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The number of ways that one can be nice or nasty to animals are legion. This article will consider only one very specific aspect of farm animal welfare, namely, those systems of intensive animal production in which the system itself, irrespective of the quality of the stockmanship within the system, appears to restrict the normal behavior of farm animals to an unacceptable degree. The systems that were considered by the House of Commons Select Committee on Agriculure (1981) include egg production from hens in battery cages, production of veal from calves deprived of solid food and isolated in wooden crates, and the most intensive aspects of pig production, namely, cages for weaners and stalls, with or without tethers, for dry sows.

In their most extreme form, the battery cage, the veal calf crate, and the dry sow stall represent the absolute limits to intensification, since the floor space allocated to each animal is, in effect, no greater than — and sometimes less than — the floor space occupied by the animal when it adopts a normal resting position. Table 1 illustrates examples of floor space allocations for hens, pigs, and calves in commercial intensive units and compares some of these with the recommendations in the revised drafts of the Welfare Codes.

The Farm Animal Welfare Council has been criticized for recommending space allowances in excess of those currently being used in commerce, without providing substantial scientific evidence to show that the welfare of laying hens would be significantly improved by increasing floor space per bird from, say, 400 to 650 sq cm. The advocates of intensive systems contrast this lack of scientific evidence in favor of increased space allowances with the benefits that have accrued from intensification, not only in terms of animal production, but also in terms of animal health. For example, it is much easier to control respiratory disease and parasitism in laying birds kept in cages than in those housed on deep litter.

It is, however, impossible to argue that the policy of space restriction summarized in Table 1 arose out of any positive concern for animal welfare. In order to generate as much gross income as possible and, more important, to stay competitive, producers have simply jammed animals in as tightly as possible. If these intensive producers are moved by compassion for their animals, it has not affected their actions in this regard. In the U.K. at least, there are no limits imposed on a farmer's right to crowd his animals to the absolute limit, and while this situation persists the intensive farmer has little option but to do just that, if he wishes to retain his competitive position in the market.

Space Restriction and Stress

As indicated above, there is little clear evidence to show that extreme space restriction affects the performance of farm animals or induces disturbed behavior. This is not altogether surprising, since it is difficult to construct ethological experiments designed to reveal disturbed

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TABLE 1 Floor Space Available to Some Farm Animals

	Welfare Codes (draft revisions)	Commercial Practice
Battery hens:		
brown birds	450-625	ca 400 cm^2
white birds	370-500	ca 360 cm^2
Pigs: growers (80 kg)	0.45 m^2	0.45 m^2
Veal calves in crates (crate width)	None	60-70 cm

behavior in environments so constricting that almost all forms of behavior are suppressed. Claire Saville and I have, however, some evidence to show that when veal calves grow to a size and age such that a 70-cm-wide crate is extremely restricting, they do show marked departures from the normal development of behavior with age seen in conventionally reared calves, as well as in calves still small enough to move around in their crates. Table 2 shows that as veal calves in crates grew from 2-14 weeks of age, there was a marked increase in the amount of time they spent in purposeless oral activity, tongue rolling, and licking and chewing the walls of their cage. There was also a marked increase in the fearfulness of their response to a set series of actions performed by an observer in the room with them. Both of these kinds of phenomena can, we think, genuinely be called disturbed behavior. Moreover, the large veal calf cannot adopt a normal lying position in a 70-cm-wide crate, and we have evidence to suggest that this disrupts normal sleeping patterns.

Alternative Husbandry Systems

The ideal solution to the welfare problem of intensification would be the development of alternative, acceptable husbandry systems that could compete economically with the most intensive forms of livestock production. However, given the current absence of any legal constraints on intensification, it is most unlikely that such alternative systems will have a significant effect on the status quo.

Table 3 summarizes (and slightly paraphrases) evidence presented to the House of Commons Select Committee on Agriculture concerning the likely costs of egg production in different systems. The cost of producing "free-range" eggs is about 45 percent higher than that for hens in battery cages at current stocking densities. The "straw yard" system, which is a more realistic

TABLE 2 Effects of Rearing Systems on the Development of Certain Activities in Calves

	Suckler calves		Early weaned calves		Straw yard veal		Crated veal	
Age (weeks)	2	14	2	14	2	14	2	14
Eating and ruminating	6.8	23	26	59	14	15	0.0	0.8
Grooming	3.8	6.9	4.8	5.1	4.4	6.7	12	13
"Purposeless" oral activity	7.0	0.1	4.7	2.4	1.2	3.8	14	24
Induced behavior[1] (overall score)	−54	−42	−12	−35	−24	−14	−48	−86

[1]From A.J.F. Webster and Claire Saville, "Rearing of veal calves," UFAW symposium: "Alternatives to intensive husbandry," 1981. (The more negative the score the more fearful the overall response.)

TABLE 3 Economics of Alternative Forms of Egg Production (Brown Egg Hybrids)

	Caged birds		Straw yards	Free range
	400 cm²	600 cm² min.		
Egg yield: bird^{-1} year^{-1}	260	260	250	240
Production costs (£. bird^{-1} year^{-1})				
Feed	5.50	5.80	5.64	6.00
Labor	0.42	0.64	1.05	2.10
Other	3.17	3.93	3.82	4.08
Capital costs	5.00	8.33	7.00	8.00
Price no. doz. to achieve				
A. Profit of 50p. bird^{-1}	44.3p	52.4	52.8	63.4
B. 10% return on fixed capital	44.3p	54.1	53.8	64.9
C. Relative to cage; 400 cm²	1.0	1.18	1.19	1.43

Data taken from submissions to House of Commons Select Committee on Agriculture by National Farmers' Union and by Dr. T.R. Morris, *Animal Welfare in Poultry, Pig and Veal Calf Production*, vol. II, Minutes of Evidence, p. 221, p. 396-397, London, HMSO.

TABLE 4 Production and Costs of Production of Veal from Calves in Crates and Straw Yards (Data From University of Bristol)

	Crated veal Friesian bulls	"Straw yard" veal Friesian bulls	Hereford x Friesian heifers
Daily liveweight gain (kg)	1.34	1.29	1.17
Carcass weight (kg)	119	98	90
Food conversion ratio	1.56	1.69	1.66
Typical costs (£/head)			
Feed	135	115	107
Calf	60	60	45
Other (excl. labor)	3.50	5.50	5.50
Selling price per calf	235	194	178
Gross profit	+36.50	13.50	20.50

alternative, appears to be about 20 percent more expensive than conventional battery systems. If, however, the space allowance for battery hens was increased to 600 sq cm, this difference would disappear.

The costs of housing and feeding dry sows in kennels and yards is about 25 percent higher than that of tethering them on concrete. Even the much-heralded straw yard system for veal calves has, in our hands, generated £16 to £23 less gross profit per quality calf sold than that achieved by us for calves in crates (Table 4). The capital cost for a straw yard system is undoubtedly lower than that for a crate system but, at present, the straw yard system is not sufficiently advanced to persuade those who have already invested in crates to change.

There are obvious exceptions to these rules. The pig farmer in an area of low rainfall and well-drained soil can run sows very economically out of doors. A few chicken farmers make a good living by producing and selling free-range eggs for the upper middle class health food market. These exceptions are, however, unlikely to be of much concern to the majority of consumers or to the majority of intensively reared farm animals.

Part of the reason why semi-intensive

systems like straw yards for hens or veal calves are less profitable than their highly intensive alternatives must be that practically all research and development in agriculture has been directed toward the most intensive systems. One of the greatest contributions that science can to animal welfare is to explore more fully the nutritional, physiological, and veterinary implications of rearing systems that are deemed *a priori* to be acceptable to a concerned public for reasons that are sound but outside the domain of science. Such research and development could not fail to reduce the economic margin between current scientifically based, highly intensive systems and current cottage-type semi-intensive systems.

Our work with veal calves at the University of Bristol is directed specifically toward this end. The specific problems are technical, relating, *e.g.*, to iron requirements, behavior patterns, or the development of the microbial flora of the gut. The overall objectives, however, are humanitarian.

Constraints on Intensification

In the U.K. there are at present no legal constraints on stocking intensity. The Commission of the European Committees is seriously considering imposing such constraints, for example, imposing by law a minimum floor space of 650 sq cm per bird. A number such as this is, of course, quite arbitrary and thus rather vulnerable to attack. If animals in intensive units were permitted the "five freedoms," as originally suggested by Brambell (freedom of movement to be able, without difficulty, to turn round, groom itself, get up, lie down and stretch its limbs), then layers in battery cages and veal calves in crates would require two to three times the amount of space they get now. Such legislation would, of course, completely destroy the conventional highly capital-intensive systems like battery cages and veal crates.

I do not include myself among those who applaud such legislation, since it would inevitably let in more devils than it would cast out. Cages and pens are, on the whole, quite healthy arrangements and the producer directed principally by profit and minimally by welfare considerations who has been forced by law and economics to get rid of his cages might be induced to rear his animals in a communal squalor that would be much more injurious to their welfare than present conditions.

Most of the recommendations that have come from informed bodies — such as the House of Commons Select Committee on Agriculture — have been more modest than this. I list below a series of recommendations of which I heartily approve and which I can, to a greater or lesser extent, support on the basis of veterinary science rather than emotional anthropomorphism.

1. Dry sows should be provided with a bedded area, which need not necessarily be straw, to improve comfort, reduce feed costs, and reduce the currently unacceptable level of injury.

2. No calf should be deprived of access to solid food, and veal calves reared to a slaughter weight of about 200 kg should be accommodated in crates no less than 80 cm wide. Provision of solid food normalizes oral behavior and the development of the digestive tract; it almost certainly reduces the incidence of enteric disease. Crates of 80-cm width do not allow calves to lie on their side nor, when they are near slaughter weight, to turn round, but they do permit normal grooming, reasonable movement, and a comfortable sleeping position.

3. The floor space available to brown birds in battery cages should be not less than 650 sq cm. This allotment does not allow the bird freedom to stretch its limbs but it does (just barely)

give it sufficient room to reach feed and water points without having to compete too severely with other birds in the cage.

The economic effects of such legislation would be twofold. First, it would increase costs in these intensive systems by about 20 percent, *i.e.*, to the point where they would become almost exactly competitive with the best of the semi-intensive systems. Second, such legislation would, in the short term, restrict output. Assuming, for example, that a space allowance of 650 sq cm for laying birds was enforced throughout the EEC (a necessary precondition for a workable system), then output from existing intensive units would fall by about 25 percent.

The crude workings of the free market are such that the consequences of this shortfall are quite predictable. At first the price of eggs to the consumer would rise by more than the 20 percent necessary to cover the increased production costs, because the producers would gain a sellers' market. In short, profits to the producer would be higher than at present. This would inevitably attract an expansion of poultry units, until such time as supply and demand were back in a reasonable balance. The particular attraction of this situation, from a welfare point of view, is that this incentive to expansion would come at a time when the rules under which farmers operate had just been changed slightly, so that the best of the alternative semi-intensive systems would become economically competitive with conventional intensive systems. The incentive to farmers to develop semi-intensive systems would undoubtedly be reinforced by the fact that, in a time of high interest rates, these systems tend to be less costly in terms of capital investment.

Once production had re-equilibrated according to the new set of rules, the increase in cost should stabilize at about 20 percent (in real terms), and this increase would undoubtedly be passed on to the consumer. However, relative to recent increases in costs of petrol and alcohol, such an increase would be trivial. There has been little, if any, organized consumer resistance to increases in food costs that are seen as necessary to achieve real improvement in animal welfare. The objections have come almost exclusively from the farming industry, in particular through its mouthpiece, The National Farmers Union. Their defense of intensification invariably equates profitability with productivity. When consumer demand is static, as it is in the EEC, then increasing productivity by one group can only be gained at the expense of someone else. Overall, increasing productivity occurs at the expense of the animals, since decreasing gross profit margin per head inevitably reduces the amount of resources that the farmer can devote to the care and maintenance of each individual.

Table 5 compares biological measures of productivity and an economic assessment of the returns per livestock unit for a variety of meat production systems. It shows a clear inverse relationship between productivity and profitability per livestock unit. When time, one of the real benefits of intensification, is taken into account, all systems generate about the same gross profit per annum. In short, the rules of climate, geography, and the marketplace have, to date, ensured that the hardworking farmer gets roughly a living wage, irrespective of the degree of intensification that has occurred in the particular type of livestock production that he practices. Therefore, a slight change in the rules, such that the intensive and semi-intensive systems would become competitive would disturb the market balance for a while — to the detriment of the housewife, but not of the farmer. After re-equilibration, things would remain

much as they are now.

Though the collective voice of agriculture may be vehemently opposed to any constraints on intensification, I know of many individual farmers who would welcome modest legislation of the type that I have suggested. Many have said to me that they are seriously concerned by the lengths to which they have to go to keep up in the race for intensification, a race for which there are no rules. Such farmers would welcome the opportunity, created by law fairly enforced throughout the EEC, to use their personal initiative, not to escape into the past, but to develop good, semi-intensive systems that enabled them to realize greater job satisfaction without bankrupting themselves in the process.

TABLE 5 Average Liveweight Gains and Gross Profit Margins (1975-78) for Different Species and Systems of Meat Production All Expressed Per Standard Unit of Animal Size (S, $kg^{0.75}$)

Species/system	Size (S) at slaughter ($kg^{0.75}$)	Liveweight gain $g.d^{-1}.S^{-1}$	Gross profit margin £.S^{-1}	£.$S^{-1}.year^{-1}$
Cattle: 24 m beef	112	6.2	1.06	0.53
18 m beef	103	7.3	1.02	0.68
cereal beef	90	12.2	0.44	0.44
veal	47	23.4	0.36	0.90
Fat lamb (off grass)	14.	12.2	0.84	0.84
Bacon pigs: breeder/feeder	28	22.8	0.44	0.94
feeder	29	22.0	0.17	0.56
Broiler chicken	1.7	23.7	0.15	0.73

From A.J.F. Webster (1979) "Healthy animals, healthy profits," Proc. Reading University Agriculture Club 1979.