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Sustaining fitness and welfare in the dairy cow

A.J.F. WEBSTER

Department of Clinical Veterinary Science, University of Bristol, Langford, Bristol, BS40 5DU, U.K.

INTRODUCTION: FITNESS AND WELFARE

The 'Animal Welfare Problem' is, in fact, two problems. One is the problem as perceived by the general (human) public. This tends to classify words like natural and grass as 'good'; words like intensive and high output as 'bad'. According to this simplistic world view, the New Zealand Dairy Industry ranks as good; an image which is your advertising industry reinforces by happy pictures of Jersey cows grazing peacefully, sometimes, quite shamelessly, with calves at foot! The other, quite distinct animal welfare problem is that perceived by the cows themselves, which cannot be reduced to pretty pictures. My address will consider only this latter problem; the impact of modern feeding, breeding and management practices on the welfare of the dairy cow herself. It is for you to decide how this information may be used for the good of the dairy cow and the good of the dairy industry.

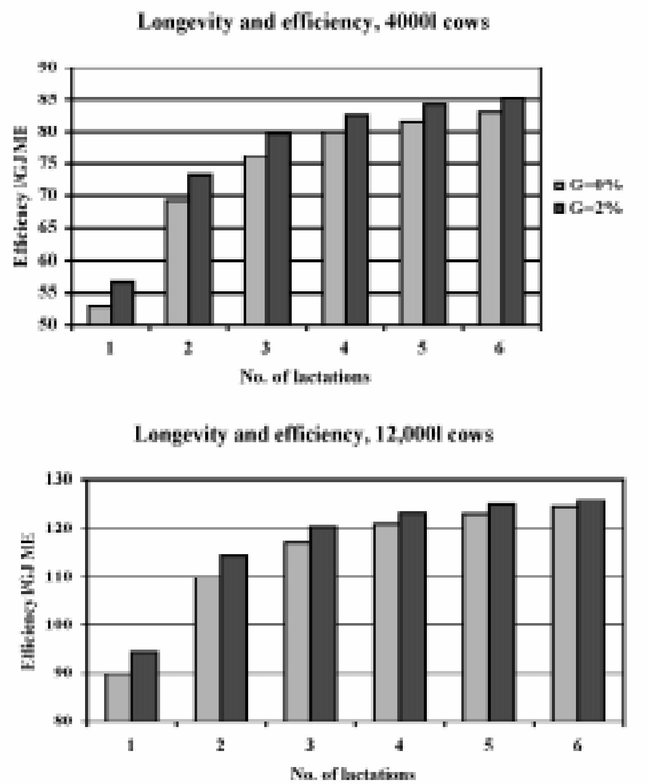
Fitness and welfare: definitions

The welfare literature is littered with rather laboured attempts to define welfare in a single sentence. Actually our aim can be stated most simply. It is to keep our animals fit and happy. To be a little more precise, their welfare state will be good if they can sustain fitness and avoid suffering. In the case of the dairy cow I shall define sustained fitness as the ability to maintain production and good health for at least four lactations. Suffering, according to my definition does not equate with stress. Some stress (be it physiological or psychological) is natural. The body and mind have adaptation mechanisms that enable them and us to cope. Suffering only occurs when an animal fails to cope with single or multiple stressors (causes of stress) because they are too severe, too many or too prolonged (MacFarland, 1989; Webster, 1994). It follows from these definitions that the concepts of fitness and suffering have to be considered in the long term. They cannot be properly deduced from a single farm visit.

Sustaining fitness

My choice of four healthy lactations as a measure of sustained fitness is justified by Figure 1 which illustrates the theoretical effect of increasing longevity on lifetime efficiency, expressed as total litres milk produced per GJ ME consumed. Figures 1a and b refer respectively to cows with lactation yields of 4000 and 12000 L in the third to fifth lactations. The calculations are made assuming no genetic improvement (G=0%) and after five years of genetic improvement at the (very high) rate of 2% per annum (GE=2%). In both examples, there is little gain in optimal lifetime efficiency after 4 lactations. For 4000-L cows, a life expectancy of only three lactations reduces lifetime efficiency by 7%; a life of two lactations reduces it by 12%. For 12,000-L cows the effect is slightly less in relative terms, 5 and 10% for three and two lactations respectively.

FIGURE 1: Effects of increasing longevity (Number of lactations) on lifetime efficiency in dairy cows. The groups G=0% and G=2% refer, respectively to efficiencies in cows with no genetic improvement and after five years genetic improvement at 2% per annum



Strong selection pressure for milk yield can achieve a rate of genetic improvement of 2% per year in first lactation and this response is still linear. Furthermore, response to selection for increased yield in Holstein cattle on high-energy diets can also be expressed on pastoral, lower energy (New Zealand) diets. (Holmes, 1995; Veerkamp *et al.*, 1995b). However a culling policy based on selection for increased milk yield (in any environment) that replaces cows after four lactations, will, after five years just match the consequences of keeping cows fit for six lactations and practising no selection at all. (Thereafter, of course, it will start to forge ahead). Culling after less than four lactations (for whatever reason) reduces efficiency measured at five years. I have met, around the world, those who have been so indoctrinated by the argument (or sales pitch) for genetic progress that they turn over cows after approximately two lactations. The message of Figure 1 is that these people are being conned.

In practice, (in UK and USA) culling occurs, on average, between the third and fourth lactations and approximately 80% of culling is involuntary; i.e. because of failure to sustain fitness, the main culprits being infertility, mastitis and lameness (Esslemont and Kossaibati, 1997). This theoretical model implies that production diseases are holding production efficiency at least 10% below optimal.

A high proportion of culling is for reasons of infertility. Pryce *et al*. (1998) obtained a genetic correlation of +0.39 between milk yield and calving interval. This reflects though does not precisely describe a large body of evidence which links selection for increased milk yield with infertility. It follows that any selection index will be overoptimistic if it does not take lifetime performance into account. It would be more consistent with sustained fitness to select for production over four lactations not one. It is, of course, much slower. The most elegant theoretical approach to my knowledge is that of Veerkamp *et al*. (1995a) whereby selection for economic merit (ITEM) is based on both milk yield and longevity and incorporates both performance and conformation traits.

WELFARE PROBLEMS FOR THE DAIRY COW

Analysis of welfare state: the 'Five Freedoms'

Fitness is a necessary element of good welfare but it is not the whole story. Equally, longevity *per se*, is not a prerequisite for good welfare. What matters to the cow is that she does not suffer physical or psychological distress as a consequence of the systems of breeding, feeding and management that we impose upon her. My approach to the analysis of the welfare state of any animal on farm, in the laboratory, the zoo, or at the bottom of the garden is based upon the logic of the 'Five Freedoms' which I first proposed 18 years ago (see Webster, 1994). These read, at first sight, like an impossible counsel of perfection but function in practice as a comprehensive checklist. As now defined by the U.K. Farm Animal Welfare Council they now read:

1. *Freedom from thirst, hunger and malnutrition* -by ready access to fresh water and a diet to maintain full health and vigour;
2. *Freedom from discomfort* -by providing a suitable environment including shelter and a comfortable resting area;
3. *Freedom from pain, injury and disease* -by prevention or rapid diagnosis and treatment;
4. *Freedom to express normal behaviour*-by providing sufficient space, proper facilities and company of the animal's own kind; and,
5. *Freedom from fear and distress*-by ensuring conditions which avoid mental suffering.

Each of the Freedoms, which define an element of welfare state, is accompanied by an expression of the provisions necessary to achieve that element. The logic of the Five Freedoms can be used to identify, in general terms, possible contributors to poor welfare through loss of fitness or mental suffering that may be linked directly to the feeding, breeding, housing and management of the dairy cow. For example:

- The cow may both suffer and fail to sustain fitness through hunger, malnutrition or metabolic disease due to a failure to supply a diet appropriate to the genetic or physiological potential of the animal to produce milk;
- She may suffer chronic discomfort; through poor cubicle design and inadequate bedding and this may become worse if she loses condition through malnutrition;
- She may suffer pain through lameness or mastitis;
- She may show an increased susceptibility to infectious disease;
- She may be bullied or denied proper rest by other cows; or,
- She may experience metabolic or physical exhaustion caused by the stress of prolonged high production.

These potential sources of poor health and welfare can be interdependent and additive. For example, the high genetic merit dairy cow, who is housed in cubicles and fed a diet based on wet grass silage and concentrate in parlour, may suffer both from hunger and chronic discomfort, partly because the quality of feed has been inadequate to meet her nutrient requirements for lactation and she has lost condition, partly because the wet silage has contributed to poor hygiene and predisposed to foot lameness, and partly because genetic selection has created a cow too big for the cubicles. Note that these are criticisms of inadequate feeding and housing for the high yielding cow. They are not a criticism of high genetic merit *per se*.

METABOLIC STRESS IN DAIRY COWS

The metabolic load of lactation

One of the great truths concerning the high genetic merit dairy cow is that the capacity of her mammary gland to produce milk far exceeds the capacity of the cow upstream to supply the nutrients necessary for milk synthesis. The first constraint to the productivity of the dairy cow is her capacity to consume and digest food to make substrates (principally metabolisable energy, ME) available for milk synthesis. This is determined primarily by the capacity of the rumen to ferment carbohydrate and degrade organic nitrogen. Table 1 presents typical values for milk yield and DM intake for high genetic merit Holstein cows in different circumstances; at pasture, fed silage plus concentrates twice daily or fed a well-balanced 'Total Mixed Ration'. This shows that a well-balanced TMR can sustain a yield of 55 L/day, more than twice that possible from the same animal when grazing, not just because the food is freely available but (mainly) because it promotes sustained rapid digestion in the rumen.

TABLE 1: Milk yields and dry matter intakes of Holstein/Friesian cows in different circumstances

	DM Intake (kg /day)	Sustained yield (L/day)
Pasture	16	25
Grass silage + concentrates(x2/day)	20	36
Total mixed ration	26	55

This table provokes two apparently contradictory questions.

- 'Is it more stressful to a dairy cow to produce 55 L/day than 25 L/day?'
- 'Is it stressful to a high genetic merit Holstein cow to restrict her to a diet that can only sustain 25 L/day?'

The British Society for Animal Science recently convened a Symposium on 'Metabolic Stress in Dairy Cows' (Oldham *et al*., 1999). This examined the short and long term consequences of high metabolic load. There was however, no clear consensus as to what is meant by 'metabolic load'. Does it, in the light of the above questions, mean sustained high yields *per se*, or yields that exceed, in the short term, the capacity of the cow to supply nutrients for milk synthesis?

Metabolic hunger v. the limits to food intake

Cows are not motivated to eat by the desire to produce as much milk as possible but by self-interest. They regulate their intake to ensure maximum comfort (or, more likely, minimal discomfort). The physiological demands of lactation create a condition of 'metabolic hunger'. The cow senses not only the continuous uptake of substrates by the mammary gland, she also senses the cumulative effect of loss of body reserves of energy and protein. Thus injections of bovine growth hormone (bGH or BST) typically increase milk yield by 15% immediately. This is followed by an increase in DM intake after a delay of about two weeks, as the cow senses the loss of body reserves that has occurred in the interim. For most lactating cows, most of the time, the primary motivation to eat is metabolic hunger. There are, at the same time, powerful factors that restrict the amount of feed she can consume. At pasture, DM intake is limited by the rate at which she can harvest the grass. The intake of cows offered grass silage *ad lib.* and concentrate in two feeds/day is constrained both by gut fill (i.e. the slow fermentation rate of silage) and by an asynchrony between the degradation of organic nitrogen (N) and fermentation of fibre. Too rapid degradation of N causes an increase in NH_3 and urea in blood, which impairs appetite. The aim of the Total Mixed Ration (TMR) fed from a mixer ration is to provide an optimal, balanced supply of substrates for microbial fermentation. This should ensure both a high rate of processing of organic matter in the rumen and a high rate of supply of available nutrients for metabolism. Thus TMR feeding can sustain both very high milk yields and very high DM intakes.

To summarise this section; the dairy cow is primarily motivated to eat by metabolic hunger (a function of both milk yield and body condition). She is motivated to *stop* eating by sensations (conscious or unconscious) associated with gut fill, unbalanced absorption of certain metabolites (especially ammonia), and the conflicting desire to do something else, such as rest. The relative importance of these constraints on food intake is indicated in Table 2.

TABLE 2: Relative importance of different constraints to the food intake of dairy cows.

	Pasture	Silage + cake	TMR
Need to rest	+++	+	+
Gut fill		+++	
Unbalanced digestion	+	++ to +++	

At pasture, the first constraint on food intake is the rate at which the cow can physically consume the grass. Thus the motivation for the cow to stop eating is more likely to arise from the desire to rest than from the sensation of gut fill. On very high N pastures food intake may be constrained by ammonia absorption. In cows offered a well-balanced TMR, all three constraints on food intake will operate but they impose far less powerful constraints on the motivation of the cow to satisfy its metabolic hunger. The motivational state of a high yielding cow offered poorly-made, high ammonia-N grass silage plus concentrate in parlour only may be defined, with brutal accuracy as hungry, tired, full up, and feeling sick.

Short-term responses to high metabolic load

When considering the potential for metabolic stress during lactation it is necessary to distinguish between:

- metabolic stress arising as a direct consequence of the high work rate necessary to sustain high yields; and,
- metabolic stress arising from the imbalance between input and output.

Lactation is very hard work (Webster, 1995; Nielsen, 1999). A Holstein sustaining a yield of 30 L/day has an ME intake of approximately three times maintenance, and heat production (work rate) approximately twice maintenance. For a 60 L/day cow the factors are approximately four and three, respectively. I have previously (Webster, 1995), using the conventional scaling rule of body weight ($W^{0.75}$). The modern, well-reared dairy heifer should be fit enough to achieve these rates of digestion and metabolism when she calves down for the first time. The question is, 'How long can this be sustained and at what cost, measured in terms of both fitness and suffering?

Knight *et al*. (1999) proposed a useful distinction between the metabolic load and metabolic burden of lactation. Metabolic load precisely defines the immediate metabolic rate required to sustain current milk yield. Metabolic burden less precisely reflects the overall costs of sustaining lactation. I shall consider this in the next section. Knight *et al*. (1999) argued that the stress directly attributable to metabolic rate should reflect actual yield relative to maximum potential yield for the genotype. By this (limited) definition a yield of 30 L/day would impose a relatively low intensity of stress on a cow capable of producing 60 L/day in the same way that the engine of a 1000cc motorcycle cruising at 60 m.p.h. would be less stressed than a 100cc motorcycle straining to maintain the same speed. This is a useful analogy so long as it is not taken too far. A yield of 25 L/day in late lactation undoubtedly poses a lower metabolic stress than that of 50 L/day for the same cow in early lactation. However a high genetic merit Holstein cow yielding 25 L/day at pasture (e.g. in New Zealand) may be more stressed than her cloned sister fed a TMR in a barn and producing 50 L/day. In this case, however any stress is likely to arise not form the metabolic load of lactation *per se*, but from the difficulties of consuming and digesting sufficient food to meet the metabolic demand of the mammary gland. The problems, as perceived by the cow, are metabolic hunger and physical tiredness (Table 2).

The second potential cause of metabolic stress, that arising from the imbalance between input and output, is defined by the magnitude of the energy deficit in early lactation. It is normal for cows (or any other lactating mammal) to lose weight (energy and protein reserves) in early lactation. However there are clear limits to this, and these losses have to be restored. Conventional estimates of energy exchanges during lactation (AFRC, 1993) equate a loss of 50 kg in early lactation to 950MJ energy or to 210 L milk. Very recent calorimetric studies with high genetic merit cows by Sutter and Beever (2000) indicate however that energy losses in lactation may be considerably greater and last longer (up to week 20 of lactation) than one would predict from body weight loss. In their experiments body energy reserves supplied approximately 600 L, or 9% of total lactation yield. It is not yet proven, but the balance of new evidence would suggest that selection in the high genetic merit cows has favoured an increased capacity to contribute body energy reserves to milk in early lactation.

Knight *et al*. (1999) deliberately created circumstances likely to induce profoundly negative energy balance in early lactation in high and low genetic index dairy cows. The stimuli used (in succession) were four times daily milking, BST injections then BST plus thyroxine injections. Both groups appeared to adapt, in the short term to BST and frequent milking, but suffered a catastrophic loss of milk yield and body weight when thyroxine treatment was added to the other stressors. This was a somewhat unrealistic scenario, and the data suggest that thyroxine elevated metabolic rate for reasons that were unrelated to milk yield.

FIGURE 2: Schematic illustration of the supply of energy and protein to the mammary gland of the dairy cow.
Key:
ME = metabolisable energy; FME = fermentable metabolisable energy;
MP = metabolisable protein; ERDP = effective rumen degradable protein; MiP = microbial protein; UEP = undegraded energy and protein

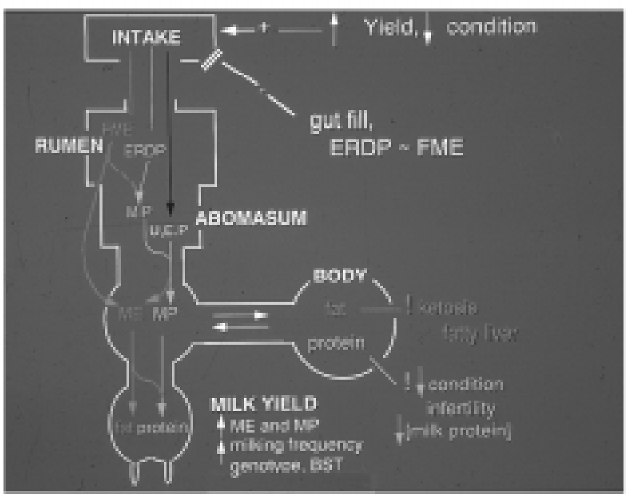


Figure 2 attempts to summarise, very simplistically, the supply of metabolisable energy (ME) and amino acids, expressed as metabolisable protein (MP) to the mammary gland. While balance studies would suggest that milk synthesis in more likely to be constrained by energy rather than amino acid supply (Sutter and Beever, 2000), infusion experiments and feeding trials usually demonstrate that increasing amino acid supply increases milk yield, in the short term. In practice, 'high protein' feeding tends to increase milk yield, so increase ME requirement, so tends to cause cows to mobilise more reserves and lose condition. Reducing the MP concentration in feeds restricts yields, so makes it easier for the cow to maintain energy balance. It follows therefore that a high genetic merit Holstein cow can *comfortably* sustain a yield of 25 L/day on a low protein ration (i.e. she won't be stressed) in the same way that a Porsche can cruise comfortably at 50 m.p.h. It also follows that when the DM intake of a high genetic merit cow is constrained by availability (at pasture) or difficulties of digestion (e.g. grass silage) then high protein concentrates will exacerbate the stress.

LOSS OF FITNESS

The most serious welfare problems for the dairy cow are likely to arise not from the intensity of the metabolic load but from the duration of the metabolic burden. Most fit cows can cope, in the short term with high yields and large energy deficits. It is equally self-evident that a very large number of cows, properly fed and managed, can sustain high yields for at least four lactations. By my definition, this is satisfactory evidence that they can sustain fitness or 'cope' with the sustained burden of lactation. Moreover, I know of no evidence to suggest that this large number of successful individuals suffers (psychologically) as a consequence of this heavy burden of work. However, the motivation and behaviour of these animals is dominated by the need to eat and the need to rest. Animal behaviourists have spent much time observing what cows do (Albright and Arave, 1998), concentrating on superficially interesting things like social behaviour. In the context of metabolic stress however, perhaps the most useful thing to measure is the amount of time that cows 'stand and stare' (do nothing). In the cow at its metabolic limits this time may become vanishingly small.

My concern is with the cows that fail to sustain fitness and here there is evidence that selection for high performance is making things worse. To return to the high speed analogy, if a car is capable of 160 m.p.h. it may not stress the engine to drive it at 100 m.p.h. but it carries a high risk of inducing a serious crash.

Too many cows in U.K., USA and (I believe) New Zealand are being culled as a result of failure he to sustain fitness. The main reasons are infertility, mastitis and lameness (Esslemont and Kossaibati, 1997). There is clear evidence increased yields, whether achieved through selection or induced through injection of BST, are associated with reduced fertility (Darwash and Lamming, 1997). There is no reason to assume that cows suffer as a direct result of infertility. However infertility may be just the most obvious presenting sign of loss of fitness resulting from an inability to cope with the metabolic burden. Other, more distressing consequences of failure to cope include:

- Exhaustion: a psychological state induced by sustained hard work and exacerbated by loss of body condition;
- Injury and pain: emaciation will cause loss of resilience in the tissues of the skin and feet, thereby increasing predisposition to injuries and lameness; and,
- Malaise: emaciation may induce immuno-suppression, leading to increased incidence of infectious disease, especially mastitis, which is also very painful.

Pryce *et al*. (1998) have analysed the heritabilities, genetic and phenotypic correlations between milk yield, calving interval, mastitis and lameness in the U.K. dairy herd (Table 3).

TABLE 3: Heritabilities (along the diagonal), genetic correlations (below the diagonal) and phenotypic correlations (above the diagonal) for 305-d milk yields, calving interval, mastitis and lameness obtained from analysis of U.K. data. (Pryce *et al*., 1998)

Trait	1	2	3	4
Milk yield (kg)	**0.33**	0.20	-0.01	0.04
Calving interval (days)	0.39	**0.025**	0.04	0.04
Mastitis (0/1)	0.26	0.11	**0.057**	0.05
Lameness (0/1)	0.17	0.20	0.33	**0.036**

The phenotypic correlations between milk yield, and mastitis and lameness are negligible. However the genetic correlations are positive and highly significant, which suggests that farmers, through improved attention to good husbandry, are just managing to hold the line despite working with a progressively unfit cow. Increasing productivity in the dairy cow does not appear to have directly increased the incidence of metabolic diseases which supports my view that dairy cow nutrition is much better than it was 20 years ago. In the U.K. however, the overall incidence of mastitis has been reduced through financial incentives to reduce somatic cell counts in milk. On the other hand, it appears that the incidence of foot lameness has significantly increased. The U.K. Farm Animal Welfare Council has identified foot lameness and the associated pain as the number one welfare problem in high yielding dairy cows. Clarkson *et al*. (1996) reported an annual incidence of 55% and prevalence of 21% of foot lameness in dairy cows in Western England. The majority of these were diagnosed as solar ulcer or white line disease, both manifestations of claw horn disruption (CHD). While certain external risk factors have been implicated in the aetiology of CHD including, conformation, feeding, housing and season (Greenhough and Weaver, 1997), there is increasing evidence that systemic events associated with parturition and the onset of lactation may impair the structural integrity of the hoof (Kempson and Logue, 1993; Leach *et al*., 1997). In certain genotypes and under certain conditions of housing and management, this loss of structural integrity, in combination with external forces on the foot, will be sufficient to disrupt the attachments of the distal phalanx, causing the pedal bone to exert excessive pressure on the sole. The primary cause of sole ulcers and white line disease is not (as traditionally thought) external damage from stones and hard floors but *internal* damage due to excess pressure from the pedal bone. While it is relatively easy to control lameness due to infection or external damage, the most serious risk factor for CHD appears to be innate to many modern dairy cows.

Lame cows are obviously in pain. Moreover, there is new evidence to show that chronically lame cows display hyperalgesia or increased sensitivity to pain (Whay *et al*., 1997). In this regard they respond as we do. We and they do not adapt to chronic pain, the sensation gets worse with time. The importance of any welfare problem may be defined by its incidence, severity and duration. By these criteria, foot lameness is the biggest welfare problem of all.

SOLUTIONS

Breeding and management strategies

As I have explained already, it is possible to feed the modern high genetic merit dairy cow in such as way as to avoid stress due to high metabolic load. However the pressure of competition forces us to drive our cows as fast as possible on the available fuel. The greater the lactation potential of the cow, the greater the risk of a crash. The better dairy farmers, whether operating intensive or extensive systems, have done much to adapt their husbandry (feeding, housing and hygiene) to meet the more searching demands of the modern dairy cow. Nevertheless, even in the best-managed herds, there are some big welfare problems which we need to address.

Breeding policy should be based on performance over four lactations. The ITEM selection index of Veerkamp *et al*. (1995a) is a welcome step in this direction. It clearly requires (though may not find) conformational, biochemical or molecular markers that can help in the early identification of traits associated with longevity.

Whereas failure to sustain fitness over four lactations may not necessarily be a direct cause of suffering, the cow that is culled for mastitis, lameness or infertility of nutritional origin may suffer from exhaustion, chronic pain and malaise (the sensation of feeling ill) for some time before she is finally put out of her misery. Early culling of unfit cows is an essential component of good welfare.

The biggest welfare problem for dairy cows (in the U.K.) is foot lameness. The most intractable condition is Claw Horn Disruption, which starts to manifest as solar haemorrhages at about the time of calving (Leach *et al*., 1998). Most of my current (as yet unpublished) research is based on the premise that the suspensory apparatus of the foot has difficulty is sustaining the weight of the modern cow and that these problems are exacerbated at the time of calving. These problems are worst when newly calved cows are housed in cubicles and fed wet silage. They may be reduced by keeping newly calved cows (and especially heifers) out at pasture or in a deep-bedded straw yard. However, we cannot escape the conclusion that we need to breed cows with stronger feet.

Quality Assurance Schemes

In the U.K., two forces are combining to drive dairy farmers towards higher standards of animal welfare. These are:

- increased public awareness (or impressions) of problems in animal production (e.g. welfare issues and especially BSE); and,
- collapse of the guaranteed milk price leading to a need to seek specialist, ‘value added’ markets.

The trusty words ‘natural’ and ‘traditional’ make the U.K. public feel good, whether or not they can be linked to high standards of health and welfare. The new use of the word ‘Organic’ makes some of the U.K. public and some of our dairy farmers feel very good indeed since the premium for organic milk is currently about 60% and supply cannot (yet) keep pace with demand. I think the demand for organic dairy products will grow briefly then decline unless, of course, there is another BSE-type scare and I could be terribly wrong. However the organic movement is just an extreme example of a much broader (and at its centre more rational) desire for quality assurance (QA) as to the food we buy, based on properly enforced quality control (QC). When the food comes from animals this quality control must incorporate guarantees as to the welfare state of the animals involved. I shall hereafter consider QC only as it relates to animal welfare in the clear recognition that this is only part of the story.

A multitude of Farm Quality Assurance Schemes (too many!) have developed in the U.K. in recent years. All offer guarantees relating to the provenance of the animals, standards of hygiene, and standards of husbandry as they relate to welfare state. The principles that underpin quality assurance (QA) based on independent audit are impeccable but the practice often leaves much to be desired. If a QA scheme can guarantee that the welfare state of animals on an accredited farm is very good then this can instil trust in the consumer, pride in the farmer and should justify a premium price both in the shops and at the farm gate. If the scheme is unable to demonstrate high welfare status and carries no premium then it becomes no more than a bureaucratic chore for the hard-pressed farmer. Some of the U.K. 'Farm-based British' schemes fall into this category mainly because the average consumer has never heard of them.

Probably the most successful welfare-based QA scheme in the U.K. is the RSPCA 'Freedom Foods' scheme. This was developed and marketed on the foundations of the 'Five Freedoms'. This obviously appeals to me for reasons of parental pride but also because it seeks to give guarantees that relate directly to the welfare state of the animals. The Freedom Foods logo now appears on approximately 90% of eggs produced from hens in colonies in barns or free-range systems. In my local supermarket they currently occupy over 50% of the allotted shelf space for eggs. The number of dairy farmers joining the scheme is encouraging but they have not yet managed to negotiate a worthwhile premium for the milk products (although many organic dairy farmers are also Freedom Foods accredited).

The Five Freedoms as defined by FAWC provide a comprehensive approach to the analysis of welfare state (which is what matters) and the provisions necessary to achieve it. To convert these broad aims into an effective procedure for quality control it is necessary to address four issues:

- *Resources:* provision of the facilities necessary to ensure proper feeding, housing and handling of animals;
- *Management:* provision of correct husbandry procedures and competent, sympathetic stock-personship;
- *Records:* provision of written evidence of use of medicines, deaths and culls, incidence of disease and injury (etc); and,
- *Welfare state:* evidence of physical fitness and mental wellbeing as perceived by the animals themselves.

Most aspects of provision (e.g. feeding and housing) can be identified and recorded objectively. Assessment of the outcome of these aspects of provision, namely welfare state, must inevitably involve some degree of subjective value judgement. Those scientists who seek, or claim to have found, truly objective indices of welfare state (usually based on measurements of adrenocortical steroids plus a selection of other biochemical measurements) are deluding themselves since the cocktail of 'objective' indices that they select tends to be the one most consistent with the conclusion they subjectively assume to be correct (Webster, 1998).

It is perhaps inevitable that the protocol for welfare-based QC visits largely involves ticking off boxes on a long checklist of items of provision. The Freedom Food Scheme is no exception. The protocol for the inspection of pig units has over 250 boxes, only seven of which can truly be said to relate directly to welfare state. At first sight it appears that this approach is missing the point. It can however be defended on three grounds:

- The farmer who provides excellent resources and management has met his/her duty of care to the animals;
- Things can go wrong with animal welfare for reasons that are not the farmer's fault (e.g., sporadic episodes of smothering or cannibalism in colonies of laying hens); and,
- The critical decision whether or not to give accreditation to a farm must be based on robust evidence, it cannot be left to the subjective whim of the assessor.

Nevertheless, the fact remains that what really matters is the welfare state of the animals themselves. Currently, we at The University of Bristol are carrying out an independent audit of the effectiveness of the RSPCA Freedom Food Scheme as applied to pigs, laying hens and dairy cattle. We are watching over the watchmen. Our project addresses three main questions:

- Does the Freedom Food scheme, as currently practised, guarantee that the farmer is providing due care for the welfare state of the animals (even if he cannot always achieve it)?
- Is the welfare state of animals on 'Freedom Food' farms significantly better than that of animals on non-participating farms? (Does it justify the premium?)
- Can the existing protocols be simplified and improved to take better account of direct indices of welfare state (without losing the robust objectivity of the current scheme)?

The basic protocol for evaluating welfare state in dairy cows is outlined in Table 4. This is not the place to discuss it in detail, but note that it is structured so as to address the five freedoms, plus long-term indices of the ability to sustain fitness.

I repeat, the aim of this detailed procedure for evaluation of welfare state is to measure the effectiveness of the current scheme, not to replace it. For a start, it is too lengthy, (it can take a whole day). Secondly, it is deliberately designed to explore variation in the indices of welfare state on participating and non-participating farms. An approach that is designed to highlight variation is not appropriate to a protocol for a workable accreditation scheme that must finally decide, simply, yes or no.

TABLE 4: Specimen protocol for the evaluation of welfare state in dairy cows.

Farm: .... Date and time of visit...........
No of cows in milk..................

1. Hunger and thirst
1.1. Condition scores (mean and range):
at calving............……………………
100d post calving............................…
drying off...…
1.2. Calving interval (mean):
<380d..……. 380-400.......... >400………
1.3. Winter feeding system: (e.g., forage + concentrates in parlour outside parlour- both; total mixed ration)………………………………
1.4. Average milk yields: yield/day at ca 100 days...............
yield/lactation..........................
2. Comfort
2.1. State of coat: clean soiled very dirty:
fine thick
2.2. Numbers standing and lying in cubicle house or yard on arrival of assessor.
2.3. Attitude of cattle in cubicles
2.4. Ease of changing position in cubicles
3. Pain, injury and disease
3.1. Appearance of feet: nos. overgrown nos. 'laminitic'
(enquire as to foot care routines)
3.2 Appearance of skin and coat: external parasites?
3.3. Appearance of limbs: incidence of swollen joints, bursae etc.
3.4. Numbers of cows showing lameness: mild....….. severe.....……
3.5. Give details of any animal that is showing signs of overt disease and indicate what provision is being made for housing and nursing
4. Behaviour
4.1. Response to presence of assessor within cubicle house or yard
inquisitive fearful apathetic
4.2. Behaviour during collection for milking (response to stockman, between cows)
5. Sustained fitness
5.1. Age profile of cows in herd
5.2. Culling rates and reasons for culling
5.3. Condition of old cows

Nevertheless, I am already convinced that there is great scope for improvement to current QC schemes based on a single visit from an assessor who fills in a checklist based almost exclusively on aspects of provision. My favoured approach is as follows:

1. The protocol should seek specific information relating to the aspects of provision, (resources, management and stock-personship) outcome (welfare state) and records (which provide evidence relating both to provision and outcome);
2. This protocol should, in the first instance, be used as the basis for a self-assessment by the owner of the animals; and,
3. The independent assessor will have studied the self-assessment in advance of the QC visit. The main purpose of the visit will be to explore and, where necessary, challenge the self-assessment.

The value of beginning the audit with a self-assessment is, first, it saves everybody's time. More importantly, it recognises the fact that the farmer will know far more about his farm and his animals than any assessor, however competent, could hope to glean at a single visit. The art of the assessment will be to ensure that it becomes more than a process of checking the facts. It is necessary not only to determine the welfare state of the animals themselves, but also to assess the perceptions of the farmer and stock-people as regards their welfare state. Both are critical to the only guarantee that we can honestly hope to achieve, which is a guarantee of good husbandry.

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