*. Breeding the best with the best gives the even better; thus far all correct. The best characters, when they are identified, will likely be found in close relatives; quite so. Then faster progress will be made if those close relatives are mated together; obviously. Trouble is, inbreeding does not just fix the characters wished for, it also weakens other parts of the animal's make-up. The result is the opposite of the 'F1' effect – debilities come through. They show especially in terms of a failing ability to cope with the challenges that come from difficult physical and psychological environments. The technique is still (unfortunately) well used amongst breeders whose unique selling points are the immediately visible physical attributes such as colour, shape, size and other special points of fashionable appearance – rather than the less visible attributes such as a long, healthy and happy life.

The second thing that went wrong needed a little more imagination, though not much. It is immediately evident that the fewer the characters on the list of 'improvements' to be made, the more rapid will be the progress to achieving them. And the more straightforward a character is to identify and to measure, the better. So, the message was 'don't get clever; keep it simple'. Dairy cows – go for milk yield; chickens – meat growth; laying hens – eggs; beef cattle – muscle; pigs – lean bacon. What's wrong with that? Nothing, and that's exactly what the breeders got and the farmers paid for. Dairy cows that poured out milk from their udders, chickens that grew so fast the difference could be seen from one day to the next, hens that dropped an egg every day, pigs that were so lean that pork-pie factories ran out of pig fat! But...

Third – and less easy to predict – was that there was no built-in early-warning system for unexpected consequences. As Britain's past Prime Minister Harold McMillan so aptly put it when asked of the reason why well-planned affairs of state would so often go awry; 'Events, dear boy, events'. When stuff happened that had not been on the initial horizon scan, the breeders first dismissed it as 'not mattering', or that it could be got around by some fix like better feeding, or it could be handled 'after', or it was just ignored until it was too late.

Neither, it was later realised, were the negative consequences restricted to selection for 'single traits'. Even when related groups of traits were selected for (mulit-genes), there would come to be losses elsewhere in the animal's genome.

By the time the nineteen-eighties had been reached, animal 'improvements' were not all positive – that is there were such things as negative 'improvements'. Productivity was plus. Efficiency, at least in terms of time and resource use, was also plus. The single simple objectives were reached, the benefits were there. The costs, when measured in terms of productivity were all on the savings side; food in shops got a lot cheaper. The minuses, when they came along, were a little more subtle and were all borne by the animals.

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Dairy cows seemed more prone to chronic diseases, some old, some new. The drugs cabinet had its door opened more often – the vet became a more regular visitor. Cows got problems with their digestive systems and could not keep their metabolism in balance. They had hoof, foot and leg problems – they went lame. Because the whole of their systems had not been improved, but just a part, the part that was improved wrought havoc with the parts that weren't. New wine put into old wineskins. Animals found it more difficult to cope. Cows got thin. Unexpectedly, their ability to eat had not gone up at the same rate as their ability to make milk, so they lost condition quickly and recovered slowly.

An early symptom was their failure to re-breed. In normal circumstances cattle have one calf every year. Beef cattle do, and they can do it more than fourteen times in their lives. The dairy cows were refusing to breed normally, slipping to one calf every one-and-a-half years. A justifiable defence mechanism one might say. With her system going full pelt providing outrageous quantities of milk, why should she volunteer to take on the further burden of a pregnancy? In the short term, productivity kept high – the cow was milking. Unfortunately life in the dairy herd was becoming busy but short. Life expectancy was for around three lactations (a little different to fourteen) – then the old girl (young girl) was off down the road to the knackers. Providing that the value of the 'spent' cow was not much different to the cost of her replacement, then economically, the benefits seemed to outweigh the costs; though not for the cow concerned.

There were unexpected consequences too for the dairy cow's offspring. To start the next lactation, a cow needs a calf. If it's a female it can look forward (or not) to life as a dairy cow. If it's a male it can be used for beef. Ah! but not if both the parents have been bred

specifically to lose their 'dual' milk & beef functions – to be specialised for milk only. What's to be done? An involuntary early exit from the world. An unforgivable foolishness.

At last some members of the dairying industry protested; suggesting that 'something should be done about it'. But conventions are always hard to change. There were those who wanted to keep selecting for more milk; the accompanying challenges could be met with better feeding and better management. Their faith in mankind's ability to control the forces of nature was misplaced. The situation only began to be resolved – gradually – when a bright spark remarked that she thought it might be a good idea to try to improve the *whole* cow; so that all parts of the system could keep in pace with each other as they improved. This meant selecting not just for few characters, but for a whole raft of characters, including the complicated ones like temperament, physical fitness, resistance to disease, longevity of life – as well as for yield of milk. To breed an animal that was 'robust'. The economic climate was also changing; the idea of a cow being in the milking herd for eight years rather than three and having in that time seven calves rather than two had become rather attractive.

As to that male calf, unless veal (reared on natural foods in unconfined yards, naturally) makes a comeback, the technology of sexing bull semen may hold part of the resolution. Helpfully, a longer life for mother in the dairy herd means fewer replacements are needed to keep up dairy herd numbers. Thus a dairy cow can be more frequently mated by a beef bull, getting a beefier calf to grow for meat.

Life for the dairy cow may be getting a little better now – but then it needed to. Before, it had all the appearances of being a life hardly worth living.

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Through until the nineteen-thirties, a pig covered in lard was a good pig. Then progressively this excess of fatness, so assiduously bred for in the eighteen hundreds (in northern climes, but not in the Mediterranean), was rejected by the human population's kitchens. By the time of the animal breeding putsch of the nineteen-sixties and seventies, pork and bacon eaters were rejecting pig meat in favour of leaner chicken.

Pigs were just far too fat. A modern kitchen didn't need lard for cooking anymore; there was plenty of vegetable oil around; from olive trees, American corn, sunflower or oilseed rape. The modern Mr and Mrs Spratt wanted only lean meat on their plates. So that was what the breeders chose to target, and perhaps while they were at it they would try to get the pig a bit more efficient in its use of feed too – more competitive with the chicken. It was a doddle. In twenty years the depth of fat on a bacon rasher fell from twenty-two mm to eleven mm. In the same time the pig feed needed to grow one kilo of grunting porker fell from around four kilos to around two. Lean pig-meat at a drop-dead price. Pork and bacon were back on the nation's menu. Job done? Not quite.

The expectation was that the pig would grow more lean per day, just like the cow would give more milk per day. The pig itself had a different, better, strategy. Grow the same amount of lean, but a lot less fat (Figure 3.1). That way it would become leaner quicker, which was what was asked for, wasn't it? Not only did the breeding schemes of the nineteen-sixties and seventies select for animals that were less fat (otherwise known as thin), they also selected for animals that had naturally smaller appetites – the best way to be thin, after all, is to eat less. The pig had lost its greedy gene.

Just like the dairy cow, breeding sows became svelte. Thin sows are not so fertile. They are more reluctant to breed and when they do they have smaller litters. They too did not last so long in the breeding herd; only for three or so litters instead of eight. But as prices for culled sows were quite good at that time, it didn't really matter.

The other thing was – that irresistible succulent porky taste – it had gone! It wasn't just that the fat had disappeared from the layer under the skin on the pig's back, it had gone from within the muscle as well. It is the fat running through the lean that gives pig meat its porky flavour. And, just to add insult to injury, the meat got tough; it cooked dry and ate

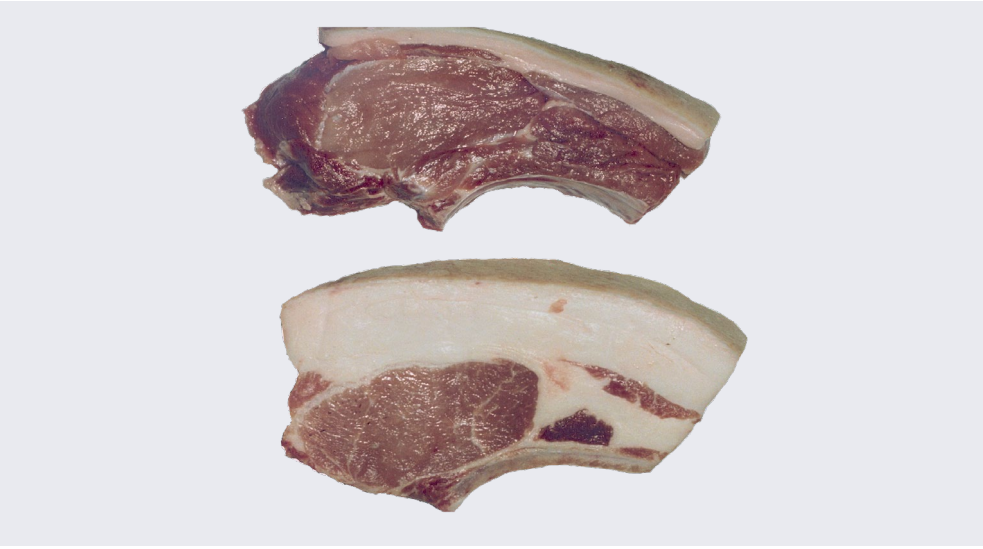

Figure 3.1. *Before determined quantitative selection against backfat deposition in pigs (late 1960s), backfat depths at 90 kg live weight would often exceed 22 mm. Year-on-year backfat depths across much of the European pig population came down at the rate of 0.5 mm per year. At the same time fat deposition in the muscle also depleted. Countries reacted in different ways. UK continued reduction down to less than 11 mm, losing meat quality on the way. Continental Europe took the opportunity to balance reductions in fat with increase in slaughter weight. Over the same period, the efficiency of conversion of food into pig live weight improved from around 3:1 down to around 2:1, partly due to faster growth, but mostly due to reduction in fat deposition (which is expensive in its usage of feed energy).*

like leather. What had been created was both lean and cheap, but the downside was that it wasn't great to eat.

Was this shift in what the pig had now become necessarily bad for the pig? After all, before the breeders got stuck in, pigs were not fat. Wild boar is not fat. It was the farmers who made the pig fat in the first place, so why should there be a problem with farmers making the pig lean again? The pig does not much care if its meat is tasteless and tough.

For the pig, the problem lay mostly with the breeding sow. Ancient (thin) sows had litters of six or so pigs, once a year. To be efficient, a modern sow needs litters of twelve or thirteen live healthy piglets, produced more than twice a year. A happy breeding sow needs to have some fat on her. To some extent, this can be fixed by feeding management; but this fix can only be delivered through a higher level of human attention and individual care.

Keeping sows just became more difficult, the sow less robust – less able to cope, more dependent upon her human carers. This became evident when epidemic diseases amongst pig herds began to increase; in frequency, in severity, and in the incidence of new sorts of diseases. The threshold ability of the animals to deal with the stresses in their environment had dropped.

Fortunately for the pig, resolution can be implemented just as rapidly as the problem was caused in the first place. What was bred out can be bred back in. Indeed, new improvements can now be added, like genes for resistance to specific diseases. Those cranks that kept little herds of useless 'rare' breeds (the fat, muscle-marbled, slow growing, not-so-prolific ones) found themselves as suddenly popular as they were previously denigrated. Those outmoded characters might be useful after all! Might there be a chance that the pig of the not-too-far-distant future will be nice to eat, biologically efficient, productive, and, dare one say it, happy? There is, but it might be a bit more expensive to produce. Indeed, the first is already happening – pork is gradually getting tasty again.

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The laying hen has been more resilient to the consequences of its improvement. Perhaps because there was a higher intrinsic capacity there to lay eggs in the first place. Noticeably, the increase in egg numbers through the nineteen-hundreds could be put as much at the door of better husbandry as could be credited to genetic selection. And meanwhile, crossbreeding (which had become the norm for producing improved commercial strains) kept some semblance of strength in the bird's constitution.

The focus of attention in the case of the broiler (meat chicken) was growth rate. Selecting for fast growing birds resulted in bigger animals with bigger appetites. Mature size of meat birds has more than doubled since active selection began in the 1950s. With faster growth, the days to reach the two-kilo bird that people like to buy fell from around ninety days to around forty-five. The efficiency of food used improved *pro rata.* (It costs food to keep an

animal alive and its heart ticking day-by-day. So the fewer days it takes to get to market weight the better the efficiency). The broiler bird, of all the animals providing food for humans, has the lowest carbon footprint.

For the same now familiar reasons, there were costs to the bird in terms of its health and well-being. Foot and leg problems became endemic in poultry flocks, and there was increased susceptibility to disease which could end in systemic malfunctioning of the internal organs (such as cardiovascular disease and oedema – ascites). These issues are now being tackled – not before time. One breeding company was early in heeding the outcry that came from society-at-large learning of the almost universal presence of lameness in broiler flocks. Breeding objectives shifted in their focus from increasing size to increasing welfare. Just as in the case of the dairy cow, this breeding objective is being attained – birds with strong legs and sound constitutions. Further, new strains – with meat that tastes like chicken always used to – are being bred. They tend to be fatter and slower growing!

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The story with beef and sheep has been a little different. A primary need here has not changed much – it is for resilience. Beef and sheep and goats need to be survivors coping with a wide diversity of environments. Quite different from pig and poultry farms, or dairy units where farms are fairly standard. Mostly, the sheep and beef breeding story has been about choosing sires that are markedly different from the traditional breeds.

Bigger and more muscly types of beef bulls, boars and rams had long existed and recently been further improved by breeders on the European Continent. They invaded all of Europe including Britain in force in the nineteen-seventies. Traditional British breeds like the Hereford, the Devon, the Angus, Suffolk, Cheviot, Yorkshire and Welsh were bowled over and out. Many would say that the eating quality of British beef, pork and lamb suffered as a result. But if that is the market's choice, then the market decides; even if not for the best. What happened next however, was not a matter merely of consumer fancy.

A wonderful anatomical 'improvement' was 'found' in continental sheep, cattle and pigs – as exampled by the extreme types of the Beltex, the Belgian Blue and the Pietrain. To look at, these animals are not formed the same way as others, as may be evident when the continental type is directly compared with the traditional (Figure 3.2). Their different shape would, in the past, have been cause for their being put aside; but now the same is seen as a benefit to the market place. Their back-ends are characterised by having a double thickness of muscle. They bulge twice the normal size. The meat-eating public wanted lean; lots of it. These animals have it in spades! Magic!

Figure 3.2. *The image to the left shows the typical physical form of the modern 'continental' bull with qualities of muscling that can be considered outstanding for modern beef cattle. The image to the right is typical of a traditional beef breed with muscling that is evident, but not excessive. Compared to the continental type, the traditional breed matures at a lower live weight, so at any given slaughter-weight this animal will have more fat both around and within the muscle. Whilst much present demand is for lean (muscle), meat with fat generally has higher eating quality (images: John Eveson).*

Sadly though; when one character changed, all the others tended not to remain the same. Big-muscled calves gave grief to their mothers at birth. The sheep flocks seemed lazy. The pigs were prone to sudden death and poor muscle quality. Many would describe these double-muscled bodies more as deformed rather than shapely – their legs seeming to not quite work right. Before we eat them, these animals have a life on earth in our care. Did anybody ask about that?

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Because genetic changes can be achieved by man-driven purposeful selection over only a few generations they are not 'evolutionary'; they are revolutionary; that is, disturbingly abrupt. The consequence is that the environment in which the genetic change has occurred has not yet adapted to the new genetics. The animal no longer fits in its previous evolutionary niche. For the animal this means trouble unless the environment is managed simultaneously and appropriately to precisely fit the requirement of the new genetics. This is rarely, if ever, achieved, Farmers manage their way to the creation of a new environment for the new genetics by trial and error – with the animals taking the consequences of the errors.

There was a view amongst livestock geneticists in the hubristic days of the 1960s and 70s that an animal improved by the new ways of genetic selection was an animal which was better. Better in all regards. Their legacy is still with us today, for the general notion of unidirectional selection lasted for almost half a century. Selection does not result in 'better', it results in 'different'. Genotype interacts with environment – without exception

and without avoidance; the different genotype produced by selection requires to live in a matched different environment. This is a simple and obvious point, and as usual for such truisms, sometimes disregarded by the scientific zealots.

Pigs bred for rapid and efficient growth in the sophisticated husbandry environments of the Netherlands, Denmark and Britain in the 1970s failed dismally when it came to their survival in the export markets of Southern Europe, North America and Asia where husbandry was at a less developed level. Indeed, sales managers of breeding companies were quick to suggest that use of the 'improved European hybrid white pigs' would solve problems, improve efficiency and increase output at a stroke. They were wrong!

Only when the livestock breeders accepted a trifle of humility and came to emend their views did the global market begin to succeed. There were two strategies; both worked. The first was to raise husbandry levels to create environments within which the 'improved' genotypes could flourish. Better housing, diet, veterinary input and staff training. This proved easiest in the case of poultry where 'turn-key' operations could be dropped just about anywhere in the globe complete with purpose-built housing, closely specified feeding, trained staff: bird genotype and environment all already matched-up. Poultry operations also benefitted from scale; tending to be large, so it was worthwhile for breeding companies to follow up bird sales with comprehensive technical support.

The pig industry followed the avian example, but with less success and less focus; not least because pig units tended to be of more modest scale. Failures led to the development of the second strategy, adopted by the more enlightened sectors of the pig genetics industry. The genome of the 'improved European hybrid white pigs' was deliberately diluted with traditional types native to the geographic area (for example, for the American market, with the traditional US Duroc and Hampshire breeds). It was a matter of building back into the pig a constitution sufficiently 'robust' to handle the different environment.

It may therefore be asserted that directional changes in genotype are most likely to be beneficial when matched by appropriate directional changes in environment.

It can be argued that the creation of new breeds of meaty sheep have failed to account for the change in the value of wool, and, given the parlous state of the sheep industry, the up-coming need for sheep types that can cope with the harsher conditions likely to be the commonplace for the hills and uplands. There is a temptation to wonder if breeds developed for use in Northern Europe, especially the sheep-renowned areas of Northern England, Wales and Scotland, will become inappropriate for currently developing farming environments (and indeed the need to use farmed livestock for the preservation of environmental diversity amongst natural flora and fauna). Sheep have for generations been bred for purposes no longer relevant, such as wool and cheap meat production (mutton was for generations the meat of the masses in Britain. Now, this accolade belongs to poultry and pig, while lamb has become a luxury). The recurrent costs of production of sheep meat outweigh value at sale from the farm gate, while the marketing chain is long and tortuous resulting in a high-price product whose popularity amongst consumers has diminished inexorably and many fold

over the last sixty years. The modern sheep itself has become mal-adapted to challenging environments, suffering from a plethora of diseases and debilitating conditions (such as foot-rot and fly-strike), and parasitic invasions that appear to require a constant stream of administered pharmaceuticals and husbandry interventions. These are not characters ideal in an animal which might need to make its contribution by sustaining more challenging environments with minimum attention. To add insult to injury, the sheep's original prime purpose, the production of wool, is now an embarrassment – shearing being a cost-incurring activity whose only purpose is the alleviation of heat stress and maggot infestation. There are however (fortunately) sufficient surviving breeds of sheep and cattle which have been spared the benefits of being 'improved'. These are now being found useful after-all!

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There is a present belief that returning animals to slower growth rates will improve meat eating quality. Taken at simplistic face value this appears not only to be incorrect, but actually detrimental to animal welfare, efficiency and sustainability. An animal whose genes are driving it to faster growth rates and larger mature size will, by being growth retarded, indeed grow slower. It is also true that slower growing animals will be older – more mature – at the given slaughter weight, and more mature meat tends be more flavoursome (and more tough).

Environmental inadequacy (such as housing quality and feeding regime) will bring about slower growth, but it will be at the detriment of just about everything else. The higher eating quality of previous years that was associated with slow growth was a characteristic of animals of different genetic make-up fitting into (interacting with) different environmental niches. Such breeds were often of small maturing type, which at slaughter weight were both more physiologically mature and fatter. The fat not only improves ease of eating, it also imparts flavour.

To try to improve eating quality with modern genotypes of poultry, pigs and cattle by environmental manipulation (such as diet nutrient density, and feeding level) is likely to be counter productive both to animal health and welfare and to achieving the desired end. Eating quality improvement will come best from first getting the genetics right, then providing the proper environmental match. An excellent example of this has been in the breeding of pigs. If the charge for growth and leanness made by the hybrid pig-breeders of the seventies and eighties made for pig meat which was cheap, tough and tasteless; then the more measured breeding programmes of the early two-thousands have resulted in pig populations which have returned both flavour and tenderness to their pork – whilst any compromise in growth rate and efficiency has not been much evident.

As always the case, change of an animal's genetic make-up, in any direction, needs to be matched by appropriate changes in the nutritional, physical and managemental environments. In the natural world, these changes are gradual and evolutionary, helping them to go step-by-step *in step.* For farmed livestock, both genetic and environmental change (especially nutritional) are governed by man, and open to being both abrupt and out-of-step. This will create unacceptable stress in livestock systems.

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In retrospect, when the population is short of food, and paying too much for it, it is not unreasonable for the food providers to breed animals that simplistically target the objectives of *more*, *cheaper*. When a meal for a child is at risk, it is not unreasonable to put food supply ahead of the well-being of the animal that can provide it.

The present position is, however, not like that at all. Populations in the Developed world eat too much of everything and probably, as will be discussed later, too much of meat. Only about twelve percent of the average person's disposable income is spent on food.

Given these things and more, animal breeders are quite properly being asked to re-focus their objectives onto the more difficult traits of health, specific and general disease resistance, immunity, longevity, ability to cope, robustness and the like. Whereas fifty years ago all animal breeding targets would have been directly related to the primary production traits such as yield, now it is only one third. The other two thirds of breeding objectives are targeting welfare, health, environmental protection and product quality.

The welfare of our animals should not just be 'safeguarded', for that is a promise that will always put welfare second in line – to be dealt with only if convenient (i.e. profitable). Animal well-being can be actively managed and bred *for*. That means other breeding objectives – such as production rates – would need to be pushed back down the line.

The dilemma between animal productivity and animal welfare is clear. But there is another, and that is between animal productivity and product quality.

Might it be that both quality of animal life and quality of animal product have been wrongly forsaken for the pursuit of *more*?

The original breeding objectives of the nineteen-sixties simply did not consider product quality. In pigs, 'carcass quality' was assessed solely by measuring depth of back fat with callipers. Milk was all about 'white water'. For chickens, rate of production was everything.

Quality of product is not merely an added character maybe needing to be 'taken into account'. In advanced economies it is more (not less) important than quantity and price. There are many aspects to 'quality'. It is not just about how good the food is to eat (vitally important as that is). Quality includes the well-being and health of the animal being eaten.

Quality further includes the knowledge that the animal used to provide human food has been respectfully and compassionately treated in its life and in its dying. This quality in food from animals is becoming a assurance attribute of ever greater importance. The targets of quality and quantity are often opposed. There may need to be a choice. A choice to be made by the consumer, and one which has money at bottom. How much will the consumer *actually* pay (rather than just promise) for a happier animal?

Chapter notes

The Classic text is that by Arend Lourens Hagedoorn published by Crosby Lockwood in 1946. William G. Hill provides a contemporary view (2016) published in *Genetics* 202: 877-881. Geoff Simm presented to the British Society of Animal Science at its 2017 Annual Conference a seminal plenary paper 'What has Animal Science ever done for us, and what does it need to do now' (https://bsas.org.uk).

In 2016 Tallentire *et.al.* reviewed the out-turn of fifty years of breeding for efficiency in broilers (*Agronomy for Sustainable Development* 36: 66); while in 2014 Zuidhof *et al.* had completed a direct comparison of the growth, efficiency and yield of commercial broilers from 1957, 1978 and 2005 (*Poultry Science* 93: 2970).

Much of the material in this chapter has been sourced from various aspects of scientific works pursued over the last hundred years at Edinburgh. For further reading into present and past activities relating to the improvement of animals by means of genetic selection, the reader might consider the comprehensive collection of the works of the Roslin Institute and its predecessors the Animal Breeding Research Organisation and the Institute of Animal Genetics, all of which may be found currently at the University of Edinburgh Library (Towards Dolly, Edinburgh, Roslin and the birth of modern Genetics, University of Edinburgh Archive and the Wellcome Trust).

Chapter 4. Subsidisation of animal farming

In the 1800s, European Continental farming interests were directly competitive with those of Britain (the opposition), but latterly the interests of all of Europe, including Britain, are now largely common and linked through the various national applications of the Common Agricultural Policy (CAP) (or its equivalents). As a basis for bringing forward a discussion of the reasons for, and the utility of, providing hand-outs for livestock farmers, the United Kingdom serves well as the core example, not least because it has a rather long history.

While the general background to nineteenth century Farm support in Europe had been one of a presumptive need to control imports, in the more industrialised United Kingdom the background was one of free trade. Both polices aimed to simultaneously feed national populations cheaply, whilst safeguarding the rural communities. In the United Kingdom, the Industrial revolution at the end of the seventeen hundreds had brought about structural change in the ways and scales that animals were farmed. This meant that dramatically fewer people working on the land were able to feed ever larger numbers of people working in the industrial and manufacturing trades. By the end of the eighteen hundreds less than 15 percent of the British population was 'agrarian'. The equivalent proportion on the European Continent however was over 50 percent of the population working on the land; structural changes there had been both less in scale and slower in implementation. That difference still remains despite continuing dramatic decline in the rural population over the last century. Whilst Continental Europe has more that 7 percent of its population involved in primary agriculture, this is more than three times than is the case in the United Kingdom. These differences have substantially influenced taxpayer's attitudes to agricultural support; being more sympathetic on the Continent than in the United Kingdom.

Amongst the European nations, it can be argued that Britain was first in line to use government interventions as means of interfering with the natural (market-driven) order of things. But North America was not far behind when export opportunities were clearly in the national interest, while in Europe as a whole it was post wartime national food shortages that drove governments to incentivise production through means which are now developed into the Brussels-led CAP.

European (EC) support schemes after World War 2 had finally culminated in the setting up of the Common Agricultural Policy in 1962. At the outset the CAP originally ate up more than three-quarters of the European Union budget. Although now less than a third of total budget, the cost of Agricultural support remains enormous. The original intent of supporting the rural community has been at least partially achieved. The reforms progressively supporting 'people' rather than 'production' has been somewhat effective, though it can be argued less so in the United Kingdom than other European nations. In the United Kingdom it is particularly evident that CAP has been unable to efficiently support small poor farmers whilst being rather better at rewarding already rich large ones. Being land-area based, and now with its environmental pillars, CAP is more evident in the

affairs of arable farmers than livestock keepers. This is unsurprising in view of some three quarters of European Union meat production coming from the (unsupported) pig and poultry sectors.

The British taxpayer first handed out finance to farmers soon after the beginnings of farming as we know it; around the middle 1800s. Parliament – which decides what to do with the population's taxes – was largely run by the landed gentry themselves, so parliament would be expected to look after farming.

In the early years after the industrial revolution, farms were given the specific purpose of feeding the urban communities. There was an open market between country and town. Food was paid for by people who had to buy it because they were no longer able to produce it for themselves. With a strangle-hold on food, farmers found themselves in a golden age.

Regrettably, the industrial work force came to be paid less by the factory owners than the farmers were charging them for their food. The monopoly had to be broken. Which was easy, because other countries had noticed that Britain was a lucrative market for agricultural products. France and the rest of Europe, and indeed North America and the newly emerging British colonies worldwide (including New Zealand and Australia), were well set up to provide animal products into Britain. Better indeed than were Britain's own farmers. Even with transport costs accounted, staples such as cereals, wool and meat were cheaper from abroad. Battle commenced.

Prices were forced down and the golden age was over. The importers won. Recession set in, farms fell into dilapidation. Parliamentarians of the middle 1800s had decisions to make. With the French Revolution and the Napoleonic wars still a potent memory, it was clearly necessary – from a strategic defence point of view if nothing else – to have a fully functioning home agricultural economy to feed the nation from its own resources. Hungry voices tend to be the ones most ready to call for revolution!

Parliament's members fell into two camps; the conservative-thinking country landowners and the liberal-thinking urban industrialists. The former camp talked of 'food security' and wanted protection for the home farmers in the shape of import tariffs. These taxes would not only put money into government coffers, they would raise the price of imported grain to the same as it cost farmers to produce it at home. The population would simply have to pay a higher price for its food. A win for the farmers; effectively supported by laws which shifted money into their pockets.

The other camp, the industrialists, wanted the import restrictions repealed and 'free trading' – whatever the presumptive dangers might be thought to be in the event of another war. Free trade is the touch-stone for any industrial economy looking to export its manufactured goods. Free trade is a win for the urban manufacturing work forces who thereby had access to cheap food. The cynic would however also point out that their industrial masters also had much to gain as they needed to pay less in wages.

After a fun-fair of legislative toing-and-froing, the farmers came out worst. The national landscape – natural and political – was no longer agrarian; it had become industrial. Without support, farming withered into depression. By the turn of the century into the nineteen hundreds, the British populace was fed by vast importations of commodities coming in from North America, the European continent, and everywhere else looking for a food market. The nation's grain, vegetables, fruit and meat came as much from the holds of ships docking into the big sea ports of London, Liverpool and Glasgow as it came from the granaries and livestock sheds of the nation's own farms.

The cycles of farming depression reached a nadir in the late eighteen hundreds with the dramatic opening-up and development of food producing lands in Eastern Europe, the Americas, and parts of Africa. These tsunamis of agricultural production were coupled with the now widespread availability of steam power – railways and boats. Food provision to the industrial towns had little if any elements of 'geographic locality'; food had become a globally traded commodity. And, given the vast tracts of new agricultural land put into production, there was excess of food in the world. Food prices plummeted, agriculture slumped, farms became worthless. Worst hit were the farmers of the highly industrially developed nations. Great Britain and North America had pauper communities in their rural parishes while town industries prospered on cheap food.

It took the great depression of the nineteen-twenties, the re-arming of the German Nation and the gathering of the clouds that would become World War 2, to wake up European politicians to the fact that it might not necessarily be the best idea for their nation's breakfast cereals, beans and bacon to come across the sea from the United States and the wheat for making their bread to come from Canada. The taxpayer began by supporting investment into farming in the late nineteen-thirties, but it was the imperatives of war and the submarine blockade that really got things going. Food shortages were rife not just for the five years of war, but for the following five years as well. The whole of Europe was hungry.

In 1947, the British Socialist Government passed laws for a suite of support programmes for farmers, paid for by the taxpayer, that would ensure three things; food that was plentiful, food that was cheap, food that was home-produced.

Farmers would be the beneficiaries of new knowledge that would be discovered by Government-funded research Institutions and given away for free by the Government-funded Advisory Service. To help implement these advances in farming technologies, Government-funded grants were awarded to farmers to offset capital costs. And just to make doubly sure that the new ways of doing things actually happened, the Government guaranteed floor prices for farmers' products. So whatever the real (global) market price might be, United Kingdom farmer's costs of production would be met. Profits were ensured. A golden age was come again.

Which was true, but not for all farmers. Some could not take on board the new, grander, innovative ways of doing things. Farm re-structuring took toll of the smaller family-farms

that had dominated the landscape since eighteen hundred. Land holdings were amalgamated to make bigger farms. New farm buildings went up while the old ones fell to decay or to domestic housing. In twenty years, the proportion of the population represented by farm workers fell from about ten percent of the population to less than three percent.

Interestingly at the same time, the poultry (eggs and meat) and pig industries, neither of which benefitted from supported prices, boomed. All the old ways of pig and hen keeping had been rapidly abandoned in favour of up-to-date housing and management together with massive increases in the scale of specialised pig and poultry farms. British farmers led the world. They were so efficient that costs of production not only competed with, but beat off, the overseas competition. The taxpayer's help was not needed.

Meanwhile similar schemes for farm support had also been put into place in other European countries (and North America). This, together with the benefits that came from mechanisation and from the economies of scale, resulted in a Europe-wide boom in farm products. So much was produced that the population simply could not eat it all. But because the prices were always covered, the farmers went on producing. Only poultry and pig self-regulated. By the 1980s there would be throughout all of the European Union lakes of milk, and mountains of beef, cheese and butter; all going to waste. Grain was stored into silos (many of them not up to the job) all over Europe. Beef carcasses were piled into cold stores. And for this excess the tax-payer kept on paying – fuelling the magic porridge pot. It had to stop. Quotas were put onto farm products, guaranteed prices and subsidies were withdrawn, farmers were encouraged to put good farm land 'aside' – to leave it uncultivated to fall to scrub. Through the nineteen-eighties European and British farming hit hard times again. Nobody wanted to be a farmer. Inward investment halted.

Major losers in all of this were the animals. More milk was dragged out of the cows as dairy farmers strove to make a profit. Laying birds were confined into the least expensive of all housing – the battery cage. Similarly, pigs were tethered into stalls, with the growers being reared intensively on concrete slats. Beef calves grew to market weight without ever seeing a grass field. Domesticated livestock were asked to be more cost-effective; to live in less space.

The nineteen-eighties and nineties saw a farming industry that had restructured into larger, fewer, more efficient units. It had become apparent that the subsidy system which supported and encouraged production output was no longer fit for purpose. If there was a need for a subsidised system, then surely it should be for supporting rural communities, not agricultural production. For that, maybe the farmers should just be given a social support grant. Money given not for what was produced, but simply for having a farm.

Government payments to post-millennial beef and sheep farmers presently raise for them more income than does the profit from the sale of the livestock products themselves. Based essentially on size of farm (the number of acres held), as a social handout it is a blunt tool; rewarding those that do not need it more than those that do. Nor does it adequately distinguish between passive land owners and active land husbanders. Farmers are getting financial incentives to do nothing with their land. Some attempt has been made to address

this by handouts now coming in two parts; part for having the land and part for caring for it. It is not at all apparent however how this tinkering with the fine tuning is ever going to effectively deal with the fact that the livestock farming machine has got a broken chassis.

Whereas previously livestock farmers were supported directly for the food they produced and sold off the farm – the milk, beef and lamb – now support is for holding land, not for producing food. This was thought to be how best to avoid another episode of over-production. In a round-about way the beef and sheep farmers, with their broad acres, do get some benefit. But the producers of milk, pigs, poultry and eggs are left hung out to compete on their own wits.

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What then, for any given nation, have home-produced livestock products going for them; such that the nation's taxpayers should legitimately subsidise them? One might reflect as follows...

Cheapness? Yes, but the nineteen-fifties and a hungry Europe are past. There is no reason for food *per se* being singled out above any other of life's effects as needing to be especially cheap to buy. While the public sees fit to throw nearly half the food produced for it uneaten into waste bins there is little ground for an argument that food is over-expensive. Besides, what right do consumers have to take an animal's life and casually throw it to waste?

Food quality? Yes, but why a subsidy? The consumer has choice; buy cheap from abroad or buy better quality (and pay more) from home. Of course that 'better' home product must actually *be* better. That it comes from the farm next door does not necessarily make it so.

In preparation for war? So we can feed ourselves from our own resources in the case of a blockade? Yes, but which war and where? What is the boundary of 'our own resources'? The Nation? The European Continent? Whatever the answers to these questions, it might seem obvious in the light of our history of war and hunger that food security – being able to feed the nation's people from the nation's land – was simply a given; self-evidently sufficient reason of supporting a viable home-nation farming economy. However, though the words are often used, the evidence is contrary. Repeatedly, industrialised nations have put their drive to trade with other countries above their own food security. That has been the case since the mid 1800s when industry (rather than agriculture) first came to dominate the psyche.

It remains the case even now when the export priorities from Europe are financial services and industrial goods. It pays politicians to talk the talk about food security, but their imperative is for the vote, and that means keeping food cheap. Imported food is both cheaper and of more constant supply than home-grown. Whatever the danger of hunger in the future, then that is for the future to fix. Politics are for the day. Food security is an undeliverable myth. Until, that is, it is too late...

In the particular case of the United Kingdom, market forces (not hand-outs) make the country – at least for the time-being – largely self-sufficient in three of the animal commodities; poultry-meat, eggs, and liquid milk. However more than half of the farm products eaten in Britain do *not* come from Britain. There is a present danger that liquid milk, eggs, and poultry meat will follow suit. Asia already has a keen eye set to expand sales of chicken and eggs – there is sufficient excess of chicken breast meat that the US is importing it for cat food.

Overall, the trade for animal products Europe-wide is about in balance; Britain being the strongest importer. Imports into the European Union are controlled to some extent by regulations concerning their methods of production – offering some barrier protection for European farmers. (Figures 4.1 and 4.2 show competing farming systems).

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Competitive trading favours producers with comparative advantages. Where grain can be grown cheaply, pigs and poultry can be competitively fed. Where grass grows freely – and northern Europe has natural advantages for that – dairy cows, beef and sheep can thrive.

In many cases comparative advantage comes not from nature, but from governmental nurture – from a non-restrictive regulatory climate that encourages the achievement of

Figure 4.1. *Farms such as these (which are in Australia, but similar can be found in many other countries such as Brazil, Canada and US) can generate livestock products on a much greater scale than is traditional in EU and Britain. European systems are also commonly less intensive, and may suggest that they have higher assurance requirements. But scale is not the primary factor affecting either product quality or animal welfare. That is more dependent upon the quality of management and husbandry available. These animals do not graze (see also Figure 6.2), their food is brought to them. The European Livestock industry is protected to a certain extent by import regulations and by Government subsidy (images: beefcentral.com).*

Figure 4.2. *Half of the pig breeding herd in UK is farmed 'outdoors'. This system is considered welfare-friendly. In European terms, outdoor pig-keeping is unusual, and pig farms are in general smaller in scale than those in North America. The beef herd is grazing pasture grass from which it is possible to fatten animals up to slaughter weight. Such systems have higher costs than those that are larger and more intensive (left image: HelenBrowningsOrganics).*

efficiencies in management and in resource use. In these circumstances efficiency savings are usually synonymous with intensification; more output from less infrastructure. Such efficiency gains are likely to be counter to the interests of the animals. And because at the back of decision-making are national government incentives, there can be wide animal-welfare disparities between the many and various nations trading into any single given market.

As long as the foods that people get from domestic livestock are seen as 'commodities' as has been the case till now, the prognosis for livestock farmers and farmed livestock is not good. If on the other hand provenance is given the upper hand and food quality includes where it comes from and how it is produced, then the outlook is much brighter.

Food is not just about nourishment, it is also (in advanced economies) about taste; the 'eating experience'. In developed economies food is eaten for pleasure – assuaging hunger is a by-product of eating; no longer its driving force.

Many farmers have come to the conclusion that the way to deliver a quality eating experience to their customers is to 'de-commodify' their products. To sell directly to consumers. Not just the fresh primary products such as milk, pork, lamb, chicken, eggs and beef, but also secondary products such as cheeses, yoghurts, ice-cream, butter, pies, cured bacon, sausages, cooked meats.

Is there to be no more of 'handout husbandry'? Is it foolish to think that *any* subsidised production process can have a long term future?

Maybe if livestock products are to come from ever larger, ever more concentrated production units, then taxpayers might perhaps be more content in supporting initiatives to create the countryside that they want. Where food production is not the primary purpose of livestock on farms then spaces can be created which have the environment and recreation first in mind.

If food is not scarce, why should the taxpayer support food producers? Not that they have been, of course, in the case of the pig and poultry industries. In contrary, should the taxpayer rather support the countryside? If so (and it is reasonable that they should), then it is not obvious that giving money to the land owners is the best way. The creation of discrete areas specially designated for public enjoyment must be a part of the agenda, but it will also be necessary to consider the broad sweep of the landscape. Much of that can only be maintained if it is populated with grazing livestock.

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Government support to help finance particular sectors of an economy; essential utilities supply, infrastructure, defence, recreation, well-being, etc. is what governments and taxes are for. Governments are also there to steer economies by trading agreements – by incentives and disincentives for exports and imports. These two arms of government activity are very different. It is unlikely that a single platform for intervention can do both.

It might be suggested therefore that there should be no hesitation in a positive response to the proposition that the countryside is deserving – requiring even – of government support. The natural landscape of a nation is not merely that nation's only safe food supplier, it is also the major and universal provider of the population's physical and spiritual regeneration. Countryside furnishes both body and soul. Notwithstanding all of this, the nation's countryside is the fabric with which the nation is made. It might be advisable that it be looked after.

The matter, then, is not one of support or no support. No, the matter is how that support is delivered and what its targets should be. The *delivery* is a matter for government administration, but the *targets* are a matter for the voting population.

Presently, the populations of the countries of Europe seem not to have noticed, nor to care about, the plight of the countryside. Thus many national governments may have scant reason to pay much attention to it either.

The support systems for farmers brought in after World War 2 were hugely effective in increasing productivity and feeding a hungry Europe. That job was done. Indeed, it was overdone, both in level of (over) supply and in (under) price. The replacement system of dishing out money for ownership of acres (even with its present elements of gentle discouragement of inadequate levels of stewardship) is failing to deliver; as evidenced by its consequences – a collapsing livestock agriculture and a deteriorating natural landscape.

That the taxpayer might wish to spend *some* money on the public good of ensuring the fabric of our natural world seems not unreasonable. But, bearing in mind competing demands, it is reasonable to presume that the amount available will never be sufficient.

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Nowadays it appears that subsidies for farmers are there because without them farmers could not compete with other nations many of whom are themselves heavily subsidised by their governments and/or who operate to lower standards of animal and environmental care. Interestingly, the levels of subsidy received by beef and sheep livestock farmers in Britain is almost exactly the same as the levels of farm margin. So if farming itself does not change, removal of subsidy will remove all profit – extensive livestock farming will cease.

For farming to remain functioning, then farming must both change the way the job is done *and* the public must pay more for farm products; exactly as much more as the subsidy that is presently paid. The public must pay one way or the other, through the tax system (subsidy), or through higher prices in the shops. (It will not have escaped the thoughtful reader that paying by tax is much more gentle on the lower income earners than higher food prices).

This debate is not helped by the difficulty of devising a subsidy system which achieves its objectives. So far, the only systems that seemed to work were the ones post 1947 when food was in world-wide short supply and the simple objective of the subsidy was to increase it; which is not presently the case.

If home food prices rise above international food prices, then import controls and levies are required to deal with an uneven international playing field. These would hold home food prices up, which the voting public might *not* like. Removal of subsidies to those whose criterion of deserving a hand-out is merely land ownership will save government revenues; which the public *will* like. There are, of course, a plethora of 'ifs' – of unknowns. One such would be the consequences of reflation (purposeful inflation). This would put food prices up, as also would a fall in the value of currency in circumstances where a substantial proportion of food is imported (presently it's more than half for the United Kingdom). This also the public might *not* like.

Unfortunately, without positive action, for livestock farming the outlook is not happy. The present subsidy system only partially delivers, but the part that does is the industry's life-line. The political imperative of the future is highly likely to be one of fostering (rather than curtailing) international trade. The Americas, Australia and Asia are overtly gearing up their livestock systems to satisfy European Quality Assurance standards. In any such environment, active protection is needed for Europe's farmers. But import controls and levies, and anything else that puts food prices up, are entirely contrary to the logic that will win urban votes – never mind entirely contrary to the needs of the financial, technological and manufacturing sectors.

Chapter notes

The European Commission – Agriculture and Rural Development website (https://ec.europa.eu/agriculture) has full information about the CAP Support system, and its previous history. EUROSTAT also gives trading statistics for Animal products (http://ec.europa.eu/eurostat).

In a general way, the Princeton Studies series are interesting reading including Princeton Studies in International Finance No 78 (available at: http://tinyurl.com/ya6yfso3).

Chapter 5. Care; an animal's rights to welfare

Just as the hunted animal was respected by the hunter, then so were domesticated livestock respected by the humans who husbanded them. This relationship was not constructed, it was inbuilt. Before the farming revolution of the seventeen/ eighteen hundreds, animals and people just got on with life and death together. The recent difficulties resulting from man's (bad) behaviour toward the animals in his care had its routes in the notion that animals were items of farm property whose purpose, like all the other items of manufacture, was to produce goods for sale.

Animals came no longer to serve directly those who looked after them; they became the provider of products for others, far distant. The link between the carer and the user was broken. At the same time the need for animals to 'perform' better, to be more 'productive', became both possible (with the improved farming practices that came with the enclosures) and necessary (with the need to feed the workers in the manufacturing industries). Animals were put under the cosh. They responded willingly. Therein lay the rub. The more that was asked of the animals, then the more they gave.

In the early years, through maybe until the 1930s, it was evident that the ever increasing productivity of animals on farms was mostly a result of their better care and management. They were simply being enabled to grow faster and give more because they were better fed, better housed, better loved, better in health, better bred. Both parties, man and animal, benefitted.

The idea that 'cruelty to animals' could happen to farm animals (rather than cats and dogs) was a bizarre notion up until the time of the improvement of society's diet in the nineteen-sixties. It was the well-fed classes who were first to cast aspersions at the very industry that had put them into that happy state in the first place. Animal husbandry, they said, could no longer be trusted to the animal husbandman. Farmers were abusing their power over the animals.

The farmers were absolutely livid at the very idea. They were being taken to task by none other than those on whose behalf they had worked so hard. They were righteously indignant. How dare the busy-body sandals and gingham brigade meddle in their business? Farming wasn't a hobby; farm animals weren't pets. There was food to be produced. At a profit too, if farming was to continue.

Farmers saw themselves as the professionals, knowing what's best for their livestock. Besides, if the beasts were not happy and well cared for then they would not be as productive as they had now undoubtedly become. So go away! But those who the farmers considered merely as urbanised do-gooders did not go away. The protest movement against intensive farming gained impetus.

The farmer's declarations were too fiercely made; maybe there was something to hide. 'The lady doth protest too much, methinks'. Indeed! The blame however might not be justifiably laid at the farmer's door. In this case the orders were coming from society itself. It was *they* who were demanding more, cheaper, food. The farmers wanted only a living; they were just doing what was being asked of them.

The times of real conflict between farmer and consumer were to come in the nineteen seventies and eighties. Even a decade before that, however, farming had already been through one phase of what could only be described as 'rather less than best practice' as far as husbanding the animals was concerned. To put the era of public protest about animal farming into context we need to go back to the 1960s. It was the phase of getting more out, without putting more in.

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By the swinging sixties, the people of Europe were no longer suffering from a lack of food, nor from the lack of any ability to pay for it. The starvation years in Europe that came after World War 2 were well and truly past. The populace may even have been able to pay more – maybe; willing to do so – never! They had become used to having plenty of affordable food and had got to really like that. What wasn't spent on putting food on the family table was money to spend on what were now cheerily called 'consumer goods'. Radios, televisions, food mixers, washing machines, motor cars with built-in rust, gramophones, thirty-three vinyls, shoes, and all those things that were previously mended and were now being thrown away. Purchasing 'stuff' needs disposable income. So cheap food had become part of the new, better, way of life. It wasn't going to be given up.

While they still wanted it cheap, they also wanted it better. A move up-market was due. The war was well over now. Milk for liquid consumption was not enough; demand soared for butter, cheese, and yogurt. Bread, pasta, potatoes, beans and cabbage would no longer suffice as the core of a proper meal. People saw themselves as deserving of eggs and bacon. Chicken was not for once a month on Sunday, it was for every-day dinner. Meat consumption was the very definition of a rise in living standard.

Farmers needed to up production. Subsidies and prices supported by government guarantee would help to push them to do it. They would be paid for what they produced. Upping animal output upped farm income. Simple.

Europe's developing appetite had not gone unnoticed. The Antipodes sent 'value' butter and lamb. France, the Netherlands and Denmark doubled up their own production of cheeses and butter. Denmark became famous for its exports of bacon with Danish written all over it. South America sent its beef, Canada shipped its wheat. America sent soy bean, corn and corn products. There was competition. Farmer's needed to get competitive and cut their input costs. Reduce labour – fewer stock-workers to husband more animals. Reduce animal feed – more output for less input. Reduce capital expenditures – replacement equipment and buildings needed to be cut-price. Pennies had to be pinched; extravagances pared out.

On farms across Europe, but especially in the United Kingdom (leading the way in productivity and efficiency at the time) it was a lethal mix. The nineteen-sixties were the beginning of the end for small mixed livestock farms looked after by the family – farms where the animals each had their own name.

The first phase of things going noticeably 'wrong', was a matter mostly of interest only to the farmers and to the animals. At this point the consuming public were both unknowing and uncaring. They were getting their meat, eggs and milk well enough.

The housing and grazing systems that had worked well for smaller, gentler, ways of keeping pigs, poultry and dairy cows now had increased numbers of animals stuffed into them. The viable size for herds and flocks doubled and doubled again. In summer, dairy cows were grazed not on fields of permanent pasture, but in electric-fenced strips of short-term leys. Sows were housed in groups open to conflict and fighting amongst each other. The deep-litter laying sheds had extra birds squeezed into them. Even sheep were considered suitable to bring in from the pastures and live in barns with slatted floors. Cattle could be kept all their lives in sheds and fattened on diets containing high levels of concentrate cereals – grain-fed-beef.

One after the other, the old ways of husbanding animals imploded under the weight of pressured production being attempted in outmoded facilities and with inadequate labour. Animal welfare dropped to its lowest ebb. Farms had not volunteered for intensivism; they had been pushed into it. Nobody was ready for it. Not the farmers, not the farms, and most of all not the animals. Livestock farming had become a less than pretty affair. Conditions were rough. Life was brutish.

The 'general public', for the most part, had yet to notice this nadir of folly in livestock farming – animal 'quarts' being unhappily stuffed into farmyard 'pint pots'. This time though, they did not need to. The agricultural community was no happier with the state of affairs than were the animals. It was the farmers who wanted the hens out of overcrowded barns, pigs out of old-fashioned sties no longer fit for purpose, dairy cows released from their long winter days spent tied by the neck with chains.

The issues were resolved piece by piece; but in the event, quite rapidly. Mixed farming was abandoned. Farmers had to choose and specialise. A livestock farm had to do one thing or the other. Poultry and pigs were given up as 'add-on' enterprises. New units were built specially for large pig herds. Small egg and broiler-meat enterprises were given up completely. Brand new poultry units were built twenty times the size. Dairy cows were loose-housed and milked in parlours.

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It was the battery cage that came to the rescue of the beleaguered, dropsical, feather-pecked, mucky, diseased, parasitised laying hen. Farmers with five-hundred odd layers in

the euphemistically called 'deep litter' shed, either got out of hens altogether or put up n-number of thousand-bird battery houses.

A 'battery house' comprised small pens, made originally from chicken wire and white-wood lath. These pens had slotted floors so the bird droppings could fall through away from the birds and the eggs could roll forward to be picked up at the cage edge. Immediately, the birds were cleaner, dramatically healthier, ate less food and laid generously. The air they lived in was no longer foetid, dusty and ammonia-charged, it was cool and clear. Birds like company, so two and three-bird cages were made. Battery cages had been in use in the US since the nineteen-thirties. It took twenty years for northern European countries to pick up on the benefits.

To go into a battery cage was to the great good fortune of hens that would otherwise be condemned to the black holes of high intensity deep-litter. The battery cage had many of the health advantages of low density housing. In gratitude the birds laid lots of eggs – clean eggs, not like the ones that came from nest boxes made grubby by dirty feet (Figure 5.1).

Figure 5.1. *The battery cage revolutionised egg production (for the better) after the mid 1900s. The battery cage being a welcome and healthy replacement for deep-litter barn systems. But batteries fell into disrepute due to over-stocking and restriction of natural bird behaviours. Many of the shortcomings can be addressed by compassionate management, but the reality of a confined life in a barren environment will always remain. The battery cage is still a staple system for egg production globally, but is being replaced in the northern hemisphere by colony and aviary systems (image: Newquip/Big Dutchman).*

The pig's salvation lay in sow stalls. There were two sorts. The farrowing crate's main purpose was to save baby pigs getting squashed by their mothers (squashed piglet mortalities were halved at a stroke from more than twenty percent to around ten percent. Which was good news for the piglets, but bad news for the farm dogs for whom piglet-porridge was standard fare). Pregnant sow stalls were a rather imaginative solution for the problems caused by sows bullying each other when kept in loose groups. Big sows got bigger by stealing food from the smaller sows. To address this inequality, feeders were built from tubular-steel and angle-iron so every pig could go into her individual stall to eat her allotted ration undisturbed. They were so popular with the pigs (especially the littler ones who could now look forward to a proper meal) that the sows would spend time just lying in their stall, safe to snooze.

The growing pigs were taken out of their muck-yards and put into 'Danish' pig houses, with solid floors for simpler mucking out, or with slats for the dung to fall through so the pigs kept clean. In their new accommodation, pigs became sufficiently efficient to compete with Danish imports on price and quality. Slatted concrete flooring became the standard throughout Europe.

Dairy cows got their release from being chained by the neck in byres and shippens thanks to the invention of the milking parlour. Instead of the milking machine coming to the cow, the cow came to the machine. The girls could be milked half-a-dozen at a time. Set up above the dairyman (or maid) their udders could be easily cleaned and the machines gently applied to the teats. While they were being milked they munched their way through their daily ration of cow-cake. When milking was done, the cows walked out of the parlour to make room for the next batch coming in. The cows could now spend the rest of the day in big sheds with places to eat their forage or lie down and ruminate or go out to the fields to graze (Figure 5.2).

Figure 5.2. *Before the mid 1900s dairy cows would spend many months of the year chained by the neck. They were housed, fed and milked tied in the same stall. Modern parlour and robotic milking systems have the cows loose housed, free to roam, and with their own protected lying places (left image: John Eveson; right image: DeLaval).*

Fancy mechanised dairy parlours and big cow sheds for the milkers to roam about in meant big investment money. This simply could not be afforded by smaller producers. Even for the larger ones the costs could only be justified by labour savings and increased milk production. Big dairy herds got bigger. Whereas in the mid nineteen hundreds a viable milking herd was twenty cows, thirty years later it was two hundred.

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When things were bad before – when the old systems were breaking down under the pressure of society's demands – nobody was kicking up any fuss. But ironically, now things were getting sorted out, come the 1970s, that same society took notice and did not at all approve; they objected.

They objected with a great shout. And by now it wasn't just a few 'radicals' with funny ideas about animals having 'rights' – it was the mainstream 'person-in-the-street'. Large and reputable charities were getting involved. New organisations appeared with specific remits to 'do something' about the dreadful state of animal welfare on Europe's farms. The shout-out would last for almost thirty years; well through into the new millennium. The media loved it.

In its early stages the campaign got violent. Holding up cattle trucks and letting out the animals escalated to putting explosive underneath them while parked overnight. Research Institutes with animals in them (many on studies to improve animal health and well-being) were set ablaze. Scientists in agricultural university faculties were advised to look under their cars before driving off to work. Their secretaries were trained in the opening of suspect parcel-bombs. Farms were targeted – people found themselves in court on charges.

Crucial to what had happened next was that by this time vastly more people in the industrialised nations were more than two generations distant from the land. The animal welfare uproar got off the ground quickest in the United Kingdom, followed soon after by Germany, France, Belgium and the Netherlands. Spain, Italy and Greece lagged behind, reflecting cultural differences in attitudes toward animals. For many years the population of North America was indifferent to animal welfare matters. Animal Rights activists tended not to be welcome where a majority of people still had close relatives working in the countryside. In Brussels and Westminster, the politics were clear, there would be no votes in supporting livestock farmers.

The Governments of the European Union and the United Kingdom set themselves an animal welfare agenda; to reverse current farming practices which were perceived to be against the interests of animals' well-being.

That agenda got a real boost when the argument that only happy animals were productive was put to rest. The science did not support it. Neither did the obvious: healthy hens still lay an egg every day, happy or sad. Meanwhile, science had also made the philosophical links

between animal well-being and animal welfare and between animal welfare and animal behaviour. Animals could expect the right to carry out their basic normal life behaviours. If these behaviours were denied, then welfare was reduced and the animals' well-being was compromised.

Experts were put to the task of determining what these essential behaviours might be. Like many in science they theorised and postulated, set up hypotheses and challenged each other over endless cups of ersatz coffee, to finally come up with the blindingly obvious. It wasn't deep science, and any stockman on any farm could have told them so.

Animals in general needed to kept heathy, fed their natural foods, watered, not beaten, not stressed, given companions to be with, protected from the vicissitudes of the harsher elements of the natural environment, given space to move around freely, and so on. Pigs should be allowed to be piggy, hens birdy, cattle bovine. It used to be called 'animal husbandry', it had been happening on farms for ten thousand years. But maybe not so much in the nineteen-sixties, when several different adverse forces had came to bear all at once.

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What was the foolishness that was going on now? What had caused this outpouring of verbal and existential violence against the animal farming community. What had they done wrong? Just when they thought they were getting it right.

Maybe everybody had simply screwed up. The answers to the earlier problems, at that time so ready to hand, were misinterpreted and shoddily implemented – some would say purposefully (to save money), some would say ignorantly, the charitable would say by happenstance.

Battery cages failed to deliver on their promises. The houses had been cheaply built with inadequate environmental controls so birds were cold in winter and hot in summer and had no means to adapt for themselves. The pens made of steel wire and bent sheet metal were populated not with twos and threes, but to maximise the use of space, in fours and fives. Birds became stressed. They had nothing to do with their day. Birds like to be busy. These were idle, their beaks perpetually seeking something to peck at – like each other.

It was the space issue that concerned the 'animal rights lobby' the most. With living space not much more than the size of an A4 sheet of paper each, the birds could not stroll around, flap their wings, have dust baths, lay eggs in nests.

For the dairy cow, the shed and parlour solution was infinitely better, by anybody's reckoning, than being chained in a stall. The welfare problem here was not the housing, it was the production level. The system had now become so well put together that the cows were giving more milk than their constitutions could stand. They got thin, bony, lame, had malfunctioning stomachs and short lives.

Sows kept in crates could be arranged in rows in bigger, more economical, buildings. The individual feeders were similarly rowed-up onto slatted floors for the dung to fall through into pits below. With the backs closed down, the sows could stay there not just for feeding, but all of the time. Quite without realising it, the pig had gone from freely ranging in a straw yard to being confined in a cage little bigger than itself. The sows – investigative, inquisitive, intelligent creatures – were bored stupid. They would either lie recumbent for the want of anything else to do but gestate, or chew everything within reach (usually the bars of their cages). Because their lives had become static, leg, foot and lameness problems abounded (for a few years an industry in denial sought a solution to this by designing trials the purpose of which was to find which vitamin or mineral deficiency in the diet might be causing the problem!).

The sow had lost her freedom – completely. She could not even turn around or move more than a foot or two backward or forward. Nonetheless, under these conditions the pigs remained productive (rather like the layers in their battery cages). What's more, the price of pork had fallen, had it not, to prices that everyone could happily afford?

And so it was that for domesticated poultry, pigs and cows, no sooner had the farmers thought they had got it right, than it had all gone wrong – again.

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Changes in production methods which started with the laudable purpose of increasing food supply and ended with a greedy gallop to animal exploitation, is well exampled by the story of the search for the best age at which to wean pigs.

In nature, little pigs wean themselves naturally from their mothers as the former learn to get a full supply of nutrients from the outside world, and the latter stops producing milk. This happens when the piglets are around twelve weeks of age.

The pig is a most intelligent animal, and within it is a most intelligent natural system to prevent overload on the sow. While she is suckling her piglets she will not get pregnant, but as soon as her piglets stop sucking, she comes back into season and allows herself to be mated to produce the next litter. Clever girl! This puts a natural brake on the frequency with which sows have litters of little pigs. But little pigs are what grow into pork. More pork production needs more piglet litters. Impasse!

Come the 1950s weaning age had been reduced from the natural 12 weeks to a more 'economical' 8 weeks. This was possible because rather than foraging for high fibre foods, the piglets could be given better food: high-density ground cereal together with extra protein from fish meal, soy-bean, dairy by-products such as skim milk and whey, and meat meal. If everything went to plan, a sow could produce two litters every year. And everything did go to plan.

The next step was to knock weaning age back again to 6 weeks. A bit more milk products and fish in the diet, and maybe a bit of cooked cereal to improve ease of digestion. This worked too, but the management needed to be improved. Which it was, because by now (the late 1960s, early 70s), pigs were a specialised production system being run by specialist pig husbandry people.

Then there came upon pig production a wonderful grand new idea. The piggy people took a glance across at the dairy farmers. Dairy calves are taken from their mothers on the first day of birth. The milk is needed for people, not calves. The youngsters were rationed to some of mother's milk for a week or so, and then moved over to cheaper feeds. Why not the same for piglets.

In the mid 1950s there had been earlier attempts to wean baby pigs into cages and rear them on re-constituted cow milk ('baby milk'). The little pigs just about survived the stress of being removed from mother and the strange diet, but could not avoid succumbing to the coli and salmonella diseases that invariably swept in. If only the wrinkles could be ironed out the possibility was clear; piglets could be weaned almost at any age. All that was needed was a few good ideas and enthusiasm from a new generation of animal scientists, equipment manufacturers and animal feed compounders, all of whom duly stepped up to the plate in the sixties and seventies.

After much trial and more error, 7-10 days of age was selected as the right time to wean piglets into special (expensive) environments and onto special (expensive) feeds. But it would be all worth while because more than an extra half a litter could be got from the sow in a year. That's another seven pigs per year to be grown into porkers. In theory. The actuality was rather less than acceptable. The baby pigs could not deal with it. Disease became rife in the early weaning cages, and lacking mother, the piglets developed 'vices' such as frantically sucking at each other. The sows were not so keen to get breeding again either, so they returned to pregnancy slower and the next litters were smaller. On this occasion it did not need members of the general public to witness the abomination before action was taken. The pig farmers did it for themselves and thankfully abandoned the idea. Anyway, it wasn't turning out to be profitable!

Compromise was reached with three-week weaning. This was fine, providing that very high quality diets made from cooked cereals and animal proteins were used. But the welfarists had cottoned on, and were not at all happy with the intensity and barrenness of the housing that the little pigs were being put into. Some scientists were also looking closer at the way the little pigs digestive systems were working. A few of those scientists could even remember that when they themselves were young, piglets on pig farms were weaned at 8 weeks because that was when the pig's digestion could manage without milk. So when exactly did the switch around occur – from a digestion system for milk to a digestive system for cereals?

The answer – given good husbandry, very high quality diets and a progressive and gentle challenge with non-milk feeds, – seemed to be four to five weeks of age. So the recommended practice became (and largely remains) four-week weaning.

Getting, however, from where we were (12 week weaning) to where we are (4 week weaning) has proved an unsavoury and painful experience for the pig. It is difficult to argue that the motives involved were solely farmers' altruistic desire to feed people better. There was an element of exploitative greed which tended to coincide with pig-keeping being seen as a specialist 'industrialised' activity, rather than a 'husbandry'. Similar stories are there to be learned from in all the other animal farming sectors.

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By the coming of the turn of the century into the two-thousands a new enlightenment had fallen upon the livestock industries. A direction of travel that would lead to the housing, breeding, feeding and care of domesticated animals putting the animal first and the business of making money from them second. Both are needed, but they *are* in contrary to each other. It is a matter of priority. By-and-large such 'priorities' are sociological matters. Both the lead and the means to follow that lead rests, inevitably, with society's representatives – the politicians.

The initiative to ban battery cages (and sow stalls) came first from Brussels, but was eagerly taken up (gold-plated and earlier-implemented) by the British government at Westminster. Batteries were all gone in the United Kingdom (but not in other parts of the world) by 2007. Regulations *do* push up standards. There had been ample warning, from both Westminster and Brussels, that this was about to happen.

When it became clear that battery cages for laying hens would be banned in Europe and the United Kingdom, albeit not elsewhere in the world, northern Europe's farmers searched for alternatives. Laying hens were put back into deep-litter barns – only to find that the reasons for them coming out of barns and into batteries in the first place had not gone away. Some elements to the barn system were however 'good'. Places for the birds to have a dust-bath, to lay their eggs in nest boxes, to perch, to move about freely; to be birdy. Some elements of the battery system were also 'good'. Bird health, clean eggs, proper feed rationing, low cost.

Free range (*in sensu stricto*) – going back to the systems of the early nineteen hundreds – ticks many but not all of the boxes; it is by no means a 'gold standard' for welfare. Bird health can be compromised at all but the very lowest stocking densities. But perhaps most importantly, production levels fall, and labour and feed inputs rise. Efficiency is reduced and costs are increased. Free range, it may be mooted, is just great for the birds, but not for ordinary people wanting to buy affordable eggs to eat.

Two systems are currently in vogue. Both cover off many of the past failures of battery and deep-litter systems.

'Colony' pens are battery cages that have been 'enriched' (Figure 5.3). Of all the systems, this one has the highest health and the best production record. Around sixty to a hundred birds are looked after in big pens arranged in tiers (just like the old batteries). Birds are

Figure 5.3. *Colony pens also have a high density of stocking, but there is much greater possibility for birds to move around, and benefit from 'enrichments' with places to nest, perch and express more natural behaviours. The birds are nonetheless 'caged' and their behaviour compromised. In Europe there has been over the last decade a consensus that the colony pen may be a satisfactory alternative to the (banned) battery system. This system has the lowest mortality and highest health records (image: Newquip/Big Dutchman).*

fed and cleaned out, and their eggs collected automatically. Unlike the previous battery system however the colony cages are equipped with perches and places to 'bath' and preen. Importantly, although the space per bird is only somewhat better than in a battery, the actual space available is greatly increased because the birds can busy themselves around the whole of the 'hundred-bird' area.

The other presently popular system is the aviary (or cage-free) house. Called 'Free-range' (because the birds have access to the outdoors – which around ten percent avail themselves of on nice-weather days), the birds live freely in houses in three dimensions (Figure 5.4). Facilities are arranged in openly available tiers, enabling the birds to lay eggs in egg-laying places, to perch, to hop and flap, to do natural things. The houses are large (often fifteen or thirty thousand birds), but the birds sub-divide themselves into hierarchical communities.

These houses are highly automated for egg collection, feeding, watering and removal of droppings. The birds are productive and efficient. The buildings and equipment are costly, so bird density is necessarily high.

Figure 5.4. *Present public perceptions of the benefits of 'no-cage' aviary systems in Europe and America has resulted in a general favouring of these over alternatives as the aviary can accommodate greater freedom of (three-dimensional) movement, and enriched behaviour possibilities including choices of perches, nesting boxes and indoor ambulation. A common adaptation is to give access to the out-doors to range freely should they so wish (left image: Newquip/Big Dutchman; right image: Glenrath Farms).*

Only ten percent or less of our eggs come from 'truly' free ranging hens. The other systems contribute about half and half. The eggs are priced in supermarkets accordingly. Battery cages – ubiquitous in Europe through the last years of the previous century and now largely absent – remain the commonplace industry standard in many other countries; some with a keen interest in exporting their eggs to the countries of Europe.

Most dairy farms employ parlour and loose-housing systems. Health problems are more due to the high levels of milk production expected from individual cows than from the systems themselves. Breeding for cows with different targets (such as a robust constitution and a longer life) is not difficult. Reducing the output from individual animals does, however, result in efficiency losses and increases in costs. Dairy farms are becoming more welfare friendly places. At the same time, those same farms are becoming less competitive. Milk and milk products that are not from welfare friendly herds are cheaper. A fact important to supermarket buyers and their shopping clientele.

The British pig industry set about releasing its sows from pregnant sow stalls and tethers (now, of course completely banned) some twenty years ahead of the rest of Europe. In advanced systems, the sows have come to be grouped into free-range straw-yard houses (with individual feeding facilities, often now in the form of electronic sow feeders where an electronic tag matches the individual with her particular ration), or, in the case of the United Kingdom, put outside into fields with shelters. Outdoor systems have transformed the well-being of pigs in Britain, although all systems are dependent upon the quality of the stocksperson in charge. Outdoor systems are particularly open to abuse if too many animals are put into too small an enclosure, and the enclosures are not rotated annually with crops.

Neither should the challenge be underestimated – to both pig and person alike – of being outdoors in the bite of a raw wet winter's easterly wind.

The farrowing crate is proving harder to replace. There is a conflict of welfare interest; between the sow that can't turn around and the baby pig needing to be saved from being squashed. There is a middle ground; the sow in a crate until the main danger of piglet squashing is over (about 4 days), then release into a bigger space (Figure 5.5). In truth, such systems have been around since the 1950s. This sort of arrangement gives some increased freedom for the sow and quite a lot of reduced squashing for the piglet, but these pens are space (and cash) profligate compared to using a crate for the duration of lactation (4+ weeks). Outdoor systems for farrowing in huts offer a similar compromise. Elsewhere in the world, few commercial sows are kept outdoors, while presently about half the British sow herd lives outside.

Stalls and tethers for pregnant sows were banned in the United Kingdom (but not in other parts of the world) by the Westminster parliament such that by 1999 they were all gone. Their removal from other European Union pig farms had been much slower. There is no argument – keeping pregnant sows in stalls is contrary to their well-being. But stalls are efficient and cost effective. That is why, globally, stalls and tethers are so universally employed.

The insistence of the Westminster parliament that Britain should lead the way in implementing European Union welfare regulations (such as the sow stall ban), gave Britain a moral advantage in terms of pig welfare improvement. But at the same time British pork and bacon became ever more noticeably expensive to produce. Outdoor pig keeping is not

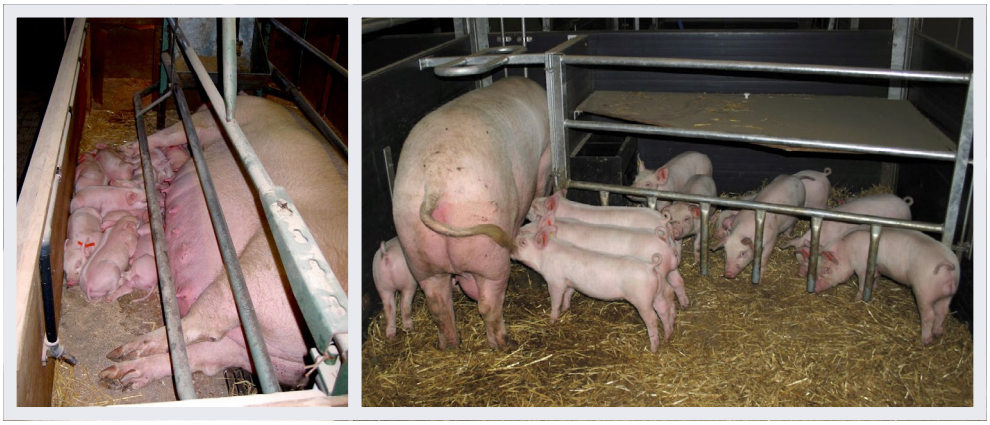

Figure 5.5. *The farrowing crate became the preferred standard for housing farrowing and lactating sows from the 1960s onward. Their main benefit lies in the first four days after parturition when the crate protects the piglets from being crushed by their mother; natural maternal behaviours such as nest-building are however also compromised. Greater freedom of movement can be arranged, but at increased housing costs.*

so efficient as indoor, and straw yards are more costly to run than sow stalls. In the nineteen-seventies the United Kingdom was well on its way to becoming self-sufficient in all pig meat and pig-meat products. Now, the majority of United Kingdom pig meat is imported. The British pig herd is now little more than one third of the size it used to be. It is a shadow of its former self. Putting in place welfare standards not adhered to by competing countries caused Britain to created for itself an 'uneven playing field' to its own great disadvantage. The losers are the pigs that live in those other countries, with lower welfare standards and for whom the United Kingdom is a prime export target.

The welfare campaigners who brought upon the pig industry these 'unintended consequences', have remained largely unaware of (or unconcerned about) what has happened. After all, they are reassured that British pigs are now 'better cared for', and there is no shortage of cheap pork and bacon (from overseas) in the supermarkets!

From the global pig (and poultry) viewpoint, the improvements in the welfare of animals on British farms has served not just no purpose, but negative purpose. When British livestock farms go out of business the world's animals suffer. The same model will likely follow for the rest of Europe. Beef, chicken and pork will be supplied from the Far East and the Americas.

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Not only have farm animals been bred with lower levels of disease resistance, they have also been knowingly put into positions of increased threat. Increased stocking densities (proximity of animals to each other) and increased stock numbers in a group predispose to disease virulence and spread.

Despite the improvements in animal care over recent years, farm animals are still getting sick all too often. It is the way they are kept. In natural populations animal groups adapt to the local diseases and develop natural resistances over time (sometimes long periods of time). Diseases ebb and flow in the normal order of things, but today's domestic animals are locked into a spiral of infection-threat and counter-treatment.

There are good reasons for this. Paramount is the need to 'do something' when an animal falls ill. If the resolution to a problem of welfare and production loss is ready to hand, then common compassion requires it to be used. Neither are all diseases self-limiting, some will destroy not just the individual, but the whole population. In these circumstances action must be taken; the imperative to provide human food can not wait on nature taking its course – else nature might take its course with the human population as well!

Nonetheless, leaping to instant treatment of every misfortune that comes the way of farm livestock is not always the most helpful in the longer term. Clearing out an infective organism not only creates spaces for reinfection by the same organism, it creates space for infection by a whole load of other organisms previously kept at bay (in balance) by the animal's immune system and by an equilibrium with acceptable (or benign) organisms.

It is well known that bugs under attack fight back. They do it by building up populations that are resistant to the weapons used against them. The treatments simply cease to work. Not only is the current solution to a disease lost, but the next solution will need to be more powerful. And in its turn the next solution will produce populations of the challenging bugs that are ever stronger and even more resistant. The evolution of life that has since its beginning controlled all living organisms is one that does not find favour with the for-ever removal of one of its members. It favours learning to live together in some sort of harmonic balance. There is no problem in having 'bad' bugs on board – all our healthy farm animals are full of them (as are we) – providing that the animal has learnt to live with them.

Killing an infective organism locks out the development of natural immunity to that organism, and thereby leaves the animal exposed to the next attack. In the long run, it can be counter productive to let infected animals live to breed another day. If they are saved, their offspring carry the same susceptibilities that were the downfall of their parents. They too will succumb and require treatment. Leaving nature to deal with the natural order of things, to kill out the families with weaknesses and to favour the ones with strengths, is 'cruel' to individuals in the short term. But in the long term, the downward spiral is broken and the population would become the better for it.

There is a reasonableness in the propositions (1) that interventions with chemicals to treat diseases are not sustainable in the long term (are sheep to be dosed with ivermectin for ever and ever?) and (2) that doing nothing will, in the long term, solve the problem by natural selection. There are two present stumbling blocks to such 'reasonableness': the welfarists and the perceived need for high output.

The position that domesticated livestock have been got into, without anybody really noticing, has simple (maybe simplistic) roots. Because the solution by medical treatment was there, it became depended upon as a normal part of good husbandry. A farmer not giving preventative treatment to his animals prior to a possible attack from a potential pestilence would be considered negligent.

However, proper management and modern technologies can avoid the 'hard' option whilst fostering a long-term approach. Families susceptible to both specific and general infections can be isolated, treated and not bred from. Animal breeders can shift emphasis and place their primary selection pressure not on production, but on disease resistance.

Biosecurity is of high priority on all intensive farms, but the threat is from other animals as much as from human activity. Time was when it was usual for a herd on a farm to be 'closed'. Stock replacements were born and bred at home – raised in the environment of the organisms (bad and good) that they would spend the rest of their lives with. In these circumstances immunity can build up over the generations as a matter of the normal course of events.

Nowadays, stock replacements are quite usually 'brought/bought in'. This is contrary to the natural order of things. No surprise then that farm livestock enterprises operating on a closed herd basis and breeding all their own replacement females are substantially healthier (and

happier) than those living on farms where breeding stock are replenished with animals from 'other places'.

The F1 Hybrid revolution in the pig industry of the 70s and 80s was beset by disease problems. The hybrid generation was made in special farms from purebred nucleus stocks, and then shipped out to their final destination on production units. The perfect mechanism for challenging both the incomers and the residents with unfamiliar infections to which they had low resistance. This did not only result in waves of various infections passing through production herds, but it also induced the necessity for prophylactic preventative measures. However good the potential performance of the hybrid, if it was in a sick environment it would not be as efficient as an 'unimproved' pig in a healthy one!

The bringing in of stock from 'other places' remains a major cause of loss of production (and welfare) not just amongst pigs, but amongst dairy and beef cattle, chickens and sheep as well. The mixing of stock of different origins and then its subsequent dispersal far-and-wide is a perfectly organised system for disease spread. It is one volunteered for on a daily basis by the livestock industry. To say it is foolish is to be charitable. It is called a Livestock Market.

The live animal market, so important historically for the trading of live animals, meat, and animal products, both amongst farmers and between countryside and town have now been largely superseded by less anachronistic means of trading. Some active markets remain; for animal products (but not so much for live animals) in Continental Europe, and for live animals in the United Kingdom. The 'Producer's Markets' have much to do with 'artisan' and local provender, whilst the live animal trade is predominately sheep trading (over half of all sheep meat produced in Europe comes from United Kingdom and Ireland).

The livestock market system *might* be justified as a link in the *one-way* chain that puts together meat-producer with meat-buyer to settle on a 'going market value' for animals destined for slaughter (although the poultry and pig industries seem to manage fine without). However, it is more difficult to find a case when animals are *not* going in one direction. In *this* case, after mixing closely with a miasma of unfamiliar infections, they are then re-distributed back to farms at all points of the compass. A mockery is made of 'bio-security'. The benefit (particularly when alternative ways of trading are available) is hard to determine, while the costs in ill-health are all too evident. Unfortunately, those disease costs are now considered a normal part of modern husbanding.

The livestock market does however continue to fulfil one vitally important rural function. It has nothing to do with the animals and everything to do with the farmers. It is their one-day-a-week opportunity to socialise in what otherwise can be a lonely and isolated life.

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Learning to care has many facets – all those aspects of animal behavioural freedoms that result in animal well-being. As will have been noticed however the over-riding question

raised about any improvement in animal well-being is whether or not it impacts positively on profitability. The main driver for profitability is animal productivity. Animal productivity comes at two levels; (1) the individual rate of production for a single animal and (2) the overall (total) rate of production for a group (or farms-worth) of animals.

Modern technologies readily allow level of production to become too great for the individual animal's biology to cope. This can be absolute amount of production (growth, eggs, milk, whatever) *per se,* or it can be *relative* production; the balance between level of output and level of input. If kept in balance, there is a better chance the animal can cope. *All* systems fall apart when pushed too hard, and an individual animal is no different.

The group rate of production invariably comes down to degree of intensivism. By and large this is seen as stocking density – the number of animals in any one enclosed space; farm, field, barn, house, pen, cage. The consequences of denying adequate space to an animal are evidenced by the animal's loss of well-being in terms of its physical and mental health. There is no way around this fundamental. Overstocking – too many animals in one space – can never be satisfactorily addressed by making the animals and/or the spaces in some way different or 'enriched'. Enrichment helps, but at best can only alleviate the symptoms. The cure is more simple; reduce animal density; augment animal experience.

This is nothing to do with the size of the farm, or even the number of animals in a single secured space. It is to do with the simple reality that animals have a minimum requirement for distances between each other. They also have lives. They need to be spending time doing those things which come naturally to them. What is inadequate space and what constitutes boredom differs between the domestic species. Space requirements are much greater for sheep and cattle than for pigs and poultry. A landscape which bores a cow will differ from one that bores a chicken. There are, unfortunately, good reasons for these self-evident truths not being fully and immediately addressed.

One, increasing density of animals within units – be that a pen, a house, a field or a farm – increases the productive output from that unit. Even though the individual performance of the animal may fall, the overall performance of the group goes up; to the benefit of the business.

Two, animals doing things – living their natural lives – takes up space, consumes capital expenditure and reduces stockworker convenience. The business model benefits at the expense of the individual animal. Optimising the circumstances of life for the individual has the inevitable outcome of increasing costs of production. Society would need to willingly pay more for its food. That has always been a *political* issue.

Finally, caring properly for animals in an open market where competing countries have different standards (and therefore costs) can only have one outcome. Those who care best for their animals will be the first to go out of business. That too is a political issue.

One is left however with an enduring puzzlement. Livestock care on farms is about the interaction of people with animals. The bond between animal and mankind is strong. People love animals. They volunteer to love them, spend time with them, nurture them. In advanced economies they happily spend huge sums of money on looking after the animals they welcome into their homes, gardens and paddocks. There are even those (rather many, actually) who say they get on better with animals than with other human beings. And yet the primary efficiency driver on livestock farms is reduction of the number of people looking after the animals – 'labour-saving'.

Chapter notes

The three classic sources for animal wellbeing are: Rachel Carson's Silent Spring, originally published in 1962 through excerpts in the New Yorker, then by Houghton Mifflin; Ruth Harrison's Animal Machines, published in 1964 by Vincent Stuart; and the Brambell Report, HM Stationary Office, 1965.

Presently prevailing conditions can best be found in the Assurance and Quality Standards Schemes to which adherence is required by government and by human-food suppliers. The base European Union Council Directive was published in 1998 (98/58/EC). Individual countries, individual schemes, and indeed the standards of individual farmers, often exceed those laid down as minimum requirements.

Chapter 6. Food and feeding; nutrients are not enough

Animals are built, inside and outside, to be food gathering, nutrient absorbing, organisms. It is their second reason for living another day.

After nearly a hundred years of scientific investigation, the requirements of animals for nutrients are now rather well known; how many calories of energy and how many grammes of protein are needed to grow a hundred grammes of body weight, or produce a kilo of milk, or an egg or whatever. Being able to give the animals in our care the nutrients they need is the least that can be done for them. It is the first and foremost of an animal's rights – the right to be properly fed. But unfortunately it is not yet possible to define food in a sufficiently complete way for the animals to be 'properly fed'.

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The thing about the concept of 'nutrient requirements' is that it is a most convenient idea. The food to be offered to an animal can be expressed in terms of calories of energy, grammes of amino acids, milligrammes of minerals and micro grammes of vitamins. This resolves so many problems all at once. It is as if the idea was invented not so much to try to feed animals better as to appear to feed them quite perfectly.

It is most convenient that things can be analysed chemically (well, some things can), so nutrient requirement can be expressed in objective terms of determinable measurements made relatively easily in a repeatable and protected place like a laboratory. If these things (the ones that can be measured in a lab) are provided at a given rate per day, or a given proportion of the diet, then the job is done. The animal is properly fed. It matters little what particular *foodstuffs* are used to feed the animal, providing only that they are put together in such proportions as to satisfy the 'nutrient requirement'. The most readily available and cheapest feeds can be put together at 'least cost'. One of the earlier uses of a computer program, actually, was to formulate diets from a list of available ingredients at 'least cost'.

Of course, this bypasses the important, but 'difficult', question of how foods (rather than chemicals) are used (in the broadest sense) within the animal's constitution. By not addressing it, sillinesses are allowed to prevail. For example, the notion that energy (and protein and the rest) can be equally as readily provided from any food that contains them: grain, meat, fish, pulse, root. Tell that to a pasture-grazing cow, a branch-browsing goat, an insect-catching hen, a grain-guzzling pig, a mouse-catching cat or a rabbit-chomping dog. It is a matter of the huge difference between the de-constructed chemical elements of a foodstuff on the one hand, and on the other hand, the actuality of the complexity of the body tissue of a swallowed prey or of the vegetative matrix that makes up a mixed species grassland.

There is more to food than nutrients. More to feeding than nutrition. Animals do not eat nutrients. Nutrients (and anti-nutrients) are described through the rather limited means of chemical analyses. The definition of nutrients is wholly dependent upon *what* can be analysed *for* within the confines of present human knowledge and laboratory technology. Animals eat crops and other animals. Whole complex things, not simple chemicals such as nitrogenous compounds. Food energy (calories) is determined in the laboratory by setting fire to food and seeing how much heat is generated. As a metaphor for animal metabolism, a fiery furnace is a little limited.

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A day in the life of a pig in the wild woodlands and the forest fringes is a busy one. The family group moving through the underbrush. Smelling, tasting, sounding, rooting for whatever good things may be found above, on and under the soil surface. Pigs are mouthy beasts; the head is a big, powerful digging machine, operated by formidable neck muscles. The jaws wield teeth that are well designed for pulling, grinding, chewing, biting, killing.

It is immaterial whether the pigs in question here are 'wild' or domesticated-gone-native. There would be no difference; domestic pigs released to the wild behave much the same as their ancient ancestors. They will create a protected environment where they can shelter from the weather, resting in the warmth of each other's bodies. They move large distances. There is nothing to be seen of that sloth that comes from boredom. Pigs are neither lazy nor languid. They are alert and quick in their reaction to danger. They will leap and run, covering the ground at speed.

Are these really the pigs that also live on farms? Yes indeed! Not so many years ago crazy animal behaviourists from Edinburgh researched that very question and found that it was so. It was not a complicated experiment. They just let the domesticated farm pigs out onto a country heath and watched what they did for a couple of years.

What are these pigs eating as they forage through their extensive domain?

First to find the food. The most obvious part of a pig, perpetually investigating its terrain with never-to-be-satisfied inquisitiveness, is its snout. The head is forever on the move, finding, testing. Pigs will put everything into their mouths. It is what pigs do. Pigs have a massive inherent drive to manipulate their environment with their jaws. They simply want to chew at everything (Figure 6.1). That is good and proper because otherwise they would starve. In their natural place, a day in the life of a pig is a day spent looking for food and eating it. They do not eat for most of a day because they are gluttonous. They eat through the day because their food tends to arrive in small packets after a diligent search, or big packets that take a lot of time chewing. Neither is this characteristic just a piggy thing. It is a *farm livestock* thing.

Figure 6.1. *In their natural environment pigs will spend much of the day rooting to find their daily needs for food. A modern pregnant sow will consume all of her daily allowance in five minutes, and then be looking for something to occupy her drive to chew; often this will be the bars of her pen.*

A pig or a fowl in their natural states feed so differently to pigs and poultry on a farm that one might pause to consider whether they have been 'domesticated' or simply 'constrained'.

During this day of hunting, the family of pigs grubbing in the woods will be eating just about everything that comes their way. Copious amounts of greenery; grasses, rushes, broad-leaved plants, saplings, shrubs. Roots, of course, of anything that grows, young or old; tubers, rhizomes, bulbs. Fungi, truffles sniffed out from under oak trees. All and anything that's going. Seeds, nuts, berries. Other animals; scavenged carcasses – carrion left by predators – or to be dug out alive, beetles, worms, grubs, mice, voles, rabbits.

The way that pigs, and poultry, eat naturally has impacted little on the decision-making process for the way these animals are fed on the farm. Domesticated livestock have different things expected of them. Shelter provision is expensive so they must make do with less space, less activity, less to do through the day. They are unrecognisably more prolific and faster in their growth than native beasts, so they must be fed more of better food. There remain, nonetheless, difficult-to-excuse aberrations in the way livestock are fed on many intensive farms around the world.

The pregnant sow has a substantial gut capacity for holding low density food, but she is fed a high density ration of cereal grains and soy bean. She is permanently physically hungry, though the diet is nutritionally complete. She is driven in nature to occupy her mouth for the most part of a day, though on the farm her meal is downed in a few short minutes.

She can cope with a large amount of plant fibre – roughage, though there is little in what she is actually given. Her jaws can break down big chunks of tough stuff, needing serious chewing; branches, roots, carcasses with sinews and bones in them. What she gets is fine-ground meal; with water it turns to gruel.

She is programmed to spend hour after hour seeking out her food; smelling, looking, grubbing, hunting – Oh joy! The finding of a scrappit! On the farm she is spared all that effort. The food arrives in one small concentrated pile, placed conveniently within a few metres (or centimetres) of her snout. How thoughtful of her human carers! The day of a tethered or crated sow is done-with in a trice, she can lie down and do nothing for another twenty-three hours and fifty-five minutes. No energy needs to be wasted in hunting for sustenance.

There are huge welfare implications of a clearly unsatisfying feeding regime (such as 'bar-biting'; Figure 6.1), while self-evidently, there is no strictly *nutritional* shortfall. The welfare issue can in part be resolved by the movement of pregnant sows out of confinement stalls into fields, or into loose-housing barns where there can be (but is not always) ample clean straw or similar substrate to chew on. However, this is not typical of most parts of the world, nor are all farms the same...

What goes for the pregnant sow may also go for the growing pig, but not so much for the lactating sow, nor the youngsters. A modern sow, with a dozen or more fast-growing piglets sucking milk from her, could not eat enough nutrients from a 'wild' diet to satisfy demand. Lots of high-powered feed is the order of the day, not grass and shrub roots. It suits mechanical feed delivery (and dung removal) systems to deal in concentrated materials.

Pig farms as specialised units appeared only within the last seventy years. Before, pigs were part of a mixed farm with a number of livestock enterprises. Here the pig's natural feeding patterns were all put to gainful employment. Pigs were sent to clear scrub and woodland underbrush. They turned straw into muck for the potato ground. Out of the dairy and into the pig-sties came buckets of otherwise-to-be-wasted skimmed-milk from butter-making and the whey from the setting cheese. Pigs ate the left-over grains from the granary. They grubbed in the courts for undigested corn in the cattle dung. They ate the root crops that were surplus to requirements; the potatoes, mangels, sugar beet. They ate the guts that came from slaughtered beasts. They ate *everything* that the humans refused; the scraps, the meat left on the bone and the bones themselves, the peelings, the fruit on the turn, the vegetables beginning to rot, the stale bakery, anything surplus to requirements...everything that was destined to come into or go out of the kitchen that was not actually eaten by the people.

Nowadays, most pigs are fed grains grown on farms for that sole purpose of making pig-meal. Meanwhile, the wastage of food in Europe is as immense as it is reprehensible. Around fifty percent of the food grown for people to eat ends up being thrown away. Why is there so little effort put into getting at least some of this down the throats of pigs? Only a small sector feeds its pigs on broken biscuits, bakery waste and the like. Is there a problem?

There *are* inherent dangers in human meat waste being fed to animals, for they can carry diseases and zoonotic parasitic organisms – of both pigs and people. Foot and Mouth disease can spread as a result of improperly cooked meat scraps being fed to a few pigs. But that is not the case for the fruit and veg, for the bread, for the wasted pastries, the confectionary...and, of course, arrangements for proper cooking are not overly difficult.

As for the meat, meat-and-bone is a natural and good ingredient for the diet of a pig. Tons of it comes out of slaughter plants. Much of that is burnt or digested to make gas, or is buried. But if it is to be fed, to dog, cat or pig, it does have to be properly treated to be sure that it carries no viable infective agents.

It will require effort, will, investment, law, new technologies and enlightened agricultural entrepreneurs to put into place a system of livestock production that will re-cycle society's profligate food wastage back into human food through the medium of the omnivorous pig. The sort of effort that the leaders of the farming revolution of two hundred and fifty years ago would have thought light of.

Having gone to the trouble to domesticate the pig, it is ironic that one of its unique contributing attributes – its feeding habit – is being ignored. By ignoring the qualities of piggyness, not only is a valuable skills resource being wasted – the animal is being denied its natural behaviours.

Can this denial be addressed? Food is concentrated into a low-bulk easy-flow medium because that is the cheapest way to transport and to move it with mechanical equipment. In the natural world the animal goes to find the food. In the farm world the food needs to find the animal. But pigs *can* be given fibrous material (such as straw or paper) to explore, manipulate and chew upon. Cereals *can* be more coarsely ground. Ingredients *can* be offered separately to allow freedom of choice. The feeding environment *can* be complexed so food must be found and worked for – not simply guzzled. These things and more. But to deliver these benefits would require a whole new approach to housing and feeding systems – one that would cost.

Are these suggestions merely for 'enhancements' – *would be nice to have*, rather than *must have*? The former would be a luxury whose cost can be measured and found excessive; the latter a necessity that has a cost which simply must be borne. Most pigs in Europe have their tails docked. This physical insult is to protect the pigs from the more dire consequences of the procedure *not* being carried out – the likelihood of having their tails chewed off by their fellow pen-mates. Tail-biting is a syndrome with a multiplicity of causes and only addressable by a multitude of actions. Some of these actions come under the heading of expected good husbandry – lower stocking density, proper control of house humidity and temperature and so on. Most however are to do with food and feeding. The mouth that bites tails is the mouth that is looking for feeding activities to satisfy.

What has been said for the omnivorous monogastric pig goes also for the omnivorous monogastric chicken. Chickens too spend most of their waking hours seeking for food.

They too are rather good at balancing their nutritional requirements. They know whether they need more grain seed or less grass, or a fly, or pebble, or beetle, or a mouse to eat. They too can handle in their crop and grinding-gizzard large chunks of food as well as small. They too eat meals semi-continuously. They too are programmed to have a life dominated by finding food; they are driven to peck.

And, just like the pig (and for the same reasons), what they tend to get on farms is a fine ground, highly digestible, nutritionally-balanced perfectly-mixed homogenate requiring no inherent knowledge on the part of the bird to determine its worth. It provides the required nutrients. No energy is wasted in the getting of it. It is perfect. But it renders a large part of the animals' guts non-functional. The intestines deteriorate through underuse. The modern chicken diet does not fulfil the required functions of a food.

If the will and the money were there, it is relatively simple to offer food in unmixed streams, requiring a (decision-making) choice as to which food to peck at. Indeed some enlightened modern poultry producers do exactly this. Coarsely ground materials can be offered to give the digestive system work to do – the grit in the gizzard something to grind at. Human ingenuity can be employed in coming up with more complex ways of providing food than currently prevails on farms. This would give the animals more of a challenge in getting the nutrients they need. Feeding would become once more what it used to be – a rewarding experience in the widest sense. Birds driven to peck more assiduously for their food might also be diverted from pecking at their companions.

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Cattle and sheep have rumens. These big microbial fermentation vats – full of bugs and foul smells – digest otherwise indigestible plant material. Sheep and cattle are wonderful efficient users of pasture; either grazed or conserved (Figure 6.2).

Huge areas of northern Europe are covered in pasture. This is a major comparative advantage over other food producing nations that find it substantially more difficult to grow good grass. It's the climate; the weather, the warm, the wet, and the soil. Grass comes to northern Europe and Britain naturally.

There is grass on arable farms as part of the rotational cropping programmes, there is grass in the low places, in the high places and the in the places in-between. There are vast tracts of grass in the British Isles, with East Anglia being the exception. Similarly green and pleasant are France, Belgium, the Netherlands, Germany, the Baltic States, and the atlantic fringes of the Iberian peninsular.

Farming systems since World War 2 have made a thorough job of reducing the diversity of plant species in Europe's grasslands. Whereas a natural pasture might normally contain (conservatively) more than twenty broadleaved species (many with important therapeutic and nutritional values), and a dozen or so types of grasses, a modern grass ley will have few

Figure 6.2. *Herbivorous cattle and sheep would normally spend most of their day grazing or ruminating. Foraging animals in an extensive and natural environment can satisfy their drive to search for, ingest, and digest food.*

broadleaved plants (otherwise classified as 'weeds'), and often only three, four or five grass species. This practice increases apparent yield of nutrients, but can only diminish effective feeding value.

The presumption that the only nutrients which exist are those that can be measured in a laboratory (where what is found is always that which (1) is looked for, and (2) is measurable) gave support to the simplification of pasture species. This way of thinking denies, amongst others, the potential therapeutic contributions of those plants which are not high yielders of carbohydrates, but may contain compounds of normal and natural benefit to grazing animals. Some of these 'weeds' may also even be labelled 'toxic'.

Grass is not a human food. Farms can feed people with the cereals and the fruit and vegetables they grow, but they can not feed people with grass. The grass has first to be eaten by the ruminants and turned into meat – *that,* people *can* eat! Herbivores great service to mankind is to turn non-food into food.

It would be enough alone that all that natural grass was gainfully employed producing meat and milk. But there is more to countryside than human food. Grasslands keep the countryside open, naturally diverse, aesthetically pleasurable to the eye, ear and nose, fit for human recreation, fit for wildlife. All of this is dependent upon grazing livestock and upon the cutting and conserving of grass for livestock's winter feed. Without the grazing sheep and cattle the landscape goes to wrack and ruin.

For those who farm the grassy country, a main part of their spendable income comes not from what is sold off the farm, but the subsidy that arrives in a cheque from Governments. This subsidy comes to farmers on the basis of the acres that they keep. The incentive therefore is to have acres. The livestock on those acres is becoming increasingly incidental.

The natural pastures are reverting in consequence. The grass environment is natural, but it is not stable; it is the livestock upon it that keeps it what it is. Without the correct grazing and cutting regimes, grassland (and the diversity of flora within) will fall – is falling – to scrub, to moor, to bog, to bracken, gorse, thistle and rush. Wonderfully, wildlife and conservation managers have come to the amazing realisation that their protected areas need for their continued preservation, grazing cattle, sheep, goats and horses.

The balance of the business model for grass is presently in favour of reducing both recurrent and capital input costs such as would be incurred by expenditures upon weed control, fertility enhancement, drainage, and land and soil maintenance. It is not a matter of considering what the land might produce, it is a matter of not spending money on it. There is not much money to be made out of keeping sheep and beef! Most important in the grazier's business model is to get the form for that government payment filled in properly, ticking all the right boxes and getting the proceeds banked. That and giving due consideration to putting up another wind turbine. In these circumstances it can hardly be expected that Britain and Europe's grasslands will be either best used or well cared for. To abuse and fail properly to husband so iconic a resource would appear, as a national forward plan, to be rather foolish.

Lamb and beef can be reared on grass (fresh and conserved) right through to 'ready-to-eat'. Feeding cereal grain to ruminants is counter to a naturally functioning rumen and counter to common sense. If there is cereal available for feeding to animals (rather than to humans), then logic dictates that it be fed to simple-stomached pigs and poultry, (1) for whom it is a natural diet and (2) by whom it is converted to meat more than four times more efficiently.

So why is it that at the present time substantial tonnages of cereal-based concentrate feeds are going down the throats of beef cattle and lambs while the broad acres of natural sheep and beef grasslands are languishing? The answer is that those farmers who feed expensive cereals to ruminants do so because they find themselves in circumstances where they can not sell their lamb and beef unless they do.

It is not the customer who is crying out for farmers to produce more tallow, it is the system of marketing. Lamb and beef animals must be 'fattened' or 'finished' (same thing). This is a singularity. It does not hold for pork or chicken, nor for goat or guinea fowl, nor venison, nor fish. Neither does it hold in all countries. Meat chickens and pigs are simply eaten when they get to required market weight. There is no 'fattening' or 'finishing' going on.

To be finished off grass the best livestock breeds are the ones which grow to mature at a relatively small size. Modern breeds grow more quickly, but that quicker growth has come from selecting for big size. These new 'continental' types, were they to be left to 'finish' naturally off grass, would end up very large. Too large for many market requirements. So, they must be hastened on to reach a state of 'finish' before they even begin to approach their natural final size. In fact, at about half their final natural size.

To be sold for human consumption, cattle and sheep need to reach target weight and target fatness simultaneously. With the 'big' breeds, this is achieved by feeding cereals. Strange it may seem, but it is the only way. The animals must be made to eat so much energy from starch that, instead of fattening *after* they have grown, they fatten *while* they are growing. That is the trick. Shovelling grain down them effectively overfeeds them. All needs for growth are satisfied, so the surplus goes to fat. The animals finish before they are fully grown. Job done. But at what a cost! It is counter-intuitive to feed grain to grass-eaters – it is profligate of every resource, it is environmentally unsustainable. Meanwhile the management of grazing lands is neglected. Oh dear!

Is it beyond the whit of man to devise an incentive scheme that encourages the husbanding of our grasslands to produce grass upon which beef and lamb can grow until they reach their required slaughter weight? Can livestock which grow quickly enough but are smaller at maturity not be bred? Can cattle and sheep not be prepared for sale as beef and lamb at a lower state of fatness? Can the graziers and the meat consumers not reach a mutually beneficial solution? Or is it the *market* which is standing between the producer and the customer to the disadvantage of both?

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Dairy cows got 'mad-cow' disease. Its spread was encouraged by the cows being fed high protein supplements in their diet which came not from vegetable protein but from animal protein – meat meal. Now, cows are, as everybody well knows, herbivores.

The Bovine Spongiform Encephalopathy (BSE) story in the 1990s was mostly about dangers to mankind from an epidemic of New-form Creutzfeldt-Jacob Disease (CJD) being caught from eating infected beef. It was not so much about the sorry state of infected cows. Despite predictions that the human population of Great Britain had already been contaminated sufficient to cause many hundreds of thousands of deaths by CJD in the new millennium, incidence has resolutely remained at around the hundred mark. But that is another story – about poor science reporting and media hype.

BSE incidence in United Kingdom dairy herds was first remarked upon in the late eighties. It peaked at four thousand in 1992. It had been dealt with by 2004 and effectively gone by 2006.

How the BSE prion came to plague our cattle in the first place is mysterious, but how it was spread about through dairy cow feed is generally agreed.

The reason why meat meal from bovines was re-cycled to dairy cows was because it increased the ability of the dairy cow to give more milk. At peak production the cow simply can not eat enough nutrients to satisfy the metabolic demands coming from her udder. There is a volume problem together with a rate of processing challenge. The cells in the mammary gland can make milk protein faster than the cells of the rumen microbes can make bug

protein out of grass. There was some good science which showed that if extra amounts of quality protein could be fed, more protein building blocks would flow into the cow's blood stream. Result; more milk. It worked a treat.

One of the best high quality protein sources was meat meal which came from the renderers; the industry which turns waste animal tissues into useful animal feed. Unfortunately, the renderers had just implemented a smart technology that both saved a bit of money and increased the quality of the product. This innovation was able to use a slightly lower treatment temperature – one that just happened to be less effective at destroying the prion protein that causes BSE. The previously broken cycle of infection had just been re-linked.

The prion problem was resolved by legislation disallowing the use of animal derived protein supplements in rations for ruminants.

The argument could also be raised that if it takes an unnatural management regime to get a lift in the rate of production – such as feeding animal tissues to a herbivore – then maybe that lift might not be such a good idea in the first place. Priority shifts that put animal output ahead of animal well-being will always have inherent risks; many of which are entirely unexpected.

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As has been pointed out already, to live, grow and breed, all animals need to ingest a given amount of nutrients every day, and by and large, these amounts – for the major nutrients – are now well known. The rules for requirements are measured in absolute terms – calories (or joules) of energy, grammes of amino acids, etc. *per day*. Those given amounts of nutrient can be provided by less of a more concentrated diet or more of a less concentrated diet. Nutrients ingested are the product of diet concentration *and* amount eaten.

Control of the amount eaten is a one-sided function. An animal can not be *made* to eat more, while if the animal eats all that is put in front of it, then, by definition, the appetite has remained unrequited. There needs then to be a little more to the existing rules. A ration should be given to the animal such that it exactly satisfies both biochemical nutrient requirement and physical appetite.

Unfortunately, whilst the feed compounder can write the rules for nutrient concentration, it is the animal that writes the rules for how much it will eat. *Voluntary feed intake* is a scientific term that on this (rare) occasion illuminates more than it obscures. So many things determine the level of 'volunteering'. Amongst those determinants are: individual feed ingredients used, feed texture and flavour, presence of unwholesome factors, gut capacity, past nutrient need, present nutrient need, future nutrient need, appetite, feed appearance, taste, smell, sight, jaw-muscle tiredness, competition amongst peers, hours in the day, and so on and so on.

The cynic might suggest that however much an animal eats, that amount will always be either not enough or too much. As any stockman will tell, the amount of food that should be given to a farm animal can not be determined with a weigh scale. The animal should get what the animal needs. And to know that, it is the animal that should be asked, not the weigh-scale.

The amount of food (of a certain concentration) to be put before an animal has been the cause of much investigation. Definitive feeding regimes have been determined for every type of farm animal. Theoretically really handy for lecture-room didactics, such 'rationing programmes' are, however, not a great deal of use to the animals themselves. It remains that despite the writing of countless manuals laying down the law about how much of what an animal should be fed, the only rules that work are; 'if growth is too fast, or too fat, or if productivity is excessive, feed less. If growth is too slow, or too thin, or if productivity is insufficient, feed more. If appetite is poor, improve feed palatability. If the animal is hungry even after enough is eaten, increase feed volume. If the gut is filled before enough is eaten increase the feed concentration.' Sometimes science can get in the way of common sense – complicating the straightforward.

The story of how to feed the weaned piglet has been (still is) a salutary tale of human folly in the face of the obvious. As has already been described, a piglet lives and grows (very fast) on mother's milk (alone) for about four weeks. Then gradually, in their natural world, they find and consume progressively more food (both vegetable and animal) from their habitat. When piglets in modern systems are taken away from their mothers it was soon learned that without high grade animal (milk and fish) feed ingredients in their diets they could not thrive. These feeds happen to not only be highly palatable to piglets (so they eat plenty), but are high in protein. Thus arose the myth that newly weaned piglets needed lots of protein. This was a convenient myth because protein (nitrogen) content can be analysed for in the laboratory, whereas palatability can not! It was not the chemical nitrogen that the piglets craved, it was the taste of milk and meat. As it happens, sow's milk is not especially high in protein, but it *is* especially high in digestible fat. The consequence of nutritionists thinking like chemists instead of like husbandmen was that piglets were offered diets progressively higher and higher in protein, whereas what they should have been offered were diets that the little pigs wanted to eat lots of; diets with compositions like mother's milk; diets high in digestible energy. They needed to consume not more chemical protein, but more *food*.

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Rule books can suppress the skills required of an animal husbandman. When the animal is captive and can not be in control of its own diet, the duty of care lies not with a book, but with the stockpeople whose eyes should be looking constantly at the animals in their charge, and whose brains should be understanding what they see.

If one wants to know if an animal is properly fed or not, then do not look into the pages of a laboratory analysis manual; look at the body condition of the animal itself.

Chapter notes

Arguably the best known series of statements of nutrient requirements of farmed animals is that produced by the US National Academy of Sciences – National Research Council. Initiated after WW2, these cover most all species and their revised editions are now running into their teens. The early editions were 'authoritative statements of singular truths'. This paradigm for presentation came under increasing criticism as (though it provided a concrete absolute that could be seen as a minimum) it was readily found to be wanting in many practical feeding situations.

'Rations for livestock', bulletin 48, HMSO, London was printed in 1948 (much of its content emanating from research before World War 2). There were a succession of updates culminating in that of 1960. In 1963 the Agricultural Research Council of the United Kingdom began its series with 'Nutrient requirements of farm livestock, poultry', followed by Ruminants in 1965 and Pigs in 1966. The Agriculture and Food Research Council published a series of requirements reviews through subsequent years, and these were then interpreted into usable recommendations by various technical advisory agencies.

Through the early years of the present century the notion that a recommended requirement for nutrients could be set on a national basis became discredited amongst some scientific sectors and many practical nutritionists.

Many European countries now have their own standards for the presumed 'Nutrient requirements of farm livestock'. Interpretations of these as used on farms may be found in the recommendations of the feed manufacturing companies and in the technical manuals of agricultural industry operating companies and in national and local Farm Certification and Accreditation Assurance schemes.

Chapter 7. The market; a most perfect imperfection

Agriculture was the perfect example, the economists used to tell us, of a perfect market. One in which there are many small producers, many independent decision-makers, with no single enterprise big enough to disrupt natural market forces. Supply and demand are balanced by price. There is a mix of alternative commodities to satisfy the consumer. There is no imperative to buy any particular product. If chicken is overproduced the price of chicken meat will fall. If the price falls, profit turns to loss and broiler producers go out of business. There is a shortage of chicken on the market, price goes up, broiler producers re-stock their chicken houses. If the consumer does not fancy chicken, then pork is just as good, or beef, or lamb, or fish or nuts or tofu.

Nothing interferes with global farming's perfect market. All producers have the same opportunities, function in the same equal market environment. And the sky is filled with flying pigs and cuckoos.

The big picture is one of a British and European farming industry with all the odds stacked against it. Other places in the world do it well enough, only cheaper. So why does any nation need a farming industry at all? If Europe in general and United Kingdom in particular wants its own farms with livestock on them, the near future might need to hold something rather different than what has happened in the near past. The continuing drive for cheap food has created a livestock industry on the horns of a dilemma. It must work the animals ever harder or it must cease trading. Losses in the beef and sheep sector are survivable only because the government intervenes with a subsidy. The traditional pig industries of Northern Europe shrink away in the face of playing the competition on an uneven field. The dairy industry could only conceivably be profitable if it followed poultry and pigs by restructuring into mega units.

The small picture is one of individual farmers caught in a pincer of increasing input costs and reducing output value. Farms are too small to individually influence this state of affairs, so are constrained to buying from and selling into markets both of which dictate unfavourable terms. Farmers are by nature independent; empowerment by cooperation does not come easy (though the Danes and Dutch are much better at it than the British).

Before the building of the railways (mid eighteen hundreds), food provision to the population was largely a local affair. While some herds of cattle may have been walked long distances to supply the (by now) large industrial conurbations, for the most part it was the local rural hinterland that supplied the towns with their food.

In those times, relationships between the consumer and the primary supplier were frequently direct and always close. Dairy and poultry farms expected to deliver direct to customers as

part of their normal business day. If milk, cheese and butter were distributed through an intermediary, it was usually only one. Cattle, sheep and pig meat would be slaughtered, jointed and sold over the counter at the same single butcher's premises. Butchers would buy their animals from single point sources. Often farming and butcher businesses, and dairy herds and town milk rounds, were run by the same person or the same family.

Similar structures applied on the input side. Farm power and farm labour was bred locally, as were the associated trades and industries – the stonemason, blacksmith, carpenter. Crops fed to the livestock were invariably grown, milled and prepared on the home farm, or close-by.

Present-day it is rather different. Steps in the rural production chain are now legion. In addition to the primary production steps (milking dairy cows, feeding pigs and poultry, collecting eggs, grazing sheep and herding beef) there are numerous other major intermediary sectors involved: transportation; livestock housing; health care; feed milling & compounding; processing; manufacture of livestock products; packing; food preparation; wholesaling; distributing; retailing; waste removal; recycling; rendering. To name not all. Further, not only is farm trading no longer local, it is international – and that goes for the inputs (such as feed grains) as much as for the outputs.

The primary farming industry is one of the smaller sectors of the economy of a modern industrialised nation, while the food industry that stems from it is one of the largest. At each step in the chain there is expenditure, and where there is expenditure there needs to be profit. The on-costs charged to the next link in the chain (profits) are divided between the sectors. It is not divided by agreement, it is fought over. There is aggressive trading at the join between each link in the chain. Investment funds are sucked out and syphoned off. Innovation is stymied.

Present times finds much of the intermediary sector not in the hands of many small operators, but in the hands of oligopolies with muscle enough to dictate terms. The farmers themselves (with some notable exceptions deserving of greater scrutiny) are in the middle of their own, powerless, 'perfect' market of small producers. The food production chain is made of weak links. Perhaps not the best anchor for a nation's food supply if the weather gets rough.

The Second World War had brought about the changes previously mentioned in farm support. A part of the overall scheme was to relieve from the producers – the farmers – the effort of marketing their produce. A guaranteed market for a guaranteed price. The farmer's interest ceased at the farm gate. After that, getting food from farm to plate was somebody else's responsibility.

Governments set up structures for controlling the marketing of most livestock products in the middle years of the twentieth century. In some cases, these did not only buy from farmers to sell on to retailers, they were also involved in import-purchasing and tariff-setting. They controlled the food market. Farmer's interests were safeguarded.

It was a good scheme for hard times, but the guaranteed market broke the link between country farmer and town kitchen. In market terms this break between the producer of goods and the customers who buy them is a quite extraordinary and counterproductive state of affairs; entirely contrary to capital principles, but very acceptable to the socialist ideas of the times. Unfortunately, as has already been seen, the protected market *de facto* was a *purposefully enforced market failure*. As a result, European farming moved into massive oversupply at the taxpayers' expense. The rug had to be pulled. And from the late 1970s onward, it was.

With the progressive collapse of the controlled economy and freeing up of both internal and external markets for farm products through the latter part of the last century, farmers were put to the sword by the combined forces of unrestricted importations and exploitative buyers. Both push farm prices down.

Problem is that although the commodity support mechanism has been withdrawn, the marketing structure has been left intact; namely the farmer's interest ceasing at the farm gate – a bizarre state of affairs for any trader.

Most farmers are still – quite unlike other industries making goods to sell – inadequately connected with their end customers, and see nothing unsatisfactory about it; despite their inability to operate a viable business.

The multi-linked chain by which food gets from farm to household kitchen is driven from the sales end by the supermarkets who dictate buying price – a price that also reflects alternative, imported, sources of the same products.

The farmers are caught in the middle of a very imperfect perfect market. Although price supports and guaranteed markets have gone, farmers still receive flat farm payments from Governments; these help to keep the ship afloat. But they also further distort the market. The actual goods produced by landed farmers are not the major source of their margin of income over expenditure. How bizarre is that!

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Attempts have been made by individuals and groups of livestock farmers to extricate themselves from this dilemma. The foundation rules for escape into the sunlight high-ground of farm business success seem to be: get integrated, get special, get large, get close.

Get integrated

Aggressive trading at the points joining the links in the chain does not just draw away investment funds into unusable bite-sized bits. It also leads to frank inefficiencies of trading decisions that deal with the chain piecemeal, rather than overall. A trading advantage at one

point can become a trading disadvantage at another. Separate optimisations of many parts in a multi-linked chain will always give a lower benefit than the single overall optimisation of the process between start and finish.

An example of this phenomenon was the bacon market in the 1990s when the trading structure differences between the Netherlands and Britain became apparent – to Britain's disadvantage. Since the events of that time the size of the British pig herd has halved.

Traditionally, the British market sold rashers over the counter with the skin (rind) on. To do this and to satisfy consumer demand for less fat (which lies under the pig's skin), the farmers were instructed by the processors only to produce pigs with very little back-fat. This way processor expense in trimming bacon before sale was saved. However, this incurred costs at farm level in terms of more expensive diets and slaughter at lower – less efficient – weights. The better integrated Continental market allowed cheaper foods to be given to pigs which were slaughtered at much higher – more efficient – weights. This meant fatter rashers, so a cost was incurred by the processor for the removal of the pig rind before sale. British processors had kept their expenditures down, but the overall cost of the product from start of production to point of sale had gone up. For Continental pigs, the overall expenditures from start to finish went down. The British public opted for those larger, fat-trimmed rindless imported continental rashers. Both British pig producers and British pig processors went out of business. Meanwhile, the British ready-meal manufacturers needed to import lard from the Continent to cook with!

Chicken and pig producers buy diets from feed manufacturers to maximise daily growth rate. But the meat processor is uninterested in this; when *they* get the animal it isn't growing any more. Some lamb meat buyers will demand large, well fattened carcasses, while smaller less fat animals, coming straight off grass pastures, are more efficient to produce. The failure of the British lamb market is well evidenced from the consistent and substantial fall in lamb consumption (at the expense of chicken and imported pork) over the last half century (from 18 to 4 kg per person per year).

There are many examples of livestock production chains where negativity from its multiplicity of links is clear and self-evident. Some nations appear far better at grasping this nettle than others. The problem is that not only does each business in the chain demand its own profit, but the determination of value relates only to that specific point of trade between two links – with no reference to either initial production costs or value at final sale.

Integrating the links within a single organisation accumulates the profit margins for each chain-link into one overall margin. Product specification is determined not separately at each point in the chain, but at the point of final consumption. All elements of the process can then target that requirement. Overall efficiency gains can be accumulated into re-investment. One of the reasons for the Dutch and Danish (and to a lesser extent French) livestock industries succeeding where the British industry has failed is that those countries are so much better at integrating the links in the chain and minimising within-chain adversarial trading. Integrating into a single business operation breeding, feeding and meat

processing, results in large efficiency gains. There are two ways to do this; the formation of cooperatives or single private ownership. Both require sufficient scale in primary production to justify the on-costs of processing and retail.

Egg producers have long since ceased trading their product to a wholesaler. They go direct to retailers. Second grade eggs are broken-out on site to go straight as liquid to the bakery trade.

Chicken and pork growers can manufacture their own animal feeds on the one side of the production step, and have a controlling interest in meat processing and human food preparation on the other. One high-end cured pork manufacturer so despaired of being able to source the meat that was required for their processing plant that they went into pig production themselves. Only in this way could the quality ex-farm be sufficiently controlled to give the excellence of cure demanded by the end-customer.

Dairy farmers can get back their margins not by reducing their production costs, but by increasing them to improve their products. Better product is of no interest to bulk milk buyers who mix all sources together at the processing plant. High-end quality dairy farmers can only exploit their benefit by refusing to accept the prices forced upon them by the large processors. Milk can be processed on-site, and distributed directly to local shops, retail outlets and chain-end customers. It is not just that the enhanced quality of the end product is such that the consumer happily pays more for it, it is that all of the profit margin at point of sale goes into the organisation generating the primary product. Re-investment of the profit goes to business growth and technological advance. The product meanwhile is self-advertising; no customer encouragement required!

Get large

The next rule to beat the mire of disadvantageous trading in the livestock farming market chain is to 'get large'. By this means a challenge can be mounted on the traditional agricultural trading model – many small producers buying from many small suppliers and selling to many small middle-men. For other sectors in the food chain that model is now open to change, but the farmer has been left one-step behind. Many small farm producers trade with few large processors who trade with few large retailers. The weakness of this position for the farmer is crippling.

Farm business is no different from other business in having scale as a defining element of success. To survive, a farm must grow ever bigger. The consequence of zero growth is demise. In the case of agriculture, where the primary resource – land – is finite, growth necessarily means either intensification or the swallowing up of smaller, less profitable, enterprises. The vital question is therefore begged. Are large livestock farms likely to be a 'good thing'? It is begged because it is inevitable that all livestock units will (have to) get bigger.

If there is an undoubted trading advantage in increased scale, is there an equally unarguable disadvantage for the livestock? There is nothing in size *per se* that predicates loss (or gain) of animal well-being. It is to do with the quality of the management, the ratio of animals to carers and the attitude and training of the staff – *all* the staff. It is a matter of orientation. Is the business exploitative? Strapped for investment cash? Environmentally aware? Attuned to animal needs? That said, a few *large* bad farms are infinitely more threatening to animal well-being than a few *small* bad farms. There is a duty on a larger farm to take precautions commensurate with its scale; greater training commitment, better bio-security, more assiduous veterinary care, higher levels of risk awareness.

By becoming large, a farming business can address its previous weak trading position. Not only can inputs such as feedstuffs be purchased in bulk, but their cost can be forced down – the feed manufacturer has a deep interest in maintaining a customer which purchases a significant part of their turnover. Neither need that same producer accept output prices dictated by those buying his product. There can be bargaining because the product buyer values the surety of volume offered by a large producer.

Get special and get close

Size alone is not enough. First, the size must be sufficient to wield power. Power comes not from absolute quantity, but from proportionality. Generally speaking, this is likely to be a proportion which is more than five percent of the market, and in some cases rather greater than that. Second, a given quantity of product will be a much higher proportion of a smaller market. The benefits of scale improve as the market that is targeted becomes more specialised. It is easier to become sufficiently large to command a small specialised market, than a large generalised one. It is easier to be a large goose producer than a large broiler producer. To command the supply of breeding ducks within a single country does not require the same scale of annual production of hatching eggs as does the broiler industry!

The difference between a general commodity and a specialised product is dependent upon both a clear definition of the specialism, and an equally clear delivery on that definition; the first is greatly easier than the second! So much so that some entrepreneurs have developed a life-time strategy of marketing undelivered promises; the promissory definition itself becomes the deliverable (the label, the brand; rather than the product). There has been a (alarming) rise in the use of product range definitions which purposefully imply that which is not wholly true. This has become known as the 'product description adjective' (outdoor-reared, free-range, additive-free, organic, grass-fed, farmer Henry, home-produced, Greenacres farm produce, etc.). Product lines can be given the names of non-existent farms and descriptions suggesting geographic finite points of origin. This is unfortunate, because it is generating a public that is becoming ever-increasingly cynical about the very thing that specialised marketing depends upon – *a truthful statement of provenance*. Those who design labels are aware of expectations, and therefore deliver them; on the label. It matters not at all whether the beef is or is not tender, the pork succulent, the chicken tasty.

It is taken for granted, naturally, that the specialism is targeting a market need. To be a successful specialised producer of ostrich eggs there needs to be a demand for ostrich eggs. But the issue here is that a large 'commodity' market (say liquid milk) is hard for any one milk producer – however large – to influence. If that market can be de-commodified (say unpasteurised Jersey milk) then one producer has a much better chance of controlling price.

The manufacture of specialised yoghurts and ice creams is a specific example of individual businesses which both grasped a large proportion of a specialised market, and integrated the production and processing links of the chain. There are a number of cases where specific branded milk products, although starting local, are now found ubiquitously on supermarket shelves.

One of the early and most persistent problems of the livestock market has been the distancing of the producer from the consumer through the intervention of intermediaries such as marketing boards and wholesalers – middle men. The middle man did not force his way in. He was invited because he made a complex chain of events all work together. A past benefit, however, does not guarantee a present need, nor that the 'middle-man' could not better be managed without.

Eggs are not traded through markets; they go direct from hen-house to shop shelf. Markets no longer hold pens of newly weaned piglets for growers to buy, nor fattened pigs for the pork butcher. The 'intensive' livestock farmers (beef as well as dairy, poultry and pigs) who throughout Europe have 'got their act together' combine into one business feed mixing, livestock breeding, growing and finishing. Their product is contracted by processors before they are born. Trade through intermediary livestock markets merely perpetuates a state of disadvantage.

Farm shops are advocated by some as the answer to everything. Some are successful. Many are not. It is because the theoretical benefits so often fail to materialise. Closeness to the customer only applies for the products that the farm generates itself – preferably specialised lines unavailable elsewhere. But customers need to be able to buy at the farm shop other goods not produced on the farm. Those other goods must be brought/bought into the shop from elsewhere. At which point the farm shop not only loses its unique selling point, but its pricing structure becomes uncompetitive.

Farm shops need the oxygen of their farm associations, but customers need continuity of supply which means large scale production and out-sourcing. Most farm shops began with the laudable ambition of selling the farm's products direct to local customers. Many however must grow to survive, and by doing that the shop becomes not a shop *for* a farm, but a shop *on* a farm.

Chapter notes

The notion of the livestock industry being comprised of many small producers in a 'perfect market' was typified by the pre-WW2 poultry industry and blown apart by Geoffrey Sykes' revolutionary exposition 'Poultry – A modern agribusiness' published by Crosby Lockwood in 1963. A useful catch-up was provided by Godley and Williams from the Henley Business School in 2007.

Chapter 8. Organic production

'Organic' is a niche market. The organic movement aspires otherwise, seeking a general solution to the world's woes – not just a *unique selling point*. Presently however, organic meats, milk products and eggs command only a small proportion of retail shelf space.

In the case of the 'Farm Shop', 'organic' commands a greater proportion of the sector; in many cases the farm shop and the organic label are presumed synonymous. But there is no direct relationship between the success of a farm shop and whether or not it is organic.

Organic production incurs significant extra costs. Agricultural production costs can bear little relationship to price (as has been seen). In the case of organics however, the label – of itself and itself alone – is perceived as sufficient given reason for a higher price tag.

Although 'organic' delivers particularities (for example avoidance of chemical treatments such as insecticides, anthelminthics, use of prophylactic drugs, and the abhorrence of genetic modifications), the extra complexities that organic production entails bring with them greater difficulty in offering higher quality products. This should come as no surprise because time was when all farms were organic and one of the reasons for their becoming 'not organic' was to raise the quality of the product. Further, and importantly, 'organic' can put animals at risk and therefore requires higher levels of husbandry input.

Where a higher level of knowledge of livestock care and management is *not* in evidence, or is in evidence but denied by the organic regime, the espousing of an organic philosophy can increase livestock's likelihood of disease – and so also the human population in the case of the many zoonoses. There is a difference between a philosophy that demands minimum use of an available, but avoidable, technology and one that abrogates its employment completely. It is also unfortunately the case that 'organic' can be used as a cloak behind which poor farming practices can hide.

The label 'Organic' has within it a variety of different schemes with different rules, regulations and codes of conduct. The schemes differ within and across national borders (which rather matters in cases of between-country trading). Importantly, there are divergences in the rubric, in rigour of application of a scheme's requirements, in quality of inspections, and in the event of non-compliance, in the pursuit of penalties and exclusions.

Often organic producers are presumed to share their philosophy with those of the customer; for example with regard to the ways in which animals are farmed and how they are protected from chemical contaminations. At base however, the buyer is paying for a 'quality attribute', while the seller must make 'profit' to stay in business.

Most schemes will have restrictions upon the use of 'un-natural' treatments to the crops that the animals eat. A major criterion of an organic animal is that it has ingested only foods

grown under organic aegis suitably proscribed according to the scheme. This usually covers limitations on the uses of artificial (chemical) fertilisers, weed-killers and pesticides, and the genetic modification of anything. It is a matter of the various schemes deciding what will, or will not, be allowed. The consequences are that the animals get a more 'natural', but more expensive diet. In difficult growing circumstances, the feeds may also be of lower nutritive value. Taken together this will reduce efficiency, retard animal development and increase costs.

But what *is* undeniably the case is that agricultural chemicals have in general been overused in both quantity and frequency of application. In many cases weed-and-pest-controllers are applied not to solve extant problems, but as an insurance policy against the *possibility* of problems. The cheaper the solution, the more likely it is to be applied when there is no need. Some pesticides and weed-killers have been found to have side-effects more serious than the original pestilence. The 'organic movement' has played its part in achieving the removal of counter-productive products from the market – resulting in general benefit to the environment and to the populace, and (dare it be said) sometimes even improvement in farm efficiency.

Farmers in general have followed the organic trend and have reduced their inputs of chemicals to the land; requiring a higher probability of risk of production loss before remedial action is taken. Now, it is not a matter of weed destruction, pest obliteration and yield maximisation. It is about level of weed and pest infestations that are tolerable to achieve an *optimum* level of yield. Farmers do a more sophisticated cost benefit analysis – one which accepts a level of production loss on grounds of economics and of environmental protection.

The very presence of the organic movement in the farming scene has the beneficial effect of moderating the general behaviour of both crop and livestock non-organic farmers.

Organic scheme regulations and guidances relating to animal treatments (other than what animals are fed) by and large target genetic modification, housing and care, treatment of animals with exogenous substances such as growth-promoting hormones, prophylactic treatments for chronic infections and parasitism, and the general use of medicines that might better be reserved for frank treatment of specific disease conditions. There is a (reasonable) presumption overall that the fastest possible rate of production is unlikely to be in the best interests of either the animals or the foods that come from them.

In the rush of technological enthusiasm in the 1950s and 60s, the idea that animal productivity should be enhanced by 'special' animal treatments were so commonplace as to go without much comment. Male chickens and turkeys could be caponised with oestrogen hormone to make them grow like they were females (which have meat of higher eating quality). When side effects were found in the human population eating treated birds, they were banned immediately in Europe (in the 1960s).

Control of reproduction by use of hormones has a long and distinguished pedigree in farm animals. Dependable hormone treatments are readily available and widely used for synchronising oestrus (and therefore ultimately parturition) in sheep and pigs. They are a management convenience, but one that might be considered marginal given that such treatments are undeniably interferences with natural systems. In any event, the animals themselves manage synchrony rather well (the pig returning to oestrus 3 days or so after weaning, and the sheep being a seasonal breeder). It is also true that batching of animals (without the use of exogenous hormones) is more readily achieved in large livestock units than in small ones.

The use of 'growth hormones' and 'muscle-builders' to promote growth and milk production was found in the 1970s to be highly beneficial to the economy and efficiency of beef, milk and pork production. However, no sooner had they become generally available than they were banned in the European Union in the late 1980s.

'Hormone-free' meat and milk falls into the classic reasoning for 'organic' production methods. But this standard is met for *all* meats and milk produced in the European Union in any event. This is not however the case in other countries where milk, beef and pork commonly emanate from treated animals. These same countries may seek to export their products into countries where such substances may not be allowed on their own farms. These (non-compliant) countries assert that both the scientific evidence, and the absence of negative consequences in their own populations give adequate safety assurances. The issue however runs deeper than the 'present state of published scientific information' (which can never be totally relied upon to deliver 'the facts').

The unnatural stimulation of growth and milk production might be 'unwise' in any event; and the European bans reflect this. But just as importantly from the animal's point of view is that natural processes of feeding and animal care seem already to be enabling rates or production that are too high for the animals to sustain. There can therefore be little justification for 'enhancing' animal production by means of special supplementation – with anything!

Similarly, organic production's ban on genetic modification makes sense if the purpose of the modification is solely to increase product value. The position is however radically different if a genetic modification is available to protect the animal against general or specific disease. Should an animal be denied that which humans seek for themselves?

Organic guidances can preclude the use of some control treatments for ubiquitous diseases and internal and external parasite infections. These infest the skin, tissues and guts of all animals, cause tissue damage and wasting, and they also carry other disease organisms. It may be presumed that an invading organism should be killed on the grounds of animal welfare. Organic regulations may run counter to this, something which is often cited as a reason for farmers not joining the organic movement, or for leaving it.

Nonetheless, treatment of animals with toxic therapeutics *does* raise issues about the safety of the foods coming from them. Further, killing infestations can sometimes just clear the system to create a 'vacuum' ready for re-infestation. There are alternatives such as the development of natural immunities, employing production systems that do not predispose to disease incursions, and using animals which have had specific disease-resistant qualities bred into them. Organic systems will always do better if robust animal types are used and they are kept at low stocking densities; both of these attributes being 'good things' in plenty of circumstances, not just organic. The benefits of a wide variety of species in grazed pastures have always been part of bio-dynamic thinking. The possibility that 'herbs' in grassland could be a positive attribute is now being more widely recognised by conventional graziers.

Many of the prohibitions first demanded by the organic movement are now in place to a greater or lesser extent within mainstream (non-organic) United Kingdom, European and other Quality Assurance Standards. Given that this is so, it is now a little more difficult to present a strong argument that organic milk, meat and eggs offer to the customer specific food quality and food safety benefits that are not currently offered, in Europe, by conventional production.

Organic regulations invariably go further than avoidance of what the schemes dictate to be 'unnatural practices'. These supernumerary requirements are set within the context of the wider 'organic philosophy'. There are positive guidances on animal husbandry and welfare. These would cover matters such as freedom of movement, space allowance and provisions to facilitate natural behaviours. Standards on how animals are housed are already laid down as a general requirement upon all farmers; but in the case of organics it is usually 'and more' – greater space, greater freedom, less restrictive housing, less intensivism, lower density of stocking, more time outside. It might be argued however that such benefits would stand to the betterment of animal welfare in *all* livestock systems.

Taken overall however, organic regulations can not, in themselves, provide any special extra protection for animal welfare or for assurances of good stockmanship over and above the quality assurance requirements set for all animal farmers in Britain and the EU; organic and conventional. Livestock welfare on organic farms is no less at risk than on any other sort of farm (Figure 8.1).

To produce organic sheep meat (and milk), and organic beef is relatively easy and cost effective. Many sheep and cattle, for example, live on grassy uplands in wide open spaces that can manage without much input of agri-chemicals. For the cereal eaters – chickens and pigs – it is more difficult. They must be fed on diets that have been themselves organically grown, and their diets can not include ingredients such as soya bean (by far the most widely used protein supplement) which may be (now commonly is) genetically modified. It is therefore more difficult to reach diet specifications that meet nutrient requirement without incurring extra cost. In a number of cases the strictures of organic rules can result in modern guidelines for 'nutrient requirement' being unable to be met. The consequence is that unless lower levels of production are managed for, the animals will suffer.

Figure 8.1. *The label and the (higher) price define this meat as organic. Customers take it on trust that quality assurance standards for organic production are being met. They must also 'buy-in' to the concept of organic food being of higher quality and safer, and organic systems being more welfare-friendly and environmentally sustainable. Organic meat (just as non-organic meat) may or may not deliver a superior animal welfare experience for the animal, and may or may not deliver a superior eating experience for the human – that is in the hands of the producer and the processor, not the writer of the label. Neither is it evident that the environmental footprint of organic systems is always lower than that of intensive systems. The beneficial influence of the organic movement on conventional farmers' attitudes towards over-usage of agricultural chemicals is however clear (image: HelenBrowningsOrganic).*

So many farmers went into organic milk production around the turn of the century that there was oversupply and price failure; there was widespread return to conventional production. Failure to secure an adequate premium to cover the extra costs of organic production is a major reason for reversion in the case of many livestock products.

The unfortunate fact of the matter is that, as a general production systems methodology, organic farming of livestock simply does not pay in Europe. It is estimated that organic production is less than five percent of total. The costs are not competitive with those that can be achieved elsewhere in the world from which food retailers are more than ready to buy. There will always remain that niche however, for those customers willing to pay inflated prices for locally sourced organic livestock products.

Nor should the hugely beneficial effect of the 'organic movement' upon moderating the excesses of intensive livestock farming be either underestimated or denied. To some extent, the Organic Movement has worked itself out of the market opportunity it created. General livestock production methods throughput Europe have become less profligate, and overall most products – although not labelled 'organic' – are produced under conditions

which, being moderated, are similar to organic (for example; zero use of hormone growth promoters, reduced usages of prophylactic drugs, and increased animal space allowances now demanded by general quality assurances schemes). There is presently evidence in Northern Europe that the trend toward general production practices coming under organic rules and regulations, so hoped for by the organic regulators (such as the Soil Association), has slowed. There is, it may be suggested, a lesser need.

Chapter notes

It is generally understood that Organic Farming movements owe their origins to Rudolf Steiner who developed the concepts of Bio-dynamic farming in response to the negative consequences upon soil conditions that resulted from the use of agricultural fertilisers and new (mechanical) cultivation techniques in the early 1900s. This is a trifle disingenuous as the real roots of organic farming are just farming as it was before the industrial and agricultural revolutions got into their strides through the 1800s. The basis of those early farming systems were ecological, holistic, inter-dependant and integrated – just like the rest of the natural environment. The Australian agricultural social scientist John Paull has written extensively on the matter in recent years.

European Union Regulations pertaining to organic farming were first framed in 1991. Presently applicable are those formulated in 2007 (EC/834/2007 and EC/967/2008). Those regulations are currently being reviewed (implementation 2020) with the objective of achieving revisions and simplifications. The Institute of International and European Affairs and the International Federation of Organic Agriculture Movements also present relevant material.

Chapter 9. Animal Machines; the mechanisation of systems

The most potent negative image of livestock farming is the metal cage – the inspiration for Ruth Harrison's hugely influential polemic against livestock farming. Her book 'Animal Machines' was published in 1964. This was the time when things were not going right with the welfare of animals kept on 'intensive' livestock farms and it was obvious then that the farmers were not doing a good job of getting things fixed. The animal in close confinement is the absolute antithesis of what the public perception of keeping farm animals should be all about (Figure 9.1).

If there is a positive picture in the minds of the majority of the people in industrialised nations of animals on farms it is of livestock – sheep and cattle – free to roam in green fields and over the gentle rolling landscapes. That is not a faulted image; but it *is* a partial one. Beef cattle and many sheep can spend their summers amongst plenty and their winters in nutritional and environmental destitution; roughing it outside, or crammed into muck yards (lives that are far from perfect, but nonetheless usually better than a US-style feedlot). Many dairy cattle in the 1950s were still chained by the neck into stalls for most of the day during the long winter months, unable to move more than two feet in any direction.

Figure 9.1. *Free-range egg production offers commercial opportunities and delivers higher levels of quality perceptions of product and bird welfare than the intensive systems that dominate the market (see Chapter 5). 'Intensive' systems can however deliver superior levels of bird health, and smaller environmental footprints per egg (image: John Eveson).*

Mrs Harrison's followers' complaints were in the most part directed to the luckless pigs and poultry, confined into closely packed, dirty, ill-ventilated housing. These failing systems were the result of attempts to modify (rather than replace) earlier systems to increase productivity. They invariably included a large amount of evil-looking metalwork. Their successors however are the greatly improved systems found on well-run livestock farms today. In large part the *positive* revolution in livestock keeping has mechanisation to be thanked; it would have been impossible without the metal-benders, the engineers and the computer geeks. It is they who the animals should be grateful for. The relationship between animal and machine is no longer diabolic (Figure 9.2).

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The first milking machine designs caused stress and injury. Udder tissue damage and mastitis escalated when machines replaced old-fashioned hand-milking. Fortunately, the mechanics rapidly evolved to allow a much softer (and more effective) milk withdrawal, which in turn led to the building of automated milking parlours. Milking is now sufficiently rewarding that the cows volunteer to walk twice daily into the parlour to be milked. This in turn allows the cattle to be loose-housed in big airy courts where they are bedded on soft

Figure 9.2. *Extensive grazing livestock systems also benefit from modern machine technology. Non-invasive pregnancy scanning of sheep by ultra-sound has become routine amongst flocks. Ewes can be divided into groups; not pregnant, one lamb, two or more lambs. This allows efficient management of the flock, and improved care and feeding for those carrying more than one lamb (image: BCF Technology, Ovi-Scan).*

mattresses, have their dung removed mechanically, and are fed individually according to their needs; sometimes through their own electronically personalised feeding gates.

As an added bonus the ability of a modern milking machine to measure milk flow from the udder not only facilitates production monitoring and, through computer controls, the linking of yield to feed provision, but it also registers (obviously) when milk flow stops. Before, the action of the machine trying to draw milk from an already empty udder was a major cause of cow discomfort and injury. Now, the cluster is released automatically from the teats the moment milk flow ceases.

Cows being milked twice-a-day (often at a 10-14 hour interval) is a human choice not a bovine one. High yielding cows get messages from their mammary tissue that will tell them that different, more frequent, times might be opportune. If a robot can take a cluster off, then for sure a robot can put a cluster on. Robotic milking gives the cow the ultimate freedoms of feeding, resting, and now giving milk at times that suit her. In all aspects of her life the dairy cow is served by machinery to her great good fortune (Figure 5.2).

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Broiler chickens, reared for meat, are all free-range – they always have been. Free (if they so choose) to walk and flutter the length and breadth of a big open-space environmentally-controlled house. Whether the stocking density is or is not appropriate remains a matter of debate, and much dependent upon other conditions prevailing, such as the quality of their litter and means of fair provision of food. But they are free (if often somewhat cramped), and it is mechanisation that has enabled that freedom to be maintained. A recent development has been the multi-tiered broiler house. That there is more than one deck should not, of itself, be of immediate concern either to bird or to welfarist, but there is big difference in visual impact. What will matter is the size and quality of the space made available.

It is automated food delivery and bird self-weighing machines that have allowed bird growth potential to be matched with feed supply, it is mechanisation and computerised control systems that provide the balanced diets which include whole and coarse-ground grain essential for normal bird gut functioning, and it is the engineers that are responsible for the mechanisms that allow automatic measurement and adjustment of house humidity, air ventilation speeds and temperature.

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It is hard to suggest other than that the happiest of all laying hens is the one in a flock of twenty or so, with a cock or two, in a stackyard by day and shut safe from the predatory fox at night (although even this life is not without its strife). This idyll however does not feed human populations in cities. When hens were kept like this, eggs (and indeed poultry

meat) were simply too expensive for ordinary people to buy – they were items indicative of luxury living.

Cheap eggs need the birds to be housed indoors in big numbers. The first step toward this goal was the deep litter house in which, as previously described, the birds were often not happy; they were sick and dirty. Looking after these hens; mucking them out, picking up the dead birds, struggling for breath in the ammonia, collecting and washing dirty eggs, was not a job that any natural animal-lover would go for. It was brutish work and not a lot of fun.

Welcome the second step; the battery cage which came along to address these issues. The birds were healthy, the eggs clean. Mechanical environmental controls provided fresh air. Food was delivered by mini-conveyor chain along the front of the cages. Droppings fell free from the birds to lie below the cage floors onto motorised webbing that carried the waste away to fall into waiting trucks.

People began to quite like looking after hens. A human being could quite acceptably share space with the hens. But the hens were not free to walk. The closeness of their confinement infringed natural sensibilities. The public outcry probably came mostly as a result of those well-publicised photographs; long rows of cages disappearing into the distance, birds with heads stuck through restraining bars – imprisoned in metalwork. An animal held within a machine; having become part of a machine. It was an unacceptable image. The battery cage proved not to be the solution for the mass production of cheap eggs; it was, in retrospect, only a temporary fix.

Colony cage houses provide many of the sought-after enhancements; the main driver (literally) however is the improved sophistication of the machinery-control and automation of every aspect of the bird's environment; feeding, watering, computerised diet formulation, dung removal, egg collection, air quality, etc. resulting in conditions that are acceptable to both man and beast. But the prison-like metal-work is still there, in tiers, in rows, confining the birds.

The laying house of the twenty-teens is proving to be 'cage-free'. This has all the automated arrangements of the colony house, but without the cages. Birds can move about the house in three dimensions amongst the tiers where they live their lives in conditions as reasonable as might be imagined – provided that the imagination is not confused by the vastness of the numbers (usually around 32,000 per house), the relative closeness of confinement (which can be alleviated by pop-holes allowing access to the outside), and the fact that every element of the bird's life is – like that of the mid-atlantic airplane passenger – fully controlled by machinery. For the bird it can be argued that the 'cage-free' house is not as good as ranging the prairie, but then people *do* get to eat the eggs.

The third 'intensively farmed' animal is the pig. In many countries fully automated environmentally controlled housing is the preferred way of protecting domestic pigs from the difficulties of climates which are either too hot or too cold for them. Temperate climates are however a little better suited to pigs, and this has allowed a more liberal attitude to pig confinement following the public outcry against overcrowded slatted fattening pens and stalls for pregnant sows. Recent years have seen some half of the British pig breeding herd (but it has to be said only the British herd) move outdoors – more than at any time in the past. There is not much mechanical about pregnant and lactating sows apparently thriving (provided they get the extra rations needed) in huts scattered over cold, wet, bare brown fields divided up by electric fences.

Intensively housed pigs on specialised sites have however also undergone substantial changes in their living accommodation. Pregnant sows are to be found no longer constricted by metalwork or chains, but free ranging in groups in courts which can be provided with manipulable substrates and bedding materials (such as straw). Fattening pigs also may be lucky enough to find themselves growing-out not cramped onto slatted floors, but in open yards. It is *de-mechanisation* that has characterised recent developments in the European pig world (though not in most other places). This has led to improvements in welfare, but also to deterioration in efficiency and global competitiveness, particularly in the United Kingdom, where less than half of its pig-meat consumption now comes from its own resources (a realistic expectation would be for 100%, and an export trade in addition).

The United Kingdom example leads to the unavoidable conclusion that globally the future welfare of pigs will lie not in their being 'let out to roam' but in the their being better husbanded within housing systems that provide by mechanical means for high levels of locomotory space simultaneously with individual pig protection and feed rationing, and computer-precise environmental control.

As might be considered appropriate to pigs, the mechanical revolution so far has not been in pig housing, but in pig feeding.

It began with the solution to bullying amongst sows in groups – the creation of the individual metal-work feeding stall within which the pig could be shut whilst eating her own exact food ration; more if they were the thin ones, less if they were over-fat. The next innovation was the automatic shifting of pig feed along pipelines into the pig houses. From the line, individual food allocations could be metered out and fed either to individual sows (in stalls), or to individual pens of pigs in the case of the fattening house. To have food flow and metering put under computer control was a simple step on from there. As pigs grow from 20 to 140 kg, or as pregnancy and lactation progress, the diet and the amount fed both need to change. Feeding a pig properly needs constant attention as food requirements alter day by day – this level of precision in animal care is something that human beings have never been able to accomplish. A computerised system can have pre-programmed-in both the nutrient mix and the amount dropped in front of the pigs. The computer has no problem whatever in following a set of algorithms – of whatever degree of complexity – on an hour

by hour basis! It was not just pig management that suddenly got a lot more efficient thereby, the pigs got better fed too!

The banning of sow stalls put a hiccup into individual pregnant sow feeding, which was rapidly resolved by the next innovation – Electronic Sow Feeding systems. Until ESF, letting the sows out of their stalls (which by definition had allowed individual sow feeding) had the consequence of requiring two housing systems in place for the same sow. An open (preferably strawed) yard for living in and a sow stall for taking her meals! (Unless, that is, it was considered acceptable to return to the bully-days of sows being fed in groups). ESF provides one computer-controlled feeding station for a score or so sows in a straw yard. The machinery recognises each sow from her personal electronic tag. Every sow can be individually rationed and gets her allocation when and how she wishes. Better even, it is a simple matter for such systems to not only drop for each individual sow a particular amount of food, but also a particular type of food – different in nutrient specification and in feed ingredient mix.

It is the computer that has cut the Gordian knot; proper feeding is no longer inextricably linked to a need for restraint. This conundrum – how to provide for individual care without loss of individual freedom – had, till now, bedevilled the livestock husbandry.

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One of the founding principles of any production process is control of inflow of raw materials and control of outflow of product. If the final product is to be of required quality, predictability and uniformity, this is an ongoing process throughout every moment of the production cycle. The more variable the input, the more exacting the within-process controls need to be to iron out variation.

The challenge of livestock production is to apply these principles when the major inputs are as inconsistent as are feedstuffs, weather and animals. That outputs from livestock production have been characterised by variation ranging from the substantial to the extreme simply bears witness to how difficult farming actually is.

Usually, the gap between the demands of the end-customer for standardisation of product on the one hand and the variability of what leaves the farm gate on the other has been dealt with by the intermediaries; the processor, the manufacturer, the butcher, the trimmer and the re-former. It's an on-cost, it is inefficient and it is only partially successful. Only few dairy farmers are reaping the benefits of dispatching from the farm the product that the public actually buys. Single-farm milk for drinking is a rarity. Named farm iced cream is getting something of a following, but that is about it. Dairy farms produce a commodity that is bulked up before it is re-distributed into liquid-processed and manufactured products.

The poultry industry has a history of rising to the challenge of producing, ex-farm, the product the consumer buys, with farm-specific meat birds and farm-branded eggs. But the pig industry is only now beginning to learn.

Producing meat from pigs starts with the weaned piglet. Here, variability is introduced by poor control (poorer than needs be) of environment and nutrient supply. The all-important phase of growth from 20 to 120 kilo is however the part that really matters. That bit is left over-much to serendipity, and the reason for that is the difficulty of process control. The secret to ongoing process control is ongoing measurement, but regular measurement of growth by weigh machine is a counter-productive nightmare hated equally by pig and pig carer. Help is to hand however, courtesy of the digital revolution.

Growing pigs live in groups of twelve to one-hundred, depending on housing system, but often the number is around twenty. Development of variability within the group is inherent, but its extent is symptomatic of quality of care, feed provision, environmental control and incursion of disease organisms. There is an imperative for on-going measurement; but how to measure, if not by constantly weighing the pigs?

The obsession with the measuring animals by recording their weight seems not to have originated from weight being the chosen *best* way of describing the state of an animal. In truth, choice of weight as a descriptor probably resulted from the long-standing existence of accurate weighing machines whose 'judgement' is inarguably both objective and impartial. The desire to weigh everything in order to evaluate worth came about because the more obvious determinants of animal state – appearance, size, shape – are *subjective*, and prone to individual interpretation. As such these measurements are unlikely to be trusted by third-parties. But what if they could be made to be *objective*? Size and shape alone are ample means to measure pig growth. Actually, *change* in size is noted in about half the time that it takes to notice change in weight, and the two are highly correlated. The quickest way to determine change in weight is to measure change in size!

With modern-day wizardry of digital photographic imaging and telemetry, the size and shape of pigs can – hands-off – now be accurately measured (Figure 9.3). What's more, these parameters are characteristic of individuals, so each pig in a group can be identified. It is a simple matter of placing a 'camera' above the pen and letting the pigs below go about their piggy day. Clever algorithms use the digitised images to determine, with great accuracy, change in size and shape. At last, non-invasive measurement of the on-going production process! Add in another set of algorithms that link food supply and type (through the computer controlled automatic feeding system) with the growth that will follow, then there is full and automatic control of the process.

Is this system, and others similar, likely to replace – even be better than – human control? Yes, because the history of the production process in livestock tells us that human control is not so good, and because in every other sphere of life, human judgement is being replaced by computer driven algorithms with substantial advantages to operational efficiency.

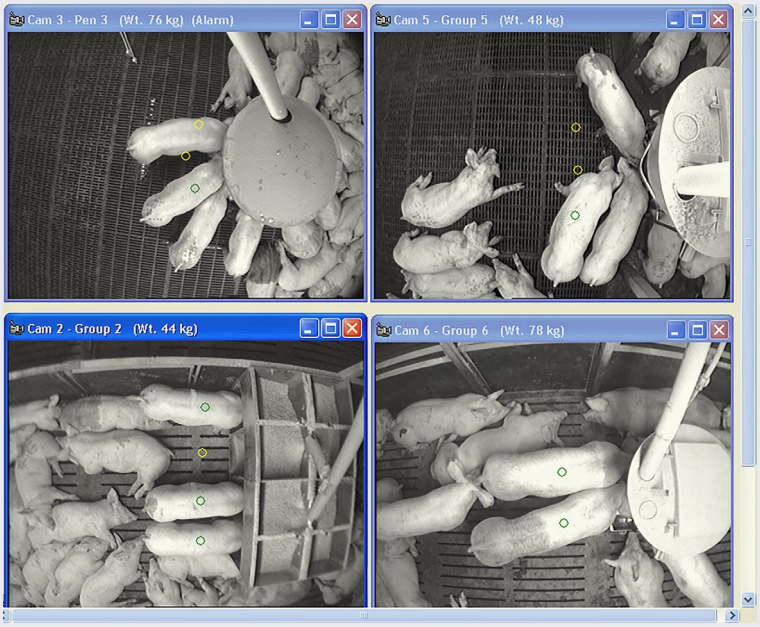

Figure 9.3. *Visual Image Analysis measures the size of the pigs as they grow without the need for disruptive weighing operations. With this information it will be possible to feed the pigs (through computerised systems responding to predictive models) according to their exact daily needs. Pig systems management will be substantially enhanced thereby (image: Innovent Technology).*

It is of course the humans who must write the algorithms and build the electronics. And it is humans who must monitor the monitors. Importantly, though, the human is relieved of the drudgery and unending time commitment spent putting food into animal pens and taking the muck from out of them – machines allow the husbanding of livestock to become a high level and highly rewarding life. Animal care can be translated into what it ought properly to be about; thinking forward as to how best to satisfy animals' needs, and spending time (and pleasure) observing animals pursuing their natural behaviours of feeding and socialising.

Chapter notes

The mood of the late nineteen-sixties is well caught in 'Intensive Livestock Farming', Ed. W P Blount (Heinemann, 1968), and in the *New Scientist*: 60, No 868 (1973)

In 2009 Wageningen Academic published 'Sustainable Animal Production', Edited by A. Aland and F. Madec. Amongst the excellent chapters is that of Christopher Wathes – Precision livestock farming for animal health, welfare and production.

Precision Livestock Farming (PLF) is now a dynamic sector for research and innovation, as exampled by the work in EU-PLF Project and AGRI-EPI. Recent initiatives may be found in the Proceedings of the 67th Annual meeting, of EAAP, Belfast, 2016.

Chapter 10. Finding things out; spreading the word

If it is people wanting to be *with* animals that makes them into animal farmers and carers, then it is the fascination with what makes animals *function* that drives animal scientists into a research career. The original motivation – the one that happens when altruistic young people have big ideas – would invariably have been a desire to change things for the betterment of the animals. This force remains, but as graduation and family life kick in, the need to earn a living has also to be accommodated. Unfortunately these motivations *are* conflicting. Research and development paths are followed not as a result of demands from the animal kingdom, but of demands from funders. If the funder is government, then research patterns follow the voter's shout; if industry, then research must target market advantage.

After World War 2, Government-funded research and development drove hard for increased food production – food security for all the countries of Europe. The consequences were, on balance, highly positive for animal productivity, but not much positive for animal wellbeing. With the production excesses of the 1970s, research and development support shifted away from government funding (it no longer being seen as justified) and toward industry sponsorship. What came to be researched was that which interested the development departments of manufacturers. For industrialists, 'development' is a word that (necessarily) is preceded by the word 'profit', not 'animal interest'.

The culture that moved animal research away from being tax-payer funded to being industry funded followed from the axiom that became popular in the 1980s: if industry it was that would benefit from the research, so industry it was that should come up with the funds! *Industry pay for industry gain*.

Industry would no longer be handed technological advantage for free. The *quid pro quo* was that if industry was putting in shareholder investment, industry needed shareholder dividends. Governments did however continue to fund, albeit at much reduced level, projects addressing voter predilections. There was an upsurge in environmental and organic research; and, to the great good benefit of farm livestock, in the study of animal behaviour and welfare.

For the bright-eyed young University research worker, and indeed the rheumy-eyed civil servant in the government research institutes, the 70s and 80s saw shock waves in animal science. Biology, and animal science with it, went bio-science – human health. Government-funded Research Groups with names that included words like 'Grassland' 'Dairying' 'Poultry' 'Animal Breeding', 'Agricultural', 'Animal', 'Hill Farming', were closed down. Included amongst these was the wonderful United Kingdom Institute of Agricultural Engineering at Wrest Park, Silsoe (now used as a film location and wedding venue).

Like many such research institutions around Europe, although many of the Silsoe departments were deserving of radical reform at the time of its final closure in the early 2000s, many other of its scientists had grouped into teams that were beginning vital work whose conclusions are now being sadly missed. These include; refinement of robotic milking for dairy cows, food engineering, animal housing and climate control, animal behaviour and welfare, early detection of disease, performance monitoring of animals and buildings, computer control and modelling of growth and lactation and so on. Above all else, it is engineers and mathematicians that are presently in greatest need if the animal sciences are be advanced.

One of the difficulties for farm livestock is that the 'livestock industry', aka 'farmers', can not themselves fund research. They are individually too small, and margins are so tight or negative that there is no investment money for forward planning. 'Industry' when it comes to funding research does not describe those trying to make money out of farming, it describes those trying to make money out of farmers – the manufacturers of medicines, feeds, and equipment. The interests of the farmers are now often presumed best looked after by bodies such as Development Boards that lie 'close to the farming community'. Serving farmers directly, development agencies concentrate on the short term so that 'useful benefit' is realised within sight of the original investment. This tends to result in an over-weighting toward 'investigations' and 'development trials' that have a nasty tendency of (1) getting the answer wrong because the question asked was not well posed; or (2) thinking that it is enough to know that 'when this happened, that also happened'; or (3) getting no answer at all because the hurly-burly of 'real-life conditions' make impossible any useful interpretation of the factors being studied.

Such organisations also have the problem of needing to deal with *all* of their members; the small as well as the large, the incompetent as well as the talented. If the target is to improve farming standards this is not the most obvious way to do it; it creates mixed messages, divisive targets and low expectations. Helping small and incompetent farms to keep trading might be charitable, but it is not good business. Industry improvement comes from pulling from the top, not pushing from the bottom. Indeed it is the leading farmers who both pay the most levy and gain least from it – not really sustainable as a commercial model. An effective development and research service will be the one that targets the problems of the largest and most successful. There may be a social need to help small and failing farmers be informed of known solutions and encouraging them to take them up, but it will not much forward the industry.

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Farmer-driven Development organisations have a tendency to believe that 'on-farm development trials' can substitute for research; besides, they are done in real life situations, so (it may be argued) are more relevant, as well as being less expensive. But a 'development trial' can only serve a purpose if it is determining how to put into practice an already proven innovative idea. Development is a matter of 'how-to-do-it'. 'What-to-do' (or 'what

to change') is a question for objective science and carefully controlled experimentation. Without a solid science base, development work goes round in circles; mythical progress – advancement without determinate direction.

The Science, Engineering and Technology paradigm starts with problem analysis, progresses to ideas generation, which is then logically followed-up with ideas testing (objective testing, that is), and finally concludes with solutions application. This formula can be delivered with a progressive sequence of independent research, development work, and technology transfer. Starting in the 1930s, and taking flight in the 50s and 60s, this recipe was delivered with such success that those countries employing it would soon lead the world in innovative livestock farming. Come the second millennium however, many Northern European nations no longer find themselves 'leading the world' because the Government-driven structures of research, development and technology transfer has been rendered largely dysfunctional following withdrawal of much of the earlier state support. Research now finds itself dependent for funds upon those whose first concern is not so much the livestock, but the improvement of short-term sales to livestock farmers. Neither can the agencies that *do* represent livestock's interests invest in long term strategic research. They are asked by the farming community to focus on farmer-orientated development, which (when it works) comes up with the answer first thought of, or (when it doesn't) promulgates false expectations.

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The attraction of research for many of the people who aspire to it is that it lies *outside* of the market place. It is *not* industry. There is nothing to sell. For the research-worker there is no downside to zero product. Diligent searching is considered sufficient reward; finding is a bonus! Research appears to offer a lifetime of happy hunting about for the interestingly new. And so it used to be. This was precisely the inheritance of the mid nineteen hundreds. But the foundation for *that*, let it not be forgot, lay in the late eighteen-hundreds and early nineteen hundreds when agricultural science was dominated by the 'gifted amateur' – the denizens of Universities and back-room laboratories who did not need to rely upon their research outcomes for their daily bread.

When government money was piled into livestock research in the massive push to get people well-fed with cheap food after World War 2, the notion that the best people to run science were the scientists themselves still held sway. The presumption of the new generations of scientists coming into the Animal Research Institutions (of which there were many) was that it was up to them to think of what it was that needed researching into, and it was for the government to pay them handsomely to do it. This delightfully generous environment threw up a wealth of dedicated investigators who did indeed have the interests of livestock farming and the nation at heart. The result was a revolution in farming practice and a surge in output and efficiency.

However, the freedom that spawned this beneficent leap forward also meant inadequate control. There were in the research and development community rather too many of those of lesser ability and motivation, or of those who were convinced that in the long-term – if only they went on for long enough – their (faulted) notions would eventually come to bear fruit. It was considered a democratic freedom of the scientific community that a trained scientist should be allowed to follow their passion – even when that passion was for a delusion! It was not evident what these people were for, nor why they were in the employ of the taxpayer. Some held the view that this residuum was needed to allow an atmosphere of 'academic freedom' to prevail amongst the really talented who were allowed to get on unhindered with their undoubtedly highly productive and useful lives.

The present environment for animal science research is very different from what it used to be. Before being a good scientist, today's researchers need to be skilled at applying for grants to fund their work. Without a research grant (and the writing of the interminable applications and interim reports that goes with such grants), there can be no experiments. The research that does get funded is, of course, not the research that the *scientists* want to be done, but the research that the *funders* want to be done. A good scientist does not only have to be a good experimenter, they have as well to have a shrewd understanding of what will be attractive to funders.

Modern experimentation is about addressing the agendas of funding bodies; more time is spent in wooing sponsors than in publicising results! Successful scientists are successful money-getters and team managers. Repeat funding follows from happy sponsors – government or industry – satisfied that the results presented are the results sought. Scientists looking for a steady flow of research grants need to be aware not just of what sort of work funders want done in their name, but that the answers going to be put out into the public domain are to the funders commercial or policy advantage. This latter can sometimes be at odds with scientific veracity. Policy makers and salespeople alike often see the purpose of science and technology as coming up with supportive *reasons* for them doing what they want, rather than coming up with *facts* that might not be so supportive. Evidence-based decision-making is only ever popular when the evidence supports the required decision!

As ever when a big change comes it is a combination of forces that does it. First, it got noticed that the Government-funded Research Groups were less usefully productive and more financially costly than were their opposite numbers in the University community. A select band of notables moved across to head-up University Departments and further accelerated the trend. Next, the over-production of milk and meat rendered yet more increases in output negatively cost-effective (wool, meanwhile had become worthless in the face of synthetic fibres). Last, the State was moving toward a philosophy of expenditure reduction and privatisation. In retrospect, something (bad) was bound to happen.

There were times in the late 1970s where (1) forward budgeting was a matter of adding ten percent to the previous year's expenditures (including the mad rush for year-end purchases of non-essential equipment), but (2) the scientists concerned with the 'applied' end of the research spectrum were at the same time hard pressed to think up interesting and useful

research programmes to spend their money on. Not a combination that could stand much audit scrutiny. Neither was the agricultural industry itself helpful in this regard – farmers and researchers were distanced from each other in ways that would have appalled the post World War 2 pioneers. The farming community did not recognise the research sector as addressing *their* problems. The consequence was that scientists were not to be trusted any more to run science at the tax-payer's expense – just like everybody else, they would need to earn their salaries by demonstrating utility as well as ability.

The subsequent disassembling of the national structures for research resulted in the new millennium seeing reductions in research inputs into animal science across Europe. Government research institutions were shrunk, closed or absorbed into Universities. To boot, the unthinkable had happened – research scientists would have to face an annual Job Appraisal Review; heaven forfend! In retrospect, it is remarkable that the system was left unhindered for so long. Even now, animal scientists are privileged with exemptions from the checks and balances that prevail in other professions. Those practicing skills that involve risk to others such as the electrician, engineer, pilot, surgeon, lawyer, veterinarian, etc. are now expected to continuously update their knowledge and to up-skill their craft. Should Animal Scientists be any different? Speed of delivery of accreditation schemes for Animal Scientists and Technologists has varied greatly across Europe. Perhaps most assiduously taken up by Germany, a United Kingdom scheme was only initiated (with little enthusiasm by any party) in 2014. It is still by no means considered an imperative to be accredited before practicing in matters with significant impact upon animal and environment.

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The particular experience of the United Kingdom serves well to demonstrate the pattern of change that has occurred over the last century.

It had been a Scotsman by the name of Sir Thomas Middleton, hailing from the Black Isle, who had come up with the rather good idea which he pressed through the corridors of Westminster in the 1930s. His grand plan reached its zenith in the 1950s. Middleton had put together a three-part fully-government-funded-free-at-the-point-of-delivery formula that would be the driving force for change in livestock farming. At bottom would be a network of research institutions. Then to take the fundamental research findings into real life would be an advisory service which would not only offer each and every farmer free consultancy services but would also run Experimental Husbandry Farms whose job it was to develop and demonstrate the new practical farming systems that had emerged as a result of the basic research discoveries. The third tier was a University education system which offered fully resourced undergraduate degrees in agriculture.

The post-war English bureaucracy (in its wisdom) translated this integrated plan into three separate (not-integrated) organisations each with its own entirely separate reporting lines and command structures. Within a decade the scheme had become not only disjoined, but competitive with itself! Its downfall was inevitable. In Scotland however, the plan took

different form. All three functions (research, advisory, teaching) would be delivered by a single organisation assimilated within one management structure.

The Scottish model proved to be much more effective. Those that researched and advised also taught the next farming generation. Those that researched were informed in their choice of projects by both the farming and the advising communities. Linkages between 'The College' and Scotland's farmers approached total saturation. Markedly different from that in England where farmers were much more sceptical of the benefits of research, and had much less influence over what was done in their name.

In the post World War 2 era, alongside the tax-payer-funded infrastructure for research and development, industry itself was highly active in both innovate and developmental research. The big 'National Feed Compounders' of which there were many across Europe, and the Agro-chemical industry (mainly fertiliser and drugs manufacturers) all had their own active R&D farms and their own consultancy services additional to their sales forces. And if all of that was not enough, the levy-boards (funded by the farmers directly, having evolved out of the earlier marketing boards for milk, eggs, meat), also chipped in with their own development and advisory arms. In some continental countries the role of the Boards was delivered, equally if not more successfully, by farmer co-operatives.

This was not overkill. The prize was greater even than the nations' health. The beneficiary was Europe's daily food supply and thereby the encouragement of the workers in the nations' manufacturing industries. But when that was done, come the 1980s, the whole structure crumbled down like a dynamited 1960s tower-block. The rubble is still well in evidence, but the new-build to replace it is not.

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Knowledge Transfer (KT) is an oxymoron because *knowledge*, to be worth while, has to be self-won. The passing across of the 'golden ball' of wisdom from the knowledgeable to the ignorant requires very many associated skills on the part of both sides. By definition, those seeking the sustenance of knowledge from others lack the ability to get it for themselves. That being so, KT is cursed from the outset.

Many ways to transfer knowledge have been tried, but there is little evidence that '*telling*' works very well! Notwithstanding the challenge, vast resources have been thrown at KT as if, in itself, it was the solution (rather than the means to a solution). Little wonder then that authoritative missive-toting 'National Advisory Services' are doomed to have short lives as governmentally subsided aids to better farming.

So what can work? *Information Transfer* (IT) can work. Information (unlike knowledge) does not require understanding before it can be used (for example, mastitis in the mammary gland needs to be treated with an antibacterial). Development work Transfers Information by delivering the message through the Demonstration of the *actuality*. 'Look! Do what I

do!' Instructions work; specially if accompanied by pictures. 'Do this, this way, at this time.' No need for knowledge – just obedience and craft.

Best is *Technology Transfer* (TT) by the transfer of *stuff* – physical entities – kit. The reason for this is that the 'thinking/reasoning' part of the knowledge has been locked away safe in a piece of 'technology'. As such it can stay *un-comprehended*, but still be *used*. Nutritional know-how can be transferred best not through knowledgeable explanations of animal metabolism, but by the sale of an already expertly formulated feed (Figure 10.1) together with instructions as to the right settings for the automatic feeding system.

Livestock can be improved genetically best not by reading books on mathematical statistics, but by the purchase from a good breeder of the right stock. The complexities of pig and poultry requirements for fresh air, warmth and humidity will never be met if it is first necessary for the stockman to understand the laws of physics. Timeous adjustment of heaters and ventilators is best left to computerised controls. An environmentally-controlled house will deliver automatically by TT all the knowledge that currently exists (Figure 10.2).

Figure 10.1 *Transfer of Knowledge through the medium of the end product. The objective of the feed company is to deliver in the truck a compounded feed within which resides the sum total of present know-how concerning animal nutrition. This is a highly effective means of nutritional Knowledge Transfer from the expert diet formulator at the feed mill to the livestock manager at the farm (image: ForFarmers).*

Figure 10.2. *Transfer of Technology through the medium of provision of equipment. Control units can regulate livestock house environments by operating ventilation, temperature and humidity controls in response to data received from sensors in the animal environment. Similar control units can deliver measured quantities of diet ingredients to livestock according to pre-determined algorithms. The incorporation of contemporary best-practice knowledge within automated systems offers to livestock managers the benefit of one-step Technology Transfer mechanisms (image: Glenrath Farms).*

With growing pigs and poultry, progress in weight gain, consequential feed requirements and associated house environments can all be interlinked and automatically (robotically) self adjusted. The time has come when the best diagnosis is by algorithm-driven model and the best management is by machine.

In a word, knowledge is best transferred if it is already built into a ready-to-use application. There are however circumstances where the required appliance does not yet exist – only improved management can deliver. Management is a knowledge-based thing – there is no package that can be bought-in to do the management (not even from the airport book-shelf). Empirical/mechanistic models for enterprise management tend to be unstable!

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The appropriate paradigm for Animal Science advancement – research, development, technology transfer – remains as ever the same. What is changed is that governments tend no longer to be the majority share-holder in the activity. Fifty years ago government was

dominant. Now, not only is the scale of functional government-backed R&D institutions hugely diminished, so also is the funding. Industry has taken up some of the slack that was caused by government withdrawal in 1980s, but only a small (and mostly sales-driven) part.

Animal Science research is primarily located in small clusters in a few Universities scattered through Europe. Many Departments of Biology have forsaken agricultural science and gone medical. It is entirely reasonable to now propose that the animal sciences might be better accommodated with the Veterinary Faculties, though for this to happen the bio-veterinary authorities would need to deliver research and teaching programmes that catered for a thinking biological farm-based ecological systems mind-set, rather than that of a practicing veterinarian in the operating surgery.

The national agricultural R, D and TT structures set up on the integrated linear pattern (as exampled by Middleton) have been rather special to the food supply industry; no other has been so favoured with tax-payers' money. There were good reasons for this – hungry voters – and the pattern was commonly repeated for agriculture in many other countries. That the Middleton pattern has now been largely dropped causes European farmers to be disadvantaged in a free international trading environment. Which the European public may or may not much care about.

Because livestock farming is a technical/scientific pursuit, long-term investment in basic science is a justifiable expectation. The general view is that strategic (blue skies) research should legitimately be funded by government as an openly available public good. However, it is not apparent that the future holds anything much different in that regard from the immediate past – no real appetite on the part of government for tax-payer funding of agriculture.

Shorter-term investment in applied research is now viewed as being the responsibility of the benefitting industry to fund. The agriculturally allied trades (feed and pharmaceutical firms mostly) need the 'right answer' for enabling sales (profits and dividends). A matter which those looking for repeat funding of their work (and the job promotions that go with it) are well aware. The funding stream for livestock farmers themselves now lies primarily with the 'near-farmer' Development Organisations and Cooperatives.

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The drive for the next tranche of research funding – the need for positive results that will please the sponsors (be they industry or government) – has severely warped the veracity not only of scientific research reporting, but also of research thinking (what the experiment is for and how it should be set up).

There is in some modern scientific writing a perception that the 'truth' comes from 'statistical significance' together with a referenced report in the scientific literature. What

is not defined as truth in this way is either untrue, or at best 'opinion'. Unfortunately, such thinking is often faulted.

First, many 'truths' start their lives as ideas or opinions. Ones that subsequently can be put to the test. Indeed, how else is a new thought to be had. In some instances the means for testing a good idea are not ready to hand, but that idea can still be useful.

Second, the published science base is itself biased; it does not contain all those negative and uncomfortable results which would displease both sponsor and referee.

Third, what is 'significant' is itself a matter of opinion. There are economical significances, biological significances, numerical significances, conceptual significances. There are significances at high level of probability and at low level of probability. That an experiment comes to a significant conclusion and therefore must be meaningful/important is nonsensical. Highly significant relationships can have highly important messages or no useful messages at all.

Notwithstanding these caveats however, an experiment is always going to get nearer to a truth than the ill-founded opinion of those who wish to pursue a subjective agenda. Science, by definition, must be well-founded, objective, unbiased and disinterested. But these qualities do not belong exclusively to refereed science journals.

Fourth, the fundamental prerequisite of experimentation seems to have got lost; that there is a hypothesis formed before the experiment is begun, following which the experiment is then designed to refute that hypothesis. Experiments set up to prove a hypothesis correct are rather easy to arrange and prove no such thing. Many experimental results are reported from analysis of data that were collected for various purposes, and which had little to do with any hypothesis that they are now being used to test (either negatively or positively). Searching a large data set for a significant outcome and then suggesting that that is an experimentally valid conclusion is a travesty of science, albeit now a common practice. Many experimental findings should be treated not as tellers of 'truths' but as formulators of opinions (hypotheses) which might be worthy of a (properly set up) experimental test.

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Despite the shortfall in overall R&D funding, if a new way of doing things is to work at all for the betterment of the Livestock Industry, then integration is key. A coming together of the animal scientists, veterinary scientists, environmentalists and production agriculturalists; of the research and development sectors; of industry and academia. Is it all too much to hope for? The pioneers of a century ago would not have thought so...

Chapter notes

The United Kingdom All-Party Parliamentary Group on Science and Technology in Agriculture publishes the evidence presented to its Past Meetings from 2008 to the present. These make eclectic reading (www.appg-agscience.org.uk/meetings.html). See in particular the meeting of 28th January 2009. The International Food Policy Research Institute published in 1999 a round-up of International research funding, 'Paying for agricultural productivity' (Alston, Pardey and Smith, Eds).

Chapter 11. Respect, compassion and business reality

Failure to respect farm animals and show them compassion requires a conspiracy between both farmer and consumer. Each distancing and dissociating themselves from responsibility.

Today, it is no different from fifty – two-hundred and fifty – years ago. Livestock farming can be empathetic, satisfying, and provide all the reason any person might wish for having their life on earth. But it can also be rugged, brutish, and demand a robust outlook on death and misfortune.

It is hard for many urban dwellers to understand the love that livestock farmers can have for their stock whilst also accepting their purpose; to give up their lives to feed us (Figure 11.1). There is little reward outside of human relationships that can possibly approach that gained from the relationship between farmers and their farm animals.

Nonetheless, caring for and sharing in the lives of animals carries with it the acceptance of the harshness of the realities of a life with livestock. Not even the most dedicated of shepherds can say that getting to the hill sheep flock in a blizzard is enjoyable; it is downright

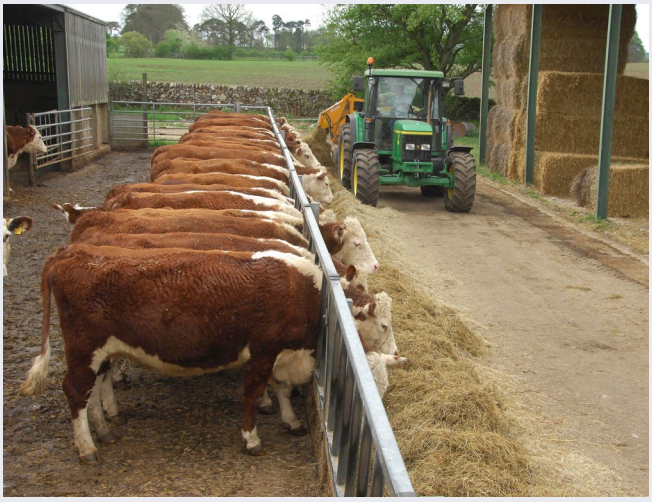

Figure 11.1. *The Animal Farming dilemma. A commercial stock unit (being fed out of a forage delivery truck/forage box). Farming animals has to be a profit-making business. In the interests of the farmer and the animal it helps if it is also a way of life. These may be conflicting ambitions (see also image 4.1) (image: John Eveson).*

dangerous! There is no delight in digging dead ewes from a snowdrift under a wall either. Nor is a cold winter's day spitting sleet in your face any time to be on a windswept plain feeding outdoor pigs. Dairy farmers whose herds are struck down by Tuberculosis or Foot and Mouth disease rarely fully recover from the bereavement they experience. Farmers of pigs and poultry get great delight from observing the behaviours of intelligent inquisitive animals in conditions of good husbandry, but no delight whatsoever in trying to do their best for those same creatures when they are forced into bad and overcrowded housing.

Common to both the bad times and the good times that make up the life of all who love to look after animals is the knowledge that the underpinning ethos to animal care is respect and compassion.

It is becoming clear that there has been extensive loss of these qualities over the last half century, and modern trends globally will do little to abate that loss. Only 'active steps' will ensure that, under modern livestock farming systems, our domestic livestock are respectfully and compassionately farmed.

In the 1950s, it was sufficient that an animal was kept adequately healthy to grow efficiently and to live until slaughtered. Through the 1980s things improved such that the animal's welfare was a consideration independent of (and indeed above) the need for just health and efficiency. Now it is required, quite properly, to give our farmed animals '*a life worth living*'. A good example of this is the way pregnant sows are kept in the United Kingdom. Sow efficiency is maximised with the use of sow stalls, but pregnant sow stalls severely compromise welfare. Only when the freedom of group housing yards (preferably provided with ample straw) was re-combined with individual feeding through means such as electronic sow feeding could it be said that our sows had 'a life worth living'.

There is little good purpose in any such 'active steps' toward the improvement of the lives that animals live on our farms at national level *unless* controls are also put into place over international trade of animal derived products. There is no benefit to farmed livestock if the country where they are looked after best has its livestock farms put out of business through their being unable to compete with importations. And yet that is what happens. Meeting responsibilities to farmed animals costs money which must come from the consuming public whose buying habits reflect their moral stance! Theoretically, countries with 'higher' welfare standards could seek to export their products into those other countries where there are buyers wishing to support, with higher prices, better farming conditions for domestic livestock. Or is that merely a fond hope?

There is presently a frank disproportionality. Other countries are able to farm their livestock at lower costs than in Europe and the United Kingdom because they are less restricted by regulations put into place by Brussels to safeguard animals' interests. Regulations such as: density of livestock populations in cages, pens, feedlots, barns, stock-houses, fields; usages of medicines, disease suppressants, and prophylactics; conditions in transporters and in processing plants; training of those responsible for animal care; and so on and so

on...practically every element that might presently be found in European codes of practice manuals for the accreditation and assurance of all aspects of livestock production.

It is not just a matter of uneven government support and subsidisation across those nations that trade in chicken meat, beef, lamb, pork and dairy products – though this is of substantial importance. It is that the rules and regulations that are meant to moderate livestock farms and address issues of animal well-being are different; both across countries freely trading within Europe, and between Europe and other countries exporting animal products into Europe.

It is simplistic for importers of animal products to mollify public opinion with statements to the effect that the welfare of the animals is 'very important to us'. Nor is it sufficient for bland statements to be made to the effect that 'all products coming from overseas are subject to the same regulation of production practices as apply to our own farmers'. Such statements are difficult to uphold, even within Europe. Requirements can differ, as can the timescales for their implementation. Interpretations and strictness of regulation are often regarded as 'local matters'.

At core, it is not government that presently delivers the regulations that control global livestock production, it is the food dealers – the wholesalers, the retailers, the supermarkets. *These* it is who can take upon themselves the responsibility to deliver animal welfare; non-compliant suppliers simply being unable to sell their product. Global food purveyors are now so powerful that they can dictate terms to governments and producers alike. It is they who set the standards for the production of the goods that they buy, process and then sell. They also interpret those terms. The rigour of their imposition will vary according to changing circumstances; both geographic and financial.

There is more, but it is sufficient to say that there are inequalities, and those inequalities in animal respect and compassion contribute significantly to differences between production costs. Where it is possible for home production to satisfy home needs, then it is difficult to suggest other than that there should be complete exclusion of foreign products that are not exactly and explicitly compliant with one's own standards. This would apply to fresh pork, beef, lamb, goat, chicken (broilers), cured and processed meat products, eggs, milk and milk products (cream, yoghurt, cheese, etc.). It would also apply to prepared foods using these products.

It is perhaps foolish for the people of a nation to oversee the emplacement of welfare regulations that will simply ensure the demise of that nation's livestock farming. The animals about which they rightly care will be the worse (not the better) for it.

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In intensive pig and poultry production systems, blanket treatments with exogenous drugs, such as antibiotics (though there are other examples including anthelmintics), usually have

immediate beneficial and cost-effective results; healthier animals, faster growth, more efficient production.

In the longer term however not only will these benefits be lost, but a dependent production regime will have been created.

Notwithstanding the inevitable build-up of resistance by the organisms under attack, the single underlying issue is that of *dependency* – both on the part of the animal itself, and on the part of the animal's careers. The animal is all the more vulnerable because the availability of drugs props up a lax management regime. Management systems can accordingly be less diligent while still turning out economically produced livestock products.

If sustainability considerations (rightly) require that disease preventatives should be used sparingly, and curatives employed judiciously, what will be the consequences of withdrawal for the animal? Often it is an immediate and catastrophic failure of both the animal's internal systems and the external environment in which it finds itself. A very poor welfare outcome for both livestock and livestock farmer.

Such is indeed the issue where legislation has brought about banning, rather than control, of materials such as feed antibiotics which both control low-level disease and prop up inadequate management. Minimisation of the chances of catastrophe can be achieved by the rate of withdrawal matching the rate of improvement in management systems. This takes time, effort and money.

In Europe the problems were evident in the 1980s, but effective action was not completed until around 25 years later (the European Union banned antibiotics in animal feed for purposes of 'growth promotion' in 2006). This is about as long as it takes for a generational change to happen in livestock-unit staffing quality, and in construction of improved livestock housing. Helpful in achieving graduality of change has been the fortuitous need to use those same drugs for disease *treatment* (a welfare necessity) as were used for disease *prevention* and the masking of poor management. When antibiotics were withdrawn from inclusions in animal feed by feed manufacturers, the animals fell ill and the drug re-prescribed by veterinary surgeons!

The present position in Europe (but not in some other parts of the world) is that prophylactic drug usages have fallen thanks to National and European Union legislation. There has been no catastrophe in livestock production, indeed in some cases there has been improvement in animal health and individual animal productivity. Complacency on this matter is however not justified. Large quantities of antibiotics are still administered to European livestock in the name of disease prevention and cure. In most cases such administrations are not the consequences of unforeseen serendipitous disease attack. They are surely the consequences of animal management inadequacy.

Normal and sustainable livestock farming can not be supported on the basis of continuous dosing with drugs that function against disease organisms and internal or external parasites.

Drug usage throughout Europe's intensive farms can be reduced only together with management changes such as: (1) a willingness to incur higher costs of production; (2) greater attention to the detail of day-to-day management and animal care; (3) breeding for robustness of animal constitution and for disease resistance; (4) heightened biosecurity and regional-level disease monitoring; (5) improvements in animal housing and reductions in stocking densities; (6) rapid diagnosis with treatment of individual animal ill-health; and (7) increasing veterinary inputs and staff training (which are usually associated with larger unit size).

Vaccination is an intervention not included in the above list; it is different in kind. It is presumed to be invariably 'a good idea', and there is a wealth of scientific activity looking to develop working vaccines for a wide range of livestock disease. In the natural order of things most livestock have immune systems that deal competently enough with the world's miasma of other organisms. Sufficient to allow them to thrive. This is the consequence of millions of years of mutual evolution. Domestication perturbed that balance to some extent, but it was the intensification of livestock systems that favoured some bugs that had previously lived harmoniously to now run amok.

The Salmonella bacterium makes a case in point. Ubiquitous in the world's environment, it was common – at unthreatening level – in all low-density (farm-yard) outdoor poultry systems. Still is. Salmonella in eggs only became a problem around the same time as the battery system of egg production was over-exploited. It is not a problem now. Today, Britain's raw eggs are declared safely 'salmonella-free'. This beneficial change is the result in part of improvements in hen welfare, but primarily through routine vaccination of poultry flocks. A beneficial exogenous intervention which restores natural immunity, vaccination may be considered as a better route to health maintenance than wholesale microbial destruction.

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Historically, it has been the pressures brought on by an urban industrial society demanding ample cheap food that brought to domestic livestock wave after wave of welfare-threatening farm practices. Since the wake-up call around the 1980s and the realisation that neither country-dwellers nor towns-folk were happy about the state of livestock husbandry there have been shifts in practice in directions favourable to the animals. However, farms are businesses, and to stay in business profits must be made.

The livestock industry in Europe, and particularly in the United Kingdom, is, by-and-large not trading profitably. Certainly not profitably enough to ensure plough-back into business development and animal care improvement. Profit, if there at all, is all-to-often mostly as a result intervention support from governments (for example through the Common Agricultural Policy). For profit to happen not only must more be paid for food, but standards and prices for imported products must be raised to be the same as those of home-produced products.

The responsibility for the nation's animals on the nation's farms rests not only with the farmers, but collectively with the nation's consumers. It is not enough to protest about the way animals are farmed and demand things be changed. The consumers must become fully involved, and that includes the funding.

Being *the* fundamental commodity upon which human life depends, it is not surprising that food is as potent a trading force in peace as it is a potent weapon in war. A nation setting for itself particular standards for animal care and product quality jeopardises its home livestock farms in the face of exporting nations with cheaper commodities to sell. The solution to this is the raising of trade barriers, and the consequences of those is inflation in the price of food. Further, those same trade barriers provoke retaliation which will be a disadvantage to non-food exporting.

The larger the 'trading nation' or trading group, the more likely food and non-food commodities can be exchanged within commonly agreed production rules. Such has been the case with the 500 million population European Union. Britain (the least agrarian of the European Union countries) has frequently found it expedient to depend upon others to supply its food since the time of the industrial revolution (late 1700s), when it wished to export manufactured goods more than it wished to grow expensive food to feed itself. However, since Britain joined the Common Market in 1973 her livestock have been advantaged with higher welfare standards than animals in non-European Union countries.

Any European country moving outside of the European Union sets herself up as a prime target for receipt of cheaper livestock products from elsewhere. Despite political protestations to the contrary, imposing European standards upon countries outside of Europe remains a difficult attainment by means other than trade barriers. Countries where the livestock economy is an insignificant proportion of the Gross Domestic Product are likely to have little appetite for such actions.

To become price-competitive with importations, Britain might allow itself to down-grade its welfare standards. The counter proposition is that standards are raised in the (probably unrealistic) hope that the populations of other European countries and elsewhere will pay a premium for the knowledge that their food comes from happier animals. History tells us that that sort of market response requires a real difference also in eating quality between the home and the imported product (such as, for example, may be seen in the British population's long-standing fondness for French cheeses and Dutch bacon).

It is difficult to imagine that any animal living in the European Union would want to leave it!

Chapter notes

In 2013 Wageningen Academic Publishers published 'Improving farm animal welfare', edited by H. Blokhuis, M. Miele, I. Veissier and B. Jones.

Chapter 12. What is animal farming for?

What is animal farming for – feeding humans obviously. But a *national* agriculture is *essential* to feeding a nation only in times when food with the required qualities can not be readily and more cheaply imported. *Non-essential* elements of livestock farming in Europe and Britain may need to make their own way in a more competitive (less subsidised) environment. Something that has happened in the past only with the pig and poultry industries. A successful livestock market will be defined by Quality, Differentiation and Security. A stark contrast to the present pattern of commodity food production trying and failing to compete with importations in the absence of trade barriers.

The original prime functions of animals on farms – provision of power, wool and hides – are defunct. Some may argue that the time has come for greater emphasis upon the next most important function; the utilisation of grasslands. Eating grass is the most obvious unique selling point for farmed livestock! Further, environmental sustainability of an open and accessible countryside requires grazing livestock (Figure 12.1).

Then there are the foods that are self-evidently 'sustainable' because they are produced from animals whose death is not dependent upon them – dairy cows and laying hens. Pigs used to contribute to the farming economy as eaters of by-products and left-overs – a quality apparently no longer needed by a society that remains content to throw away half of its food! (Environmental considerations however may again turn attention to the abilities of pigs to mitigate human profligacy). Nowadays however, the human population's desire to increase

Figure 12.1. *Animal Farming's purposes. To provide for the family meal and to provide for the national landscape. Animal farming no longer has the single objective of putting food on the nation's tables, it must also take responsibility for enhancing the welfare of the animals that are being farmed, protecting (improving) the environment, conserving the long-term future of the planet, and creating and sustaining (managing) the national landscape.*

its consumption of meat comes ever more frequently to be satisfied by chicken and pork; both grown for the specific purpose of slaughter for meat where, in developed countries, it can be argued that 'want' for meat is exceeding 'need'. Nonetheless, the argument that beef is a justifiable and sustainable human food because it can come from grass can be used in the case of the pig only when *its* feed supply is sourced from materials that the human population does not want to eat.

In the advanced industrialised nations of northern Europe, some 30-40 percent of disposable income was spent on food in the mid nineteen-fifties. Now, in the late twenty-teens, that percentage is nearer 12 percent. The downside is that too much food is being eaten. And it is not just too much of starch, sugar and oils. Too much of animal derived foods are being eaten as well. True, it is mostly more of chicken that the world is eating, and it has the lowest environmental footprint per kilogram of meat produced of all. But that cuts little ice if ever more of it is being eaten! The total chicken footprint is increasing!

There is much made of the suggestion that, notwithstanding the human race being omnivorous and rather liking to eat animal products, a vegetarian diet is the most sustainable use of limited land and water resources. Nearly a third of European arable land is used to feed livestock. Surely this is too much while our main energy resources are being extracted from fossil fuels (the ratio is, interestingly, about right if all agricultural power was to be provided from crops through draught animals and/or bio-fuel).

It is undeniable that for a part of the current human diet – the animal derived part – livestock are competitive with man for land resource. Direct consumption of cereals by man is 'self-evidently' more efficient because it removes a processing step. This does not however imply that vegetarianism is the way forward. There a great number of reasons for this; here are a few:

First, the efficiency loss differs greatly between the animal species. Beef and sheep are the least efficient users of cereal grains, but as has already been argued, their need for grains is far less than current usages. Pigs are efficient users, with poultry most efficient. So the argument needs to be species specific. Further, and vitally importantly, in making meat out of crops, animals do the uniquely complicated function of concentrating low-grade human food (crops) into high-grade human food (meat).

Second, the addition of animal derived proteins into a mixed human diet will improve the overall efficiency of use of vegetable protein (by improving the amino-acid profiles, and adding other essential nutrient elements more abundant in animal than in vegetable products). Optimum sustainability requires animal protein in the diet – albeit not as much as presently consumed in the advanced industrial nations of Europe and North America.

Third, people with money will use it as they wish, and if that wish is to eat milk, eggs, cheese, beef, pork, chicken and goat, then these things will be provided in a free market. Experience is showing quite clearly that it is indeed their wish. Social mores can however be modified by generational changes in social attitudes.

Fourth, the landscape needs animals if it is to survive as a landscape. Unmanaged grass, scrub and open forest needs ungulates, while the managed landscape needs specifically cattle, sheep and goats (and chickens and pigs), if it is to be sustained in an environmentally proper way. This function might justify special treatment. Farmers are not only entrusted to look after the animals on behalf of everybody else, they are also entrusted to look after the very fabric of the nation itself: the national landscape. (Unfortunately many of our current breeds of domestic livestock are not well suited any more for this purpose, which above all requires robust types that can look after themselves. The matter of genotype/environment interaction and the danger of discontinuities arising between animals bred for one environment being expected to perform well in entirely different environments has been considered earlier).

Fifth, if the arable side of farming is itself to be sustainable, there is an imperative for soil care and disease control that crops are rotated. Basic to crop rotation is the growing of grass. Cereal and root crops need grass; grass needs grazing livestock.

Sixth, although it is the intensively cereal-fed pigs and chickens that come in for the most severe present questioning, these animals can, of course, eat those parts of arable crops which would otherwise go to waste (or bio-fuel) such as, for example: reject human foods prior to and after the point of sale (including poorly grown, second-grade and inadequately stored primary crops, broken biscuits, stale bread, unsold bakeries, lower grade oils). Most important, though, are the huge quantities of starch and protein-rich co-products that emanate from vegetable oil production (oil-seed rape, sunflower, soy bean), bread flour milling (bran, etc.), brewing (spent grains and fruits), etc. These by-products of human food manufacture are unavoidable; their use therefore for animal feed is highly sustainable. But these 'beneficial' uses of arable crops by animals do not cover off the total. So there is a clear element of 'luxury consumption' in the habits of modern industrialised nations as evidenced in their consumption of animals.

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The Livestock Industry – as a component part of the countryside – has been subsidised, one way or another, off and on, for nearly two hundred years. Even before that, farming has been in receipt of inflows of gratuitous funding from landowners whose money has come from just about everywhere else *but* farming.

The question then is not so much about whether there will be supplementary income coming into the countryside, but about how much and what for.

Less, for sure, and of that, a higher proportion that will not relate to food production. While there are advocates of re-introductions of native predators such as eagle, lynx, pine martin, wild cat, wolf, beaver, boar, etc. to forests, wild places, hills and uplands, there are others who protest that animal farming will be threatened. Then how will the people then be fed? However, the people are not presently being fed from these sorts of landscapes!

An unsubsidised rural economy might do better farming low-intensity landscapes with ecological tourism rather than domestic livestock!

Animal farming needs a new generation of ecologists and environmentalists. Ones that are motivated by a desire to make livestock farming better; not doing away with it all together and shipping its responsibilities overseas. There is no present heritage in such skills – therefore there is an opportunity to build on a greenfield site.

Livestock production itself can expect no special rights to tax-payer subsidisation without strings attached; not in times of peace anyway. Nor, in a nation that will want free-trading, can livestock products expect to be protected by tariff barriers. Not that the pig and poultry sector ever were much subsidised in any event.

Any one nation's livestock can only compete with other nation's livestock on *value*; higher quality for same cost. Presently the sector is largely failing adequately to deliver on either quality or cost. The speciality niche producers delivering high quality, albeit at a higher cost, seem to be faring better than commodity farmers producing livestock products at standard quality but without reduced cost. Other countries outside of Europe can readily supply standard commodity products at lower prices. The Northern European livestock industry has got left behind. Innovation and capital investment are desperately needed. There is opportunity for a new generation of entrepreneurs and scientists.

Experience tells us however that, in general, improvements in efficiency and output volume have been achieved at the expense of the animals; good animal husbandry having been put into jeopardy. Improvements in breeding, feeding, housing and management on the other hand are invariably to the benefit of the animal – but they are usually associated with higher costs. Bearing higher costs has the inevitable sequitur that product value must be enhanced. If the product is not improved simultaneously with improvements in husbandry practice, then the business can not be competitive.

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Hopefully, once an animal's life has been given to feed a human (or maintain the environmental sustainability of grasslands), then all of that animal will be respectfully used – not thrown to waste. A mark of economic success appears to be selectivity in the parts of the animal that are chosen for cooking. Is this merely ostentation? If it is, it is at the unjustified expense of the death of an animal.

Hopefully also, there will be a little less meat eaten by those societies already eating more than is good for them. There is no need for this goal to be reached by extreme measures such as vegetarianism; it is a matter of moderation appropriate to a balanced diet. Developing nations aspire to such a balance; while exceeding it seems to be a badge of honour for the well-to-do. Regrettably the world's people who are rich have available to them too much meat too eat, whilst those that are poor have too little. It has been suggested that thirty

kilogram of meat per year may be enough – many people in industrialised countries are eating more like three times that. Would it be too hard to settle for fifty?

Before we kill the animals, we might perhaps consider it reasonable – indeed a moral imperative – that we eat only as many as we need, and whilst they are in our care we also give them a life worth living.

Chapter notes

OECD delivers a comprehensive source of global demographic statistics such as population developments and food consumption patterns.

Chapter 13. Fixing it

Large parts of European animal farming are not working as well as they could. Globally, things are even worse – especially if measured in terms of livestock product outputs where intensively-farmed pigs, poultry, beef and dairy are dominant. Globally, most parts of animal farming are 'less than satisfactory'.

It is not at all clear that animal farming in its present guise is sustainable. But then it never has been – right from the very beginning. All farming systems are 'out-of-balance'; to be sustained they need constant input. As this book has tried to show, many (but by no means all) of the steps forward to solve the problems of yesterday create new problems for today whose own solutions give us a less than satisfactory tomorrow. In these cases, the spiral is not a virtuous one. The most than can be done is to try to make it as positive as can be, but even this is not happening in the way that it could.

The present upheavals in the political and trading structures of the European Union and the United Kingdom will result in change throughout Europe – whatever the outcomes of present and future trade negotiations. A climate of change presents opportunities for examining, indeed fixing, at least some of the conundrums that beset the livestock industry.

People

It is a truism to suggest that the world's present 8,000 million people are too many. At the time of domestication of animals, the world played host to about 5 million people. At the start of the first agricultural revolution of the seventeen hundreds there were 800 million. At the start of the second agricultural revolution in the mid nineteen hundreds there were 2,000 million of which a fifth were in Europe. It is a further truism that the population of Europe in 1800 would allow the extensive organic livestock systems of the 1800s to prevail; which the present population patently does not.

But it is not just a numbers issue. With every justification, countries (and people within countries) with lower standards of nutrition want better. All the evidence thus far suggests that better means more of animal-derived products. Those who eschew any animal contribution to the diet are invariably the very poor who have no means to do otherwise (about 25% of the world's population). For these, a mere 15 kg of meat would transform their lives and health. Those who voluntarily choose to be vegetarian number less than five percent of the world's population. They are a privileged few, and the percentage is much higher in developed (rich) nations (8-9% in European Union countries).

The outlook then is that while already 'developed' nations might be moving away from mass meat and livestock-product consumption and be more interested in improving quality (in its widest sense, which includes concern for the animals themselves), the majority of the

peoples of the expanding world are interested in more meat, more eggs, more milk products. This is a mixed-benefit outlook for the animals.

Ideally, it is understood that self-regulation of global population numbers is best achieved by a general raising of the standard of living. Unfortunately the steps toward that goal seem to inevitably (but unnecessarily) include increasing irresponsibility in food use. Too much is eaten; too much is thrown away. In this regard a rebalancing of animal asset distribution might help. The average per capita meat consumption world-wide is about 35 kg. As it happens, around 30-40 kg of meat per year as part of a balanced diet is considered by most dieticians as adequate (indeed good) for healthy living. On the Indian sub-continent about 3.5 kg of meat is eaten per person. In Africa (excluding the Republic of South Africa) it is about 10 kg, in China about 50 kg, in the European Union about 70 kg, and in North America and Australia above 100 kg.

Whilst animal contributions to the human diet is most often measured in terms of 'meat', the value in the diet of other products such as milk, milk products and eggs is similarly beneficial. Increasing the proportion of products that do not necessitate the death of the giver would reduce the numbers of animals kept for the sole purpose of their slaughter, and it is also the case that both birds and cows could be maintained in flocks and herds for substantially longer than is presently the norm. But it is by no means the case that, without global quality assurance initiatives backed by legislation, the longer lives of laying birds and milking cows will always be 'worth living'.

As for meat itself, it is an obvious fact that as weight at slaughter increases, then the number of animals needed to supply that '30-40 kg of meat' is proportionately reduced.

Neither is the carcass of the animal that has given up its life to feed humans always utilised especially economically. The nations of the world are strangely differently selective not only in which animals they wish most to eat, but which particular parts of which animal. Some prefer the hind quarter, some the fore. Some will denigrate what others seek out as delicacies. Such preferences become a matter of concern for the 'sustainability agenda' when the end result is that what could be used as food is discarded as waste.

Unfortunately, as the economies of the world develop, profligate use of animal resource is becoming more often the case. It is a matter of inefficiency as well as a failure of respect for the animal. This latter issue is particularly difficult to address because for most people nowadays the link between their food and the animal that it came from has been entirely lost. People feel that they should spend their own money their own way; sustainable or not. Money is spent, and mis-spent, in urban environments. In 1900 only about 14 percent of the world's population lived in towns, presently the proportion is 55 percent, and rising rapidly. Fact is, most people in the globe do not live in rural communities any more.

Pressure

In many parts of the world the systems used for farming animals are dependant for their existence upon continuous, or planned-intermittent, inflows of exogenous supports of one sort or another. This is unlikely to be sustainable in the long term. Hopefully, present disruptions in European trading arrangements will create a climate that might encourage a re-think.

The usages of disease suppressants, growth enhancers and metabolic improvers are often seen as progress in animal husbandry. The cynic might note that invariably such production supports are characterised by being (1) manufactured and (2) purchasable! That same cynic might also see these 'technological advances' as indicative not of progress, but of market opportunism presenting remedial solutions to shortcomings in present husbandry systems. If the latter, then it might be better if those shortcomings were positively addressed *before* they came to afflict livestock systems, not after.

The organisms that cause disease are as natural a part of the biological landscape as the wild and domestic animals that they attack. To find the reasons for domestic livestock being so much more ready to succumb, and therefore to require so much more of protection, one must look to the acts of domestication itself, and to the consequences of the first and second agricultural revolutions in the mid 1700s and mid 1900s.

Domestication straightway put the animals in the care of man and under man's protection. Evolution of domestic livestock has been within the context of man's shielding umbrella; the animals have evolved to be dependent upon that shield. Where the protection then fails, the domesticated animal (in contrast to the wild) is left exposed with its defences weakened. The land enclosures and the need to feed an industrial workforce brought the beginnings of selective breeding for performance traits. Inherent strengths in resisting natural disease challenges began to be sacrificed in favour of output traits – milk yields, eggs, growth rates, efficiency. Diminished 'inherent strengths' were replaced by 'an environment of care' provided by man; otherwise known as 'animal husbandry and management'.

Failures in livestock systems were becoming evident in the early 1900s, when intensivism was first explored as a means of increasing output. Poultry were stocked increasingly densely on fields and then in closely-populated houses. Pigs were squeezed ever tighter into specialised fattening pens. Dairy cows kept in larger herds. Diseases that had been endemic, rumbling on at low level, became epidemic – catastrophic. The second farming revolution, with its quadrupling of livestock outputs and the scramble for all the efficiencies that intensivism can bring, brought new diseases effecting general health, reproductive capacity, locomotor ability, predisposition to cannibalism amongst pigs and poultry, and disruptions of the animals' metabolism. In a word, the increase in output brought with it the need for increasing protection by use of external 'interferences' such as were the subject of an earlier chapter.

If one is searching for those elements of the revolution of the mid 1900s that caused animals to be so dependent upon outside help from their carers, then it seems one needs look little

further for the primary suspects than (1) changes in animals' genetic make-up and (2) changes in the proximity of one animal to another – density of stocking. One might also point fingers of suspicion at the environment; lack of diversity in forages and cereal crops, inadequate complexity of dietary ingredients, failures in environmental controls, poor animal management processes, lax biosecurity, and above all diminution of immuno-competence because of increasing stress and reductions in the animals' sense of well-being (welfare/contentment). *All* of the latter can be addressed by simple expedients of the responsible application of *existing* knowledge – backed perhaps by *imperatives* contained in Quality Assurance codes. What then of the former; the genome of farm animals (1) and the density of their stocking (2)?

These too can be addressed – given the will. Not the will of the farmers, nor even of the scientists, but of the populace. The people would need to have the will to pay more, to invest, and to put up barriers against those who may be of different persuasions.

The 'paying more' will be needed to cover the inefficiencies that will result from fewer laying birds per cubic metre of layer-house space; fewer broilers per square metre of floor space; less dairy cows per metre to loaf, to lie, to ruminate and to graze; fewer pigs in intensive housing and out into fields (and those fields with less pigs per acre and more grass); pigs that are inside kept on straw rather than concrete; sheep flocks and beef herds stocked less densely in fields which grow more diverse pastures; removal of beef cattle from barren feed-lots; and so on. No member of the public would gainsay these expectations for the animals, indeed many demand them! But they must also pay for them, and the will for *that* may be less resolute.

The 'investment' should not only go into better mechanisation and instrumentation for automated control systems for livestock housing feeding and management, but into genetics. Genetic selection can move the animals' genomes so that they better fit the environments in which the animals will be put. In particular, both specific and general resistance to disease can be bred back into domestic livestock, together with all those other robust characteristics that are supportive of a long life and one of acceptable quality.

When considering 'pressure' upon livestock systems, the *density* at which a population of livestock are kept and the *scale* of that population in any single place must always be carefully differentiated. Both a small number and a large number of animals can live closely confined, whilst equally, a small number and a large number can be farmed extensively. Often a large farm is also an intensive farm, but the consequences of intensity of stocking on the one hand and the scale of the livestock unit on the other, must always be separately considered. There is little doubt that livestock units will become ever larger; some reaching a scale deserving of the prefix 'mega'. But there is no inherent danger *per se* in size of operation. There is every inherent danger *per se* in intensity of operation. (The US beef feedlot is an object lesson in this regard)

Payments

Regardless of the detail of the consequences of the present disruptions caused by the Westminster Government to the Common Agricultural Policy (CAP) payments, the general consequences will inevitably be great; not just for the United Kingdom, but across Europe as a whole. Even although the proportion of the European Union budget which is devoted to agricultural matters of one sort or another started out more than 75 percent, and has since fallen to some 30 percent, this nonetheless large proportion of the whole means that disruptions to Europe's budget will be felt most acutely of all by the agrarian community. European farmers have come to depend upon the CAP to provide the core of their take-home-pay; satisfying the requirements of the CAP is the first item in every European farmer's business plan.

The impending disruptions to those business plans will not leave the livestock sector unscathed.

Farmers must follow the market place from which the money is generated that makes for them their profit. Because much of the farming industry is made up of private businesses, profit provides directly the day-to-day spending money for families. Well and good, but where/what *is* that market place?

Few farmers see their market place as other industries do. In agriculture, only rarely is the market place where the producer interfaces directly with the users of their goods. Farmers interface instead with those 'standing at the farm gate'. These are 'middle-men' of one sort or another, interested in creating financial margins when trading with the farmer on the one side and with the end-customer on the other.

This obfuscation of trading efficiency would in itself be a big enough challenge to fix, but there is worse. The simple comfort of trading with middle-men at the farm gate and thus avoiding the angst of satisfying the whims of end-customers was considerably strengthened by the support systems for agriculture that were put in place in the mid 1900s. These bought from the farmers 'at the farm gate', delivering a government-supported price that would ensure for the average farmer a living wage. Of course, these support schemes did not have the original purpose of distancing farmer from consumer – this distancing is an unintended consequence. But, to pile on the agony, there is now an even more important consequence of the European support systems – the money from Government comprises a major part of farmer's 'take-home-pay'.

The farmer's market, the one the farmer has first and foremost to satisfy, is the government subsidy arrangements.

As the Common Agricultural Policy for farmer support evolved to its present state, five diffuse purposes have emerged; (1) food security (adequate food supply), (2) food that is affordable, (3) assurance of good farming stewardship including animal welfare, (4)

improvement and protection of the environment, and (5) support for communities living in the difficult social fabric that is the rural countryside.

The last three of the five purposes are well aligned with the benefits of 'extensivisation' considered above. There are also possible benefits for those livestock farmers in geographical areas that do not favour intensive cropping – beef cattle, sheep and goat country. Unfortunately, the presently structured support schemes do not give much of support to the dairy, pig and poultry farmers who are the *de facto* providers of adequate quantities of affordable food (purposes (1) and (2)).

Before the second farming revolution of the mid 1900s, the patterns of production, with many small-to-medium-sized family farms, created a reasonably even distribution of responsibility for food production across the whole farming community. Governmental support delivered to *all* farmers was therefore successful in increasing the amounts produced of affordable food and (as a by-benefit) also support those living in the rural environment. (As has been already noted however, the effects on stewardship, environmental protection and animal welfare were adverse). Presently, however, the pattern of livestock farming – with ever-bigger production units, – is inexorably moving toward the '80/20 rule'. Eighty percent of the productivity coming from twenty percent of the farms. This will require a most carefully considered analysis by policy makers of how best to deliver to European agriculture the five purposes (1-5, above); food security, food price, animal welfare, environment, and the rural fabric. Some 50 percent of livestock farmers are failing to make an income commensurate with effort and expectation even with present levels of CAP support. Without it, their livelihood is compromised. Without *them*, what will be the fate of large tracts of the farmed countryside?

The support system has evolved over the last seventy years in steps each of which have apparently been considered as too small to be worthy of a wholesale re-think as to the underlying purpose of the system. Further, disassembling structures upon which people have come to depend is politically risky when the alternative is to 'leave well alone'. If the cheap food agenda delivered through mass support to all and every one of Europe's farmers were to lose political favour (which is quite possible), then perhaps support structures for 'stewardship' might be beneficially extended to those farms which will be producing most of the food – intensively-farmed large-scale dairy cows, pigs and poultry. If such was found politically 'difficult' (which is also quite possible), then farming must move into an unsupported free market climate.

Prospect

Can the countries of Europe be self-sufficient in livestock products, controlling their own standards of quality, sustainability and animal care? Of course they can. Can the present nonsenses in animal farming be addressed and systems assured that the animals have a life worth living? Of course. So too can the next generations of farmers, technologists and politicians create the right business and environmental frameworks to get these things done.

But will they want to do it, and how much will society be wishing to pay?

A personal memory

The day before he was arrested (again), Professor Jan Kielanowski – erstwhile revolutionary in the Warszawa Uprisings of 1943 and 1944 and, at the time in question, Head of the Animal Research Institute, Jabłonna, and later member of KSS-KOR – told me in his office, 'Colin, you should never stop telling truth about what happened, even though nobody will thank you for it'. But then we were in Soviet Communist Poland and it was 1975.