Well-being and productivity

SIR — Three letters have remarked on my Commentary[1] on meat production. Wilson[2] says: "One problem with using productivity to measure welfare is that the welfare of an animal is a property of an individual, but productivity . . . is usually measured in terms of flock or herd production." But the whole is the sum of its parts, and the welfare of a flock depends upon the welfare of individuals.

Broom[3], cited by Wilson[2], lists the following "indicators of poor welfare": impaired growth, impaired reproduction, body damage, disease, immunosuppression, behaviour anomalies, reduced life expectation, adrenal activity and self-narcotization. The first six of these are pertinent to meat production and I focused on impaired growth, impaired reproduction (egg laying) and disease[1]. Broom says "[t]he scientific study of animal welfare should be promoted so that decisions are made on factual rather than emotional grounds", which is in accordance with my commentary[1].

Wilson alleges that "a mortality of 7 per cent is not unusual in rearing veal calves to six months". I doubt that producers would be willing to accept 7 per cent mortality. Wilson next discusses measurement of egg productivity in poultry by egg mass output or egg size. An economic decision would depend upon the same price per egg versus a premium for large eggs. He then states that "laying hens kept in battery cages often have poor feather cover and poor skin condition . . .". In such cases, alleviation should be obtainable by improved husbandry. Keeping hens (and other chickens) indoors protects them from predators, bad weather and insanitary conditions. Next, he says that "foxes kept in cages usually have good fur and skin condition, but often have low reproductive rates". This seems off the subject. Foxes are not used for meat, and they are wild animals, which might explain their low reproductive rates in captivity. Wilson then alleges that I have given credence to folklore. This is incorrect: I based my arguments on impaired production and disease prevention. Production values have been an important adjunct to aiding animal welfare. However, some of his contentions are based on hearsay, including conversations with farmers.

Schönthal's letter[4] is unsupported by references. He says I should ask myself why "chickens get their beaks cut". Debeaking, really beak-trimming, is by removal of the nonvascular tip of the beak in a manner similar to paring fingernails. This protects other birds from attack; however, it is not widely used in broiler and fryer production because it is not necessary. One company in California hatches 3.5 million chicks weekly and does not use it for broilers and fryers, but breeding males are debeaked. In Georgia, a current practice is simply to dim the lights. I used this procedure successfully years ago. Schönthal misquotes me by saying that I referred to "these animals jammed in cages". Actually, I said that "overcrowding reduces weight gain". Schönthal wishes to compare the situation of crowded animals to "Hitler's concentration camps". This is an emotional and inaccurate analogy. Hitler's victims were starved to emaciation and death. Animals used in meat production are well fed and nurtured. Chickens often tend to crowd voluntarily at one end of their quarters. They do not usually try to escape as long as their is abundance of food.

Schönthal makes a common mistake in claiming that farm animals today are "much more prone to diseases because of the conditions in which they are raised". On the contrary, they are less prone. Animals in extensive, as opposed to intensive, production systems are exposed to greater environmental extremes (see above), to increased "exposure to internal parasites" and have an associated higher disease susceptibility[5]. The control of common poultry diseases, also of predators, is best achieved under confinement rather than "out on the range".

Rowan[6] pleads for the development of "confinement systems that retain most of the advantages for farmers and the animals while eliminating most of the adverse effects". I agree: my point was that too-close confinement systems are usually counterproductive, and that this has led to their improvement.

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3. Broom, D. M. *J. Anim. Sci.* **69**, 4167–4175 (1991).
4. Schönthal, A. *Nature* **356**, 556 (1992).
5. Hays, V. W. *Agricultural Uses of Antibiotics*, 7 (American Chemical Society, Washington DC, 1986).
6. Rowan, A. N. *Nature* **356**, 556 (1992).

UK science

SIR — Terence Kealey asserts that only an absolute growth in British science is sufficient to meet national needs and that the relative decline of science is both inevitable and desirable (*Nature* **358**, 272; 1992). These are erroneous beliefs and, as guides for science policy, misleading. With only an absolute expansion, national living standards decline and unemployment rises. This would hardly qualify as meeting national needs.

The explanation is fairly simple. As economics mature, resource costs rise, particularly labour. Cheaper imports from newly industrializing nations find a ready market, as labour costs in these poorer countries are held stable at low levels by an abundant workforce and high unemployment. The competition from lower wage rates can be offset in mature economies by increasing labour productivity and worker skills through the application of technological innovations. To maintain living standards and employment levels, higher productivity skills must improve job performance for those just entering the workforce and also for workers displaced by cheaper production from poorer countries. Unless improvements encompass both groups, wage rates can be expected to fall and production decline. The British economy has a larger share of workers in trade-sensitive industries than more insular economies and therefore requires a larger effort.

The gains from the application of technology can be seen from US experience. The observed increase in the differential earned in the 1980s by the more highly educated portion of the US workforce came from the use of new technologies such as computers, communication, photocopying and other capital equipment incorporating high technology (J. Bound & G. Johnson *Am. econ. Rev.* **82**, 388–389; June 1992).

There is no reason to believe that the source of improved labour-force skills is limited by national frontiers. It is also questionable whether citations of the scientific literature can serve as a reasonable proxy for those skill-enhancing factors. Whatever the nature of productivity improvements, it is their adaptation that is of primary importance. Presumably, adaptation is more likely to take place in the country of origin and publication of the science. An example to the contrary, however, is the application by Japanese industry of science and technology breakthroughs originating in the United States.

What is not tenable is the equanimous acceptance that a minimal expansion in science is sufficient to meet national needs. Such a policy leads to falling wages and rising unemployment. Surely the factors that make a decline inevitable are more likely to be found in sloth and ministerial neglect. There are many examples in history to show that both conditions are reversible.

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