THE HUMAN-ANIMAL RELATIONSHIP IN AGRICULTURE AND ITS CONSEQUENCES FOR THE ANIMAL

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Abstract

Although human factors are recognized as influential factors affecting the welfare and productivity of farm animals, only limited research has been conducted to identify these important human characteristics and to quantify their effects. During the last 13 years we have studied two apparently important human factors: the attitude and the behaviour of stockpersons towards farm animals.

We have proposed that in intensive animal production systems there are some important sequential relationships between the attitude and behaviour of the stockperson towards farm animals and the behaviour, performance and welfare of farm animals. Basically we have suggested that because a stockperson's behaviour towards animals is largely under volitional control, it is strongly influenced by the attitudes and beliefs that the stockperson holds about the animals. Furthermore, the stockperson's behaviour towards animals affects the animals' fear of humans which, in turn, affects the animals' productivity and welfare. It is the occurrence of a stress response by animals which are highly fearful of humans which places their productivity and welfare at risk. We have published data which strongly support these interrelationships between human attitude and behaviour and animal behaviour, productivity and welfare. This paper reviews this and other research on this subject. The results of research in the pig industry and, to a lesser extent, the poultry industries indicate the excellent opportunity which exists to improve animal productivity and welfare by training and selecting stockpersons to have desirable attitudinal and behavioural profiles towards farm animals.

Keywords: *animal welfare, behaviour, fear, human-animal interactions, productivity, stress*

Introduction

With the exception of the immediate family, many humans interact more with domesticated animals than they do with other humans. These interactions are often frequent and intense and consequently complex and strong social relationships can be

formed between humans and domesticated animals. Results of recent research on the interactions between humans and farm animals show some surprising and substantial consequences for the animals.

As a consequence of this research on the interactions between humans and farm animals, we have made two major theoretical proposals. Firstly, we have suggested that in situations where the farm animal is regularly or frequently handled and is fearful of humans, there is the opportunity for the animal to experience an acute or a chronic stress response. It is the occurrence of a stress response, particularly a chronic stress response, that places both the animal's productivity and welfare at risk. The results of our research on both experimental and commercial animals, particularly pigs, strongly support this proposition and demonstrate that the productivity and probably the welfare of a substantial proportion of farm animals may be at risk due to high levels of fear of humans (Hemsworth *et al* 1981a,b, 1986, 1987a, 1989a, Gonyou *et al* 1986, Hemsworth & Barnett 1991).

The second theoretical proposal is that because a stockperson's behaviour towards animals is largely under volitional control, it is strongly influenced by the attitudes and beliefs that the stockperson holds about the animals. Furthermore, it is the stockperson's behaviour which is an important determinant of the animal's fear of humans which, in turn, affects the animal's productivity and welfare. We have published data which strongly support these interrelationships between human attitude and behaviour and animal behaviour, performance and welfare (Hemsworth *et al* 1981a,b 1986, 1987a, 1989a, Gonyou *et al* 1986, Hemsworth & Barnett 1991).

This research has been predominantly conducted on stockpersons and animals in the pig industry, however, some less comprehensive research has been carried out in the laying hen, broiler chicken and dairy industries. The objectives of this paper are firstly to review the data from this research and secondly to discuss some of the potential benefits that may arise from investigations in this area.

Measurement of the level of fear of humans in farm animals

In intensive animal production the animal is in frequent contact with humans and frequently this contact involves the close presence of humans and, at times, intense handling by humans. One of the main motivations of the animal that will determine the animal's response to humans is fear. In this review, fear will refer to a state of motivation and fear responses will include those behaviours leading to withdrawal from or avoidance of the stimulus. Although there is debate concerning the concept and measurement of fear (Hinde 1970, Murphy 1978), we have adopted a functional approach in studying the behavioural responses of farm animals to humans (Hemsworth & Barnett 1987). Since it is generally accepted that fear responses function to protect the animal from harmful stimuli (Toates 1980), we have proposed that the amount of avoidance of an approaching experimenter or, conversely, the amount of approach to a stationary experimenter in standard tests is a useful measure of the animal's fear of humans. In these tests, particularly the latter, although the degree of novelty of the test arena is

reduced because of the similarity of the arena with the home pen, animals introduced into this new environment will attempt to explore and familiarize themselves with the environment once the initial fear responses have waned (Hinde 1970, Toates 1980). Therefore, although the two conflicting motivations of fear and exploration of the arena and the human stimulus may be important motivations in the test, the animal's fear of humans will have a major influence on its approach to the human stimulus. In other words, animals which are highly fearful of humans will avoid the human stimulus in this test, even though they are motivated to explore the arena.

In studies with the pig we have used their approach behaviour to a stationary experimenter to assess their fear of humans. There is supporting evidence for interpreting that a major component of the behavioural response of the animal in this test is a consequence of the animal's fear of humans. It is generally accepted that exposure to fear-provoking stimuli results in a range of physiological responses in the animal, one of the most consistent being elevated plasma corticosteroid concentrations (Mason 1968, Selye 1976). A significant negative association between the magnitude of the corticosteroid response of the pig to an experimenter in its home pen and the amount of approach behaviour of the pig to a stationary experimenter in the standard test, supports our behavioural assessment of fear (Hemsworth & Barnett 1987). Furthermore, the imposition of aversive handling treatments designed to increase the pig's fear of humans resulted in a marked reduction in the approach behaviour of pigs to a stationary experimenter in the standard test (Hemsworth *et al* 1981a, 1986, 1987a, Gonyou *et al* 1986, Hemsworth & Barnett 1991). A number of studies on poultry have also used avoidance of the stimulus to assess fear of humans or fear of novel objects (Murphy & Duncan 1977, Jones & Faure 1981).

The development of the behavioural response of farm animals to humans

The animal's response to a stockperson in an intensive production system may have components of both stimulus-specific fear and general fear. We have previously proposed that while the initial response of a naïve farm animal to humans may involve a response to novelty or unfamiliarity, with subsequent experience of humans there is the development of a specific response to humans (Hemsworth & Barnett 1989, 1991, Hemsworth *et al* 1990, 1991). The initial response of a naïve animal to humans may be similar to the animal's response to unfamiliar animals of another species or an unfamiliar object, however, as a consequence of the amount and nature of subsequent interactions with humans, the animal will develop a stimulus-specific response to humans. Therefore, although there will be some components of novelty in the response of experienced animals to humans, which will occur with changes in the stimulus property of humans (changes in behaviour, clothing, location of interaction, etc), a major component of this response will be experientially determined. Other authors have recognized the distinction between general responses and stimulus-specific responses of farm animals to fear-provoking stimuli (Murphy & Duncan 1977, Jones 1985, Jones *et al* 1991).

There is evidence to support the idea of the development of a stimulus-specific response by farm animals to humans. For example, handling treatments varying in the nature of human contact, but not in the amount of human contact, can result in rapid changes in the level of fear of humans by farm animals (Hemsworth *et al* 1981a, 1986, 1987a, Gonyou *et al* 1986, Hemsworth & Barnett 1991). Furthermore, regular handling appears to have its main effects on the response of the animal to humans rather than to novelty (Jones & Faure 1981, Jones *et al* 1991).

Our research on a number of farm animals, particularly the pig, indicates that the interactions between the stockperson and the animal will determine the subsequent stimulus properties of the human for the animal (Hemsworth *et al* 1981a, 1986, 1987a, 1989a, Gonyou *et al* 1986, Hemsworth & Barnett 1991). The characteristics of these stimulus properties will include the familiarity of the human (ie the extent to which the animal has habituated to the presence of the stockperson), and the rewarding and aversive properties of the human (ie the extent to which the stockperson has been associated with rewarding or aversive events). Although there is some controversy over the mechanism by which avoidance behaviour becomes conditioned by punishment (Walker 1987), it is well established that animals learn to avoid stimuli that are paired with aversive events (Hall 1989). Furthermore, through the process of stimulus generalization, the behavioural response of a pig to an individual human can extend to all humans (Hemsworth *et al* 1981b, 1991). Our studies with pigs indicate that the aversive properties of humans, which will increase the animal's fear of humans, include hits, slaps and kicks by the stockperson, while the rewarding properties, which will decrease the animal's fear of humans, include pats, strokes and the hand of the stockperson resting on the back of the animal. The proportion of these aversive interactions to the total physical interactions will determine the commercial pig's fear of humans (Hemsworth *et al* 1989a). Although less research has been conducted, there is similar evidence that the interactions with humans will determine the stimulus properties of the human for other farm animals such as cattle, goats and poultry (Murphy & Duncan 1977, Jones & Faure 1981, Boissy & Bouissou 1988, Lyons 1989, Jones 1991, Barnett *et al* unpublished data).

The development of the stockperson's behaviour towards farm animals

The origins of stockpersons' beliefs about farm animals have not been studied. However, because stockpersons are normally not formally trained, most attitudes and beliefs probably develop from incidental observations of other stockpersons and personal observations of their own interactions with farm animals. Our research in the pig industry has shown strong correlations between the attitude and the behaviour of the stockperson (Hemsworth *et al* 1989a). It is therefore most likely that the stockperson's attitude and behaviour become mutually reinforcing through interactions with pigs. For example, if negative or aversive behaviour by the stockperson towards pigs leads to avoidance or escape behaviour by pigs, then in time this would reinforce the belief that pigs are difficult to handle. In turn this may lead to more inappropriate behaviour by the stockperson. This mutual reinforcing of attitudes and behaviour has been well established

elsewhere (Festinger & Carlsmith 1959).

The particular beliefs which are relevant to the stockperson's behaviour have not been widely studied. In our own research in the pig industry, the stockperson's beliefs about various aspects of pig handling were the best predictors of the nature of the behaviour of the stockperson towards pigs (Hemsworth *et al* 1989a). Other research has shown that the characteristics of the stockperson are related to animal behaviour and productivity. Seabrook (1972a, b) reported that job satisfaction of stockpersons in the dairy industry, as measured by freedom of decision making, a liking of cows, recognition by others of the stockperson's ability and personality, were related to behaviour of the cows and milk yield of the herd: in 28 one-person herds, the highest-yielding herds were those where the stockpersons were introverted and confident and where the cows were most willing to enter the milking parlour and were less restless in the presence of the stockperson. Although Seabrook (1972a, b) used a composite score of the stockperson's characteristics rather than separately analysing each of these stockperson variables, it is possible to determine the relative contributions of each of these stockperson factors. English (1991) has argued that empathy may be an important stockperson characteristic leading to desirable handling techniques for farm animals. Variables such as confidence, introversion and empathy, may modulate the manner in which a stockperson's beliefs, behaviour and their consequences are established (see Ajzen & Fishbein 1980). It has yet to be determined whether such variables would independently contribute to fear and productivity in farm animals or would act by modulating attitudes and beliefs as Ajzen and Fishbein (1980) have proposed. For example, personality may affect the way in which the stockperson responds to problem situations with animals, and may therefore modify the stockperson's beliefs about the animals. This issue has not been fully investigated and the role of specific personality variables on the welfare and productivity of farm animals requires further study.

Behavioural and physiological responses of farm animals to humans

On exposure to stimuli which are threatening, unfamiliar or painful, there are basically three types of interrelated biological responses that are available to the animal: behavioural, autonomic and neuroendocrine. These responses provide the principal resources the animal utilizes in its attempts to cope with the stressor. Therefore, if the animal is highly fearful of humans, the close presence of a stockperson will initiate significant coping/adaptive responses. This is the so-called 'emergency reaction' (Cannon 1914) and these responses may include escape or avoidance responses, as well as autonomic responses and neuroendocrine responses (such as the release of catecholamines from the adrenal medulla), which prepare the animal for these behavioural responses. These autonomic and neuroendocrine responses function to mobilize the body's reserves for appropriate action to the challenge (eg increase in heart rate and availability of glucose; see Moberg 1985, Oliverio 1987). Although the sympathetic portion of the autonomic nervous system is generally considered as an emergency system and concerned with the rapid release of energy to meet critical situations, the parasympathetic portion

may also function to restore energy and produce the relaxation that is necessary to prepare for sudden energy release (Bone 1988 p330-334). Indeed, Bohus *et al* (1987) have recognized the role that the parasympathetic nervous system may play in situations where a passive behavioural strategy, such as an immobility response, may initially be most appropriate.

These emergency responses, often called the 'fight or flight responses', last for only a short period and, if the stressor is not removed, a second series of events occurs. This is the short term or acute stress response and is corticosteroid dependent (Selye 1946, 1976). We have good evidence that animals that are highly fearful of humans show a marked increase in plasma corticosteroid concentrations in the presence of humans (Hemsworth *et al* 1981a, 1986, 1987a, Hemsworth & Barnett 1991). This response, which may last from minutes to hours, has the major function of providing glucose from non-carbohydrate sources (particularly protein from muscle), for the required increased metabolic performance. This physiological state will disappear once the stressor is removed, with possibly no real ill-effects to the animal apart from a depletion of energy reserves. However, it must also be recognized that while acute stressors are short-acting, they could have detrimental effects. For example, while a single event of an acute stress response may not be detrimental, it is unknown what magnitude and duration an acute stress response would need to be before there would be adverse effects or when a series of acute stress responses would become a chronic stress response. An acute stress response at specific times in the reproductive cycle can interfere with different aspects of reproduction (Liptrap 1970, Paris & Ramaley 1973, Paris *et al* 1973, Euker *et al* 1975, Hennessy & Williamson 1983, Rivier & Rivest 1991).

If the stressor persists (ie the short-term responses are ineffective in enabling the fearful animal to avoid or alleviate the challenge of the close presence of the stockperson), the response continues to the third series of events - the long-term or chronic stress response. This response is also corticosteroid dependent and comes at a physiological cost to the animal (ie decreased metabolic efficiency, impaired immunity and reduced reproductive performance). Our research on experimental animals has shown that high levels of fear of humans may markedly reduce the growth and reproductive performance of the animal and that the mechanism involved appears to be a chronic stress response, since in a number of experiments, animals that were highly fearful of humans had a sustained elevation of free corticosteroid concentrations in the absence of humans (Hemsworth *et al* 1981a, 1986, 1987a). How serious these costs are depends on how long the animal is required to divert physiological resources to maintain homeostasis.

While the above discussion has concentrated on the physiological assessment of stress as mediated by corticosteroids, this is not to imply that corticosteroids are the only physiological variables affected by stressors. Other hormonal systems are responsive to stressors in a number of species and changes have been identified in a number of hormones including catecholamines, thyroid hormones, growth hormone, prolactin and endorphins (see Selye 1976). However, our understanding of the significance of some of these changes is poor. The role of endorphins in the stress response and their effects

on behaviour and the immune system have been areas of intense research during the last 10 years. There is good evidence that β-endorphins are released in response to stress in a number of species (Lim *et al* 1983, Kalin *et al* 1985, Olson *et al* 1986, Shutt *et al* 1987, Guiffre *et al* 1988, Flores *et al* 1990). There are also suggestions that endorphins are involved in the development of stereotypies (Cronin *et al* 1985, Kennes & Ödberg 1987, Rushen *et al* 1990) and pain-induced analgesia (Guiffre *et al* 1988, Fell & Shutt 1989) and that endorphins may adversely affect ovulation via effects on luteinizing hormone (see Blicknell 1985).

Review of pig, poultry and cattle research

The consequences of human-animal interactions on animal productivity

In intensive animal production there is frequent and often intense contact between stockpersons and animals, particularly young and breeding animals, and there is evidence that this human contact may have consequences for the productivity of the animal. Commercial pigs may be highly fearful of humans (Hemsworth & Barnett 1987) and our research on both experimental and commercial pigs has shown that high levels of fear of humans by pigs may markedly reduce their growth and reproductive performance (Hemsworth *et al* 1981a, b, 1986, 1987a, 1989a, Gonyou *et al* 1986, Hemsworth & Barnett 1991): a summary of the results of some of these studies is presented in Table 1. The mechanism involved appears to be a chronic stress response, because in a number of experiments, pigs which were highly fearful of humans had a sustained elevation of free corticosteroid concentrations with consequent adverse effects on nitrogen balance and reproduction (Hemsworth *et al* 1981a, 1986, 1987a, Barnett *et al* 1983). The results of studies on commercial pigs (Hemsworth *et al* 1981b, 1989a) indicate that high levels of fear of humans may be a major limiting factor to the reproductive performance of commercial pigs. For example, in one of the studies, fear of humans accounted for 20 per cent of the variation between farms in reproductive performance (Hemsworth *et al* 1989a). Fear of humans may also have important implications for the welfare of commercials pigs if, as seen in experimental pigs, commercial pigs that are highly fearful of humans experience a chronic stress response.

Seabrook and Bartle (1992) have also reported negative effects of aversive handling on the productivity of pigs. In contrast to these studies, Paterson and Pearce (1989) and Pearce *et al* (1989) found no effects of regular aversive handling on the growth performance of young pigs. Differences between studies in the nature, amount and imposition of the handling treatments may be responsible for these contradictory results. For example, a behavioural response (eg withdrawal) of animals to an apparently aversive stimulus may be an effective strategy to enable the animals to cope with this stimulus without having to resort to any long-term physiological adjustment. Furthermore, it is possible that because the stimulus is highly predictable, the aversiveness of the stimulus is substantially diminished. In relation to these two points of predictability and control, studies with laboratory animals indicate that animals that can exercise some degree of control over an aversive stimulus and can predict its occurrence, experience a lower stress

response than animals with less control over and less opportunity to predict the stressor (see Gray 1987). Indeed Wiepkema (1987) has emphasized the importance of predictability and control by animals of their environment on their stress physiology.

Table 1 The responses of pigs to positive, minimal and aversive treatments - summary of five studies.

Study and parameters measured	Handling treatment		
	Positive	Minimal*	Aversive
	Mean value of parameter[1]		
Hemsworth* et al *(1981a)			
Time to interact with experimenter (s)†	119	-	157
Growth rate from 11-22 weeks (g/day)	709^{b}	-	669^{a}
Free corticosteroid concentrations (ng/ml)#	2.1^{x}	-	3.1^{y}
Gonyou* et al *(1986)			
Time to interact with experimenter (s)†	73^{a}	81^{ab}	147^{b}
Growth rate from 8-18 weeks (g/day)	897^{b}	881^{ab}	837^{a}
Hemsworth* et al *(1986)			
Time to interact with experimenter (s)†	48^{x}	96^{y}	120^{z}
Pregnancy rate of gilts (%)	88^{b}	57^{ab}	33^{a}
Age of fully coordinated mating response by boars (days)	161^{x}	176^{xy}	193^{y}
Free corticosteroid concentrations (ng/ml)#	1.7^{a}	1.8^{ab}	2.4^{b}
Hemsworth* et al *(1987a)			
Time to interact with experimenter (s)†	10^{x}	92^{y}	160^{z}
Growth rate from 7-13 weeks (g/day)	455^{b}	458^{b}	404^{a}
Free corticosteroid concentrations (ng/ml)#	1.6^{x}	1.7^{x}	2.5^{y}
Hemsworth and Barnett (1991)			
Time to interact with experimenter (s)†	55^{a}	-	165^{y}
Growth rate from 15kg for 10 weeks (g/day)	656	-	641
Free corticosteroid concentrations (ng/ml)#	1.5	-	1.1

[1] Means in same row with different superscripts differ significantly ($^{a,b,c}P<0.05$; $^{x,y,z}P<0.01$)

* Treatment involving minimal human contact

† Standard test to assess level of fear of humans by pigs

\# Blood samples remotely collected at hourly intervals from 0800 to 1700 hours

Experimental and on-farm studies of broiler chickens and laying hens indicate that high levels of fear of humans may limit the productivity of the bird. For example, a number of experiments have examined the effects of human contact on growth performance of broiler chickens. In an experiment with young chickens, Gross and Siegel (1979) found that birds that received frequent human contact, apparently of a positive nature, from five weeks of age, had higher growth rates than birds that received minimal human contact. Although the behavioural response of the birds to humans was not quantified, the authors stated that the handled birds were easier to handle during weighing and blood sampling than the other birds. The results of a number of other studies support the proposition that handling, presumably of a positive nature, of chickens is associated with increased growth performance (Thompson 1976, Gross & Siegel 1980, 1982, Jones & Hughes 1981, Collins & Siegel 1987). In contrast, Reichmann *et al* (1978) found no effects of handling on the growth performance of either young broiler or layer chickens, whereas Freeman and Manning (1979) suggested that regular handling decreased growth performance in layer chickens. Variation in the nature of handling between these studies may have been responsible for the variation in the effects of handling. For example, Buckland *et al* (1974) demonstrated negative effects of aversive handling (blood sampling by cardiac puncture) on the growth performance of broiler chickens.

The results of two recent studies on commercial poultry indicate significant negative between-farm relationships between the level of fear of humans and the productivity of commercial broiler chickens and laying hens. The egg production of laying hens was inversely related to their level of fear of humans (Barnett *et al* 1992). The efficiency of feed conversion of broiler chickens was inversely related to the level of fear of humans by birds; the level of fear by broiler chickens accounted for 29 per cent of the variation in feed conversion efficiency across the 22 commercial units (Hemsworth *et al* unpublished data). In an experiment examining the effects of cage position on fear and egg production of laying hens, level of fear of humans was significantly and negatively related to egg production and efficiency of feed conversion (Hemsworth & Barnett 1989). In observations on the behavioural response of laying hens to an observer, Bredbacka (1988) reported that egg mass production was lower in hens that showed increased avoidance of the human.

There is also some limited evidence that human-animal interactions may have consequences for the productivity of the dairy cow. Two studies have shown that dairy calves reared in visual and tactile isolation from conspecifics produce more milk in adulthood than herd-mates raised with visual and tactile contact with conspecifics (Warwick *et al* 1977, Arave *et al* 1985). It has been proposed that in the former case cows may have 'imprinted' upon the stockperson and thus may have adapted more easily to the milking procedure which involves intense human contact. Creel and Albright (1988) rejected this hypothesis on the basis of similar approach behaviour of isolated and control calves to a stationary experimenter. However, they also found that the isolated calves had a shorter flight distance to an experimenter than control calves. It is also of

interest that dam-reared goats, which showed increased avoidance of humans, exhibited greater milk ejection impairment than human-reared goats (Lyons 1989).

Seabrook (1972a) reported that cows in the highest yielding herds tended to be the most willing to approach the milker, to return from pasture and to enter the milking parlour. These reports suggest that milk yield may be at risk when cows are fearful of humans. Therefore, there is some limited evidence to indicate that animals that are less fearful of humans may have advantages in terms of their milk production. In contrast, there are reports of significant positive between-herd associations (Purcell *et al* 1988) and within-herd associations (Willis 1983, which were not confirmed by Purcell *et al* 1988) between restlessness during milking and milk production.

There is limited evidence that indicates that animals which are the most difficult to handle may have meat quality problems when slaughtered. Fordyce *et al* (1988) found that beef cattle that were the most active and vocal when restrained in a weighing scale had most carcass bruising and tended to have tougher meat. Although part of the behavioural response of cattle when restrained in a weighing scale would be responses to restraint and novelty, a significant component of the response would be to humans. Grandin (1991) has suggested that a higher incidence of pale soft exudative (PSE) meat is likely to be encountered in situations in which pigs are difficult to handle.

As expected, human-animal interactions may have some marked effects on the ease of handling of the animal. A number of studies have indicated that increased human contact and contact of a positive nature will improve the ease of handling in a number of farm animal species. For example, studies by Gonyou *et al* (1986) and Grandin *et al* (1986, 1987) indicated that regular handling of a positive nature resulted in an improvement in the ease of handling of pigs. Boissy and Bouissou (1988) reported that dairy heifers handled from birth to nine months showed less avoidance of humans and were easier to catch and handle than those that had received less human contact. The former group of animals also showed lower heart rate and plasma cortisol responses in a range of situations involving varying amounts of human contact. Similarly, Boivin *et al* (1992) found that calves that were handled for short periods during rearing were easier to handle in a number of handling tests at a later age than calves that had not been handled. There is also evidence that dairy heifers handled at the time of parturition are subsequently less fearful of humans and less restless during milking than heifers isolated from human contact at parturition (Hemsworth *et al* 1987b, 1989b).

The consequences of human-animal interactions on animal welfare

The previous section provides evidence that the human-animal relationship affects both behavioural and physiological responses of farm animals, with adverse consequences on production. Evidence has been provided that behavioural responses (measured predominantly on the basis of withdrawal behaviour), indicative of fear of humans, and physiological responses (measured predominantly on the basis of free cortisol concentrations), indicative of a chronic stress response, can occur in the presence of humans and are affected by human behaviour. In the previous section it is also implied

that high levels of fear and a chronic stress response are indicative of poor welfare. However, this is not axiomatic and it is necessary to substantiate that fear and stress responses of the magnitude described are indicative of poor welfare.

All criteria used to assess welfare rely on showing some evidence of change. For example changes associated with the stress response have been widely used as physiological indicators of welfare (Dantzer & Mormede 1983, Dantzer *et al* 1983, Moberg 1985) owing to the belief that if stress increases, welfare decreases. Similarly, changes in behaviour, particularly the occurrence of abnormal behaviours, have been used as behavioural indicators of welfare (Buchenauer 1981, Broom 1983, Wiepkema *et al* 1983). The debate arises over interpretation of the changes. Change *per se* is not an indicator of a change in welfare as the animal's behaviour and physiology are continually being adjusted to maintain homeostasis: an animal is obviously not in a continual state of changing welfare because of these continued adjustments. The important question for animal welfare in both disciplines is *'at what level of change (in physiology and behaviour) is welfare at risk?'*

We have attempted to clarify this question, particularly for physiological criteria in pigs, by a retrospective analysis of data from a number of experiments on both the human-animal relationship and housing system design. This analysis has been reported in detail (Barnett & Hutson *1987*, Barnett & Hemsworth *1990)*. Basically, we have proposed that the welfare of the animal is at serious risk if the animal experiences a prolonged elevation in free corticosteroid concentrations, ie a chronic physiological stress response, of a sufficient magnitude to have detrimental consequences. The detrimental consequences of an increase in free corticosteroid concentrations were either physiological (measured in terms of immunoreactivity or plasma glucose, urea or protein concentrations), or production-related (measured in terms of growth rate, sexual behaviour, conception rate or litter size). There have been criticisms of this approach (Mendl 1991). However, we do not believe there is any argument with the hypothesis that the animal's welfare is at risk when adverse effects can be demonstrated. The corollary of this, that the animal's welfare is not at risk when adverse effects cannot be demonstrated, has not been substantiated. In a number of the studies conducted at our laboratory, detrimental consequences of a chronic stress response were demonstrated for pigs showing high levels of fear of humans; there were adverse effects on nitrogen balance and reproduction and it is likely that the pigs' welfare was adversely affected. Therefore, we suggest that the welfare of animals displaying high levels of fear of humans may be at serious risk in production systems in which they are in frequent contact with humans.

Potential outcomes arising from this research

The overall proposal we have been developing is that in intensive animal production there are some important sequential relationships between stockperson attitude and behaviour and animal behaviour, performance and welfare. The evidence for this is firstly from experimental studies, particularly on pigs, in which fear of humans has been manipulated

and the consequences for the animal examined. Secondly, the correlated relationships between human and animal variables have been examined in the industry, particularly the pig industry.

To examine whether there are cause and effect relationships existing between these human and animal factors in the pig industry, we have been studying the effects of improving the behavioural profiles of stockpersons towards pigs on the level of fear and productivity of pigs. Data collected from a recently completed four year study in the Australian pig industry, provide evidence that an improvement in the behaviour of stockpersons towards pigs results in both a reduction in the pigs' level of fear of humans and an improvement in the reproductive performance of these animals (Hemsworth *et al* unpublished data). These results, together with the results on the adverse effects of increasing the level of fear in experimental pigs (Hemsworth *et al* 1981a, b, 1986, 1987a, 1989a, Gonyou *et al* 1986, Hemsworth & Barnett 1991), indicate that human factors, by affecting fear of humans by pigs, may be important in affecting the productivity and welfare of commercially kept animals. It should be recognized that the stockperson's attitude towards pigs, by affecting other important human factors which may alter the work performance of the stockperson (such as work ethic and job satisfaction), may influence the productivity and welfare of commercial pigs. Therefore, it appears that the attitude and behaviour of stockpersons towards farm animals are integral components in the pathways which affect animal productivity and welfare. Furthermore, there appears to be considerable opportunity for the pig industry to improve the performance and welfare of their animals by training and selecting stockpersons in terms of their attitude and behaviour towards pigs. Similar research is required in other animal industries. One likely outcome of future research is the development of staff training and selection procedures which augment the productivity and welfare of farm animals by improving the attitudinal and behavioural profiles of stockpersons towards farm animals.

Conclusion

In conclusion, research on both experimental and commercial animals has demonstrated the consequences of human-animal interactions on the productivity and welfare of a number of farm animal species which are intensively handled by humans. We have proposed that in situations in which a farm animal is regularly or frequently handled and is fearful of humans, there is the opportunity for the animal to experience a series of acute stress responses or a chronic stress response. It is the occurrence of the stress response, particularly the chronic stress response, that places both the animal's productivity and welfare at risk. Furthermore, we have proposed that the stockperson's behaviour towards farm animals is strongly influenced by the attitudes and beliefs that he/she holds about the animals, and that this behaviour by the stockperson affects the animals' fear of humans. We have published data which strongly support these interrelationships between human attitude and behaviour and animal behaviour, productivity and welfare.

Animal welfare implications

In addition to productivity risks, we have also proposed that the welfare of intensively handled farm animals is at risk in situations in which these animals are highly fearful of humans. This concern for welfare is based firstly on the finding that highly fearful animals may experience a chronic stress response and secondly on the reasonable belief that as stress increases, the risks to welfare increase. Furthermore, in situations where animals are fearful of humans and thus the attitude and behaviour of the stockperson towards the animals may be negative, the stockperson's commitment to the surveillance of and the attendance to welfare issues can be questioned.

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