The Role of Animals in an Organic Agricultural System

E. BOEHNCKE

University of Kassel, Faculty of Agriculture, Witzenhausen /F. R. G./

Many of the environmental consequences of technological development are related to agriculture. The reason why farmers, scientists and other people all over the world ask more and more questions about the general trend of food production is the recognition that our present patterns of consumption and pollution cannot be sustained into the future indefinitely. The questions are derived from a sense that collectively we have a duty to future generations to preserve the essential conditions of a tolerable life.

Looking at the relationship between man and nature we see that acid rain kills our woods as never before. And agricultural soils too suffer from sulfuric acid falling from the sky. The dramatic decrease of soil pH-values facilitates the uptake of toxic heavy metals by plant roots. Serious scientists predict the impossibility of growing food on those soils in only a few years.

Why has this alarming situation developed within a rather short period of time? There are several different reasons. One of them is the excess of our power to act over our power to foresee and judge. The reliable prediction of the impact of technological development upon natural systems is seldom possible. We find ourselves in a state of ignorance and uncertainty regarding the secondary and tertiary consequences of most technological innovations.

Research to increase yields is part of the attempt to ensure human health and safety, since a larger food supply is a prerequisite for the elimination of starvation and hunger. But ironically, techniques for improving the quantity of agricultural production figure prominently in the rise of technological risks. The most obvious example is the excessive use of pesticides and other chemicals in agriculture /THOMPSON, 1984; DOWER, 1983/.

The purpose of this review is to make evident some of the contradictions within modern animal breeding. The examples will be taken from the various sections in which farm animals are involved in agricultural processes.

1. Animal feeding. - During the past few years scientists investigated the disadvantages of concentrate overfeeding in ruminants. The question arises whether the health and longevity of dairy cows can be positively influenced by reducing the use of concentrates and by changing to more farm grown feedstuffs of high quality which are rich in fibre.

2. Animal housing. - The development of swine environment - housing and management - has not been beneficial in all respects from the viewpoint of animal health and welfare during the last two decades. This is prominently due to the fact that modern housing systems are constructed mainly with a view to save labour. One of the contradictory consequences is that we use increasing amounts of antibiotics and other drugs to fight diseases partly or totally caused by environmental factors.

3. Animal breeding. - The intensive use of the latest genetic findings has led to a considerable increase of milk yield in dairy cows or of daily gain in fattening pigs. But in countries with intensive dairy production the productive life span of cows is too short and far from the economic optimum. Daily gain and feed conversion efficiency in fattening pigs have reached a remarkably high level. But these pigs are highly susceptible to stress, and health problems take away an increasing part of the profit.

4. Ethology. - In most countries animal protection laws include the demand that farm animals should have the possibility to realize their complete behavioural repertoire. But especially in close confinement the welfare of pigs and fattening bulls is more and more impaired.

5. Veterinary medicine. - It is probably not an exaggeration to declare that veterinary medicine is in a serious crisis. Veterinarians try to prevent or to cure diseases which are strongly related to misguided development in animal feeding, housing and breeding. Therefore it becomes more and more difficult to remain one step ahead of resistant pathogenic bacteria or to overcome the animals' impaired immunity caused by immunosuppressive housing conditions and environmental pollution.

Animal feeding

The ruminant provides meat and dairy products for man using fibre and non-protein resources while it is not in competition with man for food /VAN SOEST, 1982/. A classification of ruminants according to feeding habit shows that there are significant differences within this group of herbivores. While the roe deer and the goat belong to the concentrate selectors or intermediate feeders, respectively, cattle and sheep are roughage eaters /HOFMANN and SCHNORR, 1982/. Therefore chronic concentrate overfeeding, occurring commonly in countries with intensive dairy production, causes various health problems. The negative effects of diets with a too high proportion of concentrates are often underestimated.

The ingestion and rapid fermentation of dietary carbohydrates increases the production of lactic acid in the rumen, resulting in a lower pH-value. These conditions are unfavourable to the rumen lining /VAN SOEST, 1982/. Bacteria present in the rumen flora invade the lesions and form abscesses in the deeper layer of the rumen wall. Bacterial emboli penetrate into the hepatic portal venous system, are carried to the liver, and localize in the hepatic parenchyma with subsequent abscess formation /SCANLAN and HATHCOCK, 1983/. Thus the liver, the central organ of intermediate metabolism, is damaged by an unpropitious high grain diet fed to an animal which originally had the ecological function to digest cellulose and other components of plant cell walls.

The liver of high-yielding dairy cows is additionally affected by the fatty liver syndrome. REID /1981/ investigated the liver fat content of 200 cows immediately after calving. The published data indicates an incidence of 60% of moderate or severe fatty liver. One important clinical consequence appears to be an adverse effect on fertility. Cows with moderate

or severe fatty liver have significantly longer calving intervals when compared to cows with mild fatty liver.

Liver damage is not the only consequence of chronic concentrate overfeeding in cattle. Substances like lactic acid and histamine may penetrate through the rumen wall into the blood stream and reach the hooves, causing chronic inflammation. The relationship between a diet low in fibre but high in starch and the incidence of lameness was shown by LIVESEY and FLEMING /1984/.

Cows fed a low-fibre high starch ration had a 68% incidence of clinical foot diseases such as laminitis and sole ulcers, whereas only 8% of the animals receiving an adequate amount of fibre /physical structure of the diet/ exhibited afflictions of the hooves. In Germany the significance of foot diseases in dairy cows increased dramatically during a period of only 12 years. In 1970 as few as 0.5% of all culled animals were slaughtered because of more or less incurable foot diseases. By 1982 this figure increased up to 7% /SCHNELLER, 1984/. During 1977 a survey was undertaken of the incidence of different lesions causing lameness in British dairy cattle. The average incidence of lameness among all cows was 5.5%. Most lesions /88%/ occurred in the feet /RUSSELL et al., 1982/. Without doubt fibre deficiency is not the only cause of the development of hoof diseases in cattle. Inadequate housing conditions such as incorrect slatted floors also lead to this disorder /GROTH, 1984/.

The most far-reaching consequences of concentrate overfeeding, however, was recently detected by LACHMANN et al. /1984/. The scientists found that a chronic metabolic acidosis impairs the activity of certain white blood cells. These cells have the function to enclose and to digest pathogenic microorganisms and are part of the host defense system /GALLIN and FAUCI, 1982/. Significantly more pneumonia and other infections are observed in fattening bulls receiving rations high in concentrates and low in fibre /LACHMANN et al., 1984/.

In organic farming the ruminant should be a member of a well-balanced farm. Feeding has to be in accordance with a proper crop rotation, which serves the long-term health of soil, plants, animals, man, and environment. Forage quality and improved ways to conserve or harvest forage crops are of foremost importance in moving toward the goal of increasing forage and decreasing grain for lactating dairy cows /WANGSNESS and MÜLLER, 1981/. Unfortunately the quality of forage is only poorly defined. The attention to maximum yield often displaces other important considerations. The composition of intensively-fertilized pasture grass may be unfavourable for dairy cows. DROCHNER et al. /1984/ recently analyzed grass samples from Northern Germany. A total of 25 to 50% of the samples showed rather high potassium and nitrate contents, representing a potential danger to animal health and fertility /LOTTHAMMER, 1982; LOTTHAMMER et al., 1982/.

In some cases the relationship between feeding and animal health is even more direct. BERTSCHINGER et al. /1981/ investigated the effect of a low protein and high fibre diet on the resistance of weaned pigs to coli-enterotoxaemia. After an experimental infection with a virulent E. coli strain, 31% of the animals in the group which received a diet containing 19% protein and 4% crude fibre died of the disease. The loss was reduced to only 2.5% in the pigs fed a ration with 8% protein but 11% crude fibre.

Animal housing

There is a growing trend to raise animals in total-confinement buildings. A major advantage of this is the greater productivity per unit of

building space. Automation in these industrialized animal production systems of "factory" farms, and crowding the animals together, make it possible for one man to oversee thousands of animals. Total-confinement rearing saves land and labour, but there are many problems that have to be addressed and solved, especially animal health, welfare and behavioural needs /FOX, 1984/.

The relations between housing conditions and animal health are investigated by scientists in several countries. HANNAN and MURPHY /1983/ from Ireland studied the morbidity rates for cattle on slatted floors. The overall disease incidence in a total of 12,010 beef bullocks kept on slatted floors amounted to 9.7% and was nearly twice as high as that for their counterparts /2,882/ living in traditional straw yards /all diseases = 5.4% of all cattle in risk/. The difference is highly significant.

Such results have to be interpreted in connection with many other factors. Today there is a strong tendency to prevent environmentally-caused diseases in farm animals by the use of medicated feed containing antibiotics and other drugs /TOMI et al., 1984/. Total-confinement rearing is believed to be an economic necessity and only few people are of the opinion that the whole system is a contradiction in itself. SCHLICHTING et al. /1983/ measured the cortisol concentration in bulls 10 minutes after lying down on straw or on slatted floor, respectively. The content of this stress-related hormone in the blood of bulls kept on slatted floors was nearly twice as high as that of the animals on straw.

We have to keep in mind that environmental stressors are involved in the etiology of important livestock diseases. It is generally assumed that stress affects the immune system of the host /KELLEY, 1980/.

Furthermore the continuous application of antibiotics to farm animals produces an increasing number of resistant pathogenic bacterial strains, which are already spread worldwide. It would be extremely interesting if one could compute or even estimate the social costs caused by a misguided development of animal housing systems. Some components of these social costs would be rather unexpected. DONHAM and LEININGER /1984/ studied the pathologic changes in laboratory animals housed in a swine confinement building to predict the potential health effects on persons working in these buildings. The animal studies confirmed that the atmosphere in modern pig houses resulted in serious injury to respiratory tract tissues of rabbits and guinea pigs. The changes seen in these test animals enhanced the supposition that long-term occupational exposure to the atmosphere in swine confinement buildings could lead to chronic pulmonic disease in persons.

SOMMER /1979/ investigated the effect of housing conditions on the duration of parturition in sows. In tethered sows the average duration per piglet was 35 minutes, while it decreased to 23 minutes in another group which had the opportunity to move around. The duration of parturition is related to the incidence of the mastitis-metritis-agalactia-syndrome in sows. Diseases arising about the time of farrowing make up a complex of great economic impact. Their importance must be viewed on the basis of their high frequency and the common consequences, which include a rise in off-spring mortality rates /HALGAARD, 1983/. The importance of a certain amount of movement prior to parturition can be seen from the data in Table 1.

Comparable problems are caused by the ever growing number of animals kept per farm or per person. As Table 2 shows there is a definite correlation between the size of sow herds and the incidence of rhinitis atrophicans.

An increasing number of sows kept per farm obviously favours the development of multifactorial diseases. Several factors, such as the growing infectious pressure, the decreasing intensity of caretaking or the more in-

tensive housing system in farms with large sow herds may be responsible for these interrelations. It is interesting to note that the use of medicated feed also increases with an increasing herd size. In spite of this preventive measure, the incidence of rhinitis atrophicans is twice as high in farms keeping more than 60 sows in comparison with 16 to 30 animals per farm.

Table 1

Parturition and puerperal disorders of sows restricted in crates or pens versus sows free to move in large pens /FOX, 1984/

	Number of litters	Sows with udder inflammation		Sows which required a hormone injection to start farrowing	
		number	%	number	%
Restricted in crate or tether pen	432	51	11.8	18	4.2
Free movement	194	11	5.7	4	2.1

Table 2

Herd size, use of medicated feed and incidence of rhinitis atrophicans in German pig farms /NIEDERSTUCKE, 1982/

Herd size, number of sows per farm	Number of farms investigated	Use of medicated feed	Incidence of rhinitis
		in % of investigated farms	
16-30	231	11	7
31-45	119	19	8
46-60	84	18	17
over 60	60	27	18

Animal breeding

Cattle breeding has been very successful in selecting dairy cows with a high milk yield per lactation. But there is common agreement that these high-yielding animals show some remarkable disadvantages. The average productive life span amounts to only 3-4 years and tends to become even shorter. The culling rate is so high that 20 to 40% of the productive dairy cows cannot reach the economic optimum. The two most important reasons for this situation are infertility or reproductive disorders and mastitis.

The published data concerning the relationship between fertility and milk yield are somewhat conflicting. But one of the latest reports including a total of 510 Brown Swiss cows clearly shows the negative effect of

milk yield on fertility parameters. In animals yielding 3,500 kg milk per year the mean first insemination success was 80%. This declined to less than 40% in cows milking more than 7,500 kg per year /BRAUN et al., 1983/.

Alternative breeding concepts deny the long-term efficiency of selecting dairy cows on the base of lactation yield only. Such new programs work with cow families showing a significant longevity in combination with a high life milk yield. This breeding program was started about 25 years ago. In the years 1974 to 1978 the cows in the program accounted for only 1.7% of all Bavarian dapple black cows, but they represented 26% of all living cows with a life yield of more than 50,000 kg milk /HAIGER, 1983/.

The above mentioned type of dairy cow is highly suitable to the aims of organic farming. Their capacity to utilize roughage and to stay on the farm for more than 10 lactations, the longevity, and the high life milk yield make it possible to restrict the stocking density to one cattle unit per hectare.

Modern pigs may gain between 800 and 1000 g/day. This is the result of the selection of animals with an excellent capacity to transform nutrients into muscle protein. But the relative heart weight in fattening pigs is only about 0.3% in comparison with 0.6% in cows or up to 1% in race horses. Thus the unstable blood circulation is not able to provide the huge muscles with enough oxygen. Additionally the animals exhibit a tremendous stress susceptibility, which leads to increasing transport losses. Another consequence of these properties is poor meat quality. Fast-growing pigs with a high standard carcass often develop the PSE-syndrome. This means that the meat becomes pale, soft and exudative during the slaughtering process. The PSE-syndrome represents a severe muscle disease because the structure of muscle proteins is partly destroyed by large amounts of lactic acid. This phenomenon again is the expression of contradictions in modern meat production: pigs corresponding to the present breeding aim supply a meat of poor quality.

This gives organic farmers the opportunity to fill a market niche. They lower the daily growth rate slightly by feeding diets with a high proportion of farm-grown feedstuffs, improve the housing conditions, do not use antibiotics in the feed and thus try to produce pork of better quality. A growing number of consumers are willing to pay higher prices for pork produced under such conditions. They do so not only because the pork is of better quality, but because they feel compelled to support an environmentally-sound agriculture in this way.

Ethology

The Brambell Committee, which was formed by the British Government to investigate the welfare of intensively housed livestock, stated that "Welfare is a wide term that embraces both the physical and the mental well-being of the animal. Any attempt to evaluate welfare, therefore, must take into account the scientific evidence available concerning the feelings of animals that can be derived from their structure and function and also from their behaviour."

As organic agriculture should practise a more holistic view of biological interrelations, every factor concerning animal welfare has to be included in the farming system. However, the whole welfare debate hinges on the question: "Can we find indicators which reveal the subjective feelings of farm animals?"

Many people believe that productivity is a suitable parameter of animal well-being. They are of the opinion that if a pig gains 1000 g per day,

nearly nothing can be wrong with the fattening procedure. But taken alone, productivity cannot be regarded as a reliable indicator of animal welfare. Assessment of animal welfare entails an analysis of many factors, including health status, disease incidence, longevity, reproductive performance, physiological as well as behavioural indices /ALBRIGHT, 1983/.

Physiological criteria include investigations of the influence of stressful stimuli on the stress hormone level in blood plasma. Also rather sophisticated experiments such electroencephalographic recordings of the sleep-waking pattern of pigs are used to evaluate the adaptation of animals to different housing conditions.

The pathological approach deals with the examination of lesions caused by the special properties of a housing system. This was done to evaluate calf boxes and included hoof lesions as well as gastric ulcers /SMIDT, 1983/.

Animal ethologists take the view that behaviour disturbances represent the most sensitive indicator of impaired well-being. For example stereotypes are often shown by animals in monotonous environments. FRASER /1975/ demonstrated the effects of straw on the occurrence of stereotypes in sows. Biting and licking bars and chains occurred significantly more often in sows kept without straw than in another group on litter.

For labour-saving reasons fattening bulls are housed predominantly on slatted floors and fed only corn silage and concentrates. Under these conditions all of the bulls investigated by SAMBRAUS et al. /1984/ showed at least one of the following behaviour disturbances:

- preoccupation with the body parts of stallmates;
- preoccupation with dividing bars, walls, and floor;
- urine drinking;
- tongue rolling.

Veterinary medicine

With the structural changes in agriculture, veterinary medicine has changed too. Before World War II, spectacular epidemic diseases were the main concern of veterinarians. Today these diseases are partly extinguished or under control. But the problems of maintaining farm animals in proper health status have not become easier since then. On the contrary, new, even more intricate problems have arisen from the changed situation.

The character and nature of new disease problems can be described by the expression of "multifactorial diseases" /MAYR, 1983/. FOX /1984/ gives a review of these diseases that are associated with intensive confinement husbandry:

Dairy cows:	mastitis, metritis, infertility, hoof injuries;
Calves:	respiratory diseases, scours, leg weakness;
Sows:	MMA syndrome, leg injuries, anoestrus;
Pigs:	enhanced mortality, respiratory diseases, scours, hoof injuries, agressiveness, leg weakness.

Besides microbial factors such as resistance to antibiotics and disinfectants, MAYR /1983/ holds that altered breeding and housing conditions as well as immunosuppressive environmental factors are responsible for this threatening situation.

Resistance to antibiotics has been known almost as long as antibiotics. By now usually only a few years separate the introduction of an antibiotic and the isolation of resistant strains. Treatment of infections is further complicated by the emergence of multi-resistant strains containing trans-

ferable resistance factors /ACKERMAN et al., 1983/. This means that resistant bacteria are able to transfer their resistance to other, still sensitive bacteria which have never had any contact with an antibiotic. Therefore the worldwide use of antibiotic drugs is often questioned. Special attention has been paid to such use in animals due to its possible threat to antibiotic therapy in humans.

This problem, however, is not restricted to the use of antibiotics in human and animal therapy. Numerous studies with enteric bacteria have shown that the use of antibiotics at subtherapeutic levels in feeds increases the relative proportions and prevalence of antibiotic resistance /DAWSON et al., 1984/.

The discussion of this potentially dangerous development in this field of veterinary medicine is confusing and contradictory. One group of scientists believes that there are no alternatives to the use of antimicrobial drugs in animal breedings. They propose to perform more and more experiments in order to eliminate undesirable side effects of antibiotic application. Others are of the opinion that we have to change animal housing and feeding to minimize the use of antibiotics or to develop alternative concepts which render them superfluous.

There is no doubt that resistant strains of enteric bacteria are already present everywhere. This fact is documented by a huge number of reports from all over the world. KANAI /1983/ isolated E. coli strains from hens, pigs, cows and humans in Japan. From 39 to 100% of the strains were resistant to one or several antibiotics. But not only farm animals and humans are afflicted by this ecological phenomenon. KANAI et al. /1981/ isolated drug-resistant E. coli strains even from wild birds such as sparrows, pheasants and partridges. NIEMI et al. /1983/ investigated the distribution of resistance to ampicillin, chloramphenicol, sulfonamides, tetracycline, and streptomycine among fecal coliforms in sewage, surface waters and sea water in Finland. The intricate problem of antibiotic use is further complicated by the fact that not only antibiotics themselves may select pathogenic bacteria which are resistant to antibiotics. Copper, which is used worldwide as a potent growth promoter in pigs, proved to be a strong selector of multiple-resistant E. coli strains /GEDECK, 1984/.

Resistance to other heavy metals such as lead has also been shown to be plasmid mediated, and the genetic determinants responsible for heavy metal resistance often reside on plasmids which mediate antibiotic resistance /MIETZ and SJOGREN, 1983/.

Animal-to-human and human-to-animal routes of infection by pathogenic, drug-resistant bacteria are intensively discussed these days. In 1982, 7 gentamycin-resistant Salmonella strains were isolated from humans. These strains were indistinguishable from those isolated from chickens, and the possibility must be considered that strains of avian origin have entered the food-chain /THRELFALL and ROWE, 1984/.

The human-to-animal route seems to exist likewise. Gulls have become adapted to feeding on the waste from modern society. The range and frequency of Salmonella serotypes carried by gulls was similar to that found in the human population. After feeding, gulls roost in nearby fields to rest. The pastures thus become contaminated by fecal microorganisms, and as they are often grazed by farm animals, they may become a source of livestock infection /FENLON, 1984/.

Regarding the above described situation it is not surprising at all that alternative medical approaches are of growing interest. Especially young veterinarians who have worked some years in agricultural practice are often disappointed. They feel that the treatment of infertility, mastritis,

respiratory diseases, and scours by conventional means is rather ineffective. Thus experienced veterinarians who apply homeopathy /MACLEOD, 1981/ or acupuncture /KOTHBAUER and MENG, 1983/ have changed from laughed-at outcasts to experts held in high esteem. But the change from one medical method to another is only partly useful if the treatment remains purely symptomatic.

Current attitude towards control and treatment of infectious diseases is divided: there are veterinarians who seek more effective antibiotic-based remedies, while others favour immunological approaches as preferred alternatives to antibiotic usage.

In this connection one has to bear in mind that environmental factors can induce stress situations which result in high blood stress hormone levels and thus can act as immunosuppressives. In modern animal husbandry practice such factors exist and can influence disease resistance resulting in multifactorial diseases /OSTERLEE, 1982/. Such environmental factors may be internal as well as external.

In adequate housing systems /METZ and OSTERLEE, 1980/ as well as the contamination of feedstuffs with mycotoxines /CYSEWSKI et al., 1978/ may lead to a measurable decrease in antibody production. But even the positive or negative attitude of the caretaker of farm animals can alter their immune response /GROSS and SIEGEL, 1982/.

As to the external factors, ZÖLDAG et al. /1983/ investigated the influence of airplane noise on pregnant dairy cows. The results suggest that repeated noise can act as a stressor and lead to a significant increase of stress hormone concentrations in the blood. Two of the cows aborted due to hormonal effects on the placenta.

Last but not least, stress seems to cause comparable psychosomatic diseases in cattle and humans. SMITH et al. /1983/ reported on 42 cases of gastric ulcers in dairy cows and came to the conclusion that the syndrome of peptic ulcer in man so closely resembles that of abomasal ulcer in cattle in the variety of clinical presentation, location of the lesion within the stomach, and the pathologic appearance of the ulcer, that a similar etiology and pathogenesis is indicated.

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