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The Effect of Stress on Productivity of Animals:A Review

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ABSTRACT
The aim of this paper is to examine the stressors of farm animals and their implications to animal productivity. Domestic animals are routinely faced with different stressors. Most stressful conditions, including cold, heat, handling, transporting, temperament, introduction to a new flock, diseases and parasites. Stress reduces the fitness and productivity of the of the animal. Little is known about the signs of stressed animal, in turn, almost all farmers lose their animals through death. Moreover, in the future population growth, urbanization and income growth in developing countries are fuelling massive global increase in demand for food of animal origin. However, the effects of stress has a great impact on the productivity of farm animals. It is imperative that the issue receive more research attention in minimizing farm animal stress and optimizing in product yield and quality.
Keywords: stress, fitness, productivity, farm animals, signs

1. Introduction

Stress is the biological response elicited when an individual being under a threat to its homeostasis (Moberg, 2000). Physiologists define "stress" as external body forces that tend to displace homeostasis and "strain" as the internal displacement brought about by stress (Stott, 1981). As reported by Dobson and Smith (2000), stress is revealed by the inability of an animal to cope with its environment, a phenomenon that is often reflected in a failure to achieve genetic potential. Stress in general is looked down as a symptom resulting from exposure of an animal to a hostile environment. To some, it is a non-specific response to all environmental forces; others feel there are specific stress symptoms caused by specific environmental forces. The term stress is sometimes used to describe the hostile environment (Stott, 1981). The individuals tries to relieve stress (keep homeostasis) by behavior response or alteration of various physiological and biochemical response to readjust animals biology for possible new state of homeostasis with a different set- point (Yousef, 1988).

In animal husbandry, stress has actually been conceived as a reflex reaction that occurs ineluctably when animals are exposed to adverse environmental conditions and which is the cause of many unfavourable consequences ranging from discomfort to death (Etim *et al.,* 2013). There are environmental forces that are continuously acting upon animals that disrupt homeostasis, resulting in new adaptations that can be either detrimental or advantageous to man's interest (Stott, 1981). The natural environment is composed of various potentially hostile stressors. It is a basic requirement of life that the cells of an organism must be maintained within closely defined physiological limits. The maintenance of a constant interior milieu results from physiological and behavioural homeostatic adaptations. The physiological regulation of homeostasis is achieved by complex endocrine interactions, principally by the hormones secreted from the adrenal glands (Harvey *et al.,* 1984).

Inability of livestock farmers to identify or recognize environmental factors and management practices that pose stress to farm animals may result in lower performance and reproductive ability of animals leading to shortage of animal and animal products supply. Understanding of stressors that impact domestic farm animal productivity and management practices that can relieve stress within the environment will enhance animal comfort and maintain a secure, productive and low-cost food supply (Curtis, 2012).

The scientific contributions of this paper are 1) Identifying of stressors that affect productivity of animals 2) Knowledge on effects or implications of stress on animal productivity.3) Understand- ing the response of the animal to the stressors

2. Environmental and management stressors

Environmental stress is not limited to climatic factor but extends to nutrition, housing and any stimuli that demand a response from the animal to adapt to new circumstances (Lee, 1993). As reported by Gwasdaukas (1975) of environmental stressors that affect reproductive efficiency, adverse effects of heat stress are most dramatic and the most documented. Other stressors include: animal handling techniques, environment, transportation, disease, management techniques and changes in day length among others.

Cold Stress

Hypothermia occurs when the body temperature drops well below normal. In general terms, with cattle, mild hypothermia occurs with a body temperature of 30°C–32°C, (86°F–89°F), moderate hypothermia at 22°F–29°C, (71°F–85°F) and severe hypothermia below 20°C (68°F). As rectal temperature drops below 28°C (82°F), cows are not able to return to normal temperature without assistance through warming and the administration of warm fluids. As hypothermia progresses, metabolic and physiological processes slow down, and blood is diverted from the extremities to protect the vital organs. Teats, ears and testes are prone to frostbite. In extremes, respiration and heart rate drop, animals lose consciousness and die. Cold stress has been shown to decrease the rate of absorption of colostrums in new born calves. The upper critical temperature, approximately 85°F, is reached when the calf cannot dissipate enough metabolic heat to the environment to maintain homeothermy. Thus, food intake is reduced, thereby lowering heat production generated by digestion and absorption of nutrients. This decreases the growth rate in calves. Other environmental factors such as humidity, wind chill factors and moisture due to rain or mud affect the upper and lower temperature of the environment (Stull, 1997).

Cows try to increase feed intake in an effort to meet their energy requirements. Given the opportunity and gut capacity, cows will eat more feed to help meet their increased energy demands. Practically, it is usually expedient to feed grain as well. This increases feed costs, increasing the cost of keeping cows, however the expectation is that cows will maintain their body weight!

Heat Stress

High ambient temperatures, high direct and indirect solar radiation and humidity are environmental stressing factors that impose strain on animals. Despite having well developed mechanisms of thermoregulation, ruminants do not maintain strict homeothermy under heat stress. There is unequivocal evidence that hyperthermia is deleterious to any form of productivity, regardless of breed and stage of adaptation. The best recognized effect of raised body temperature is an adaptive depression of the metabolic rate associated with reduces appetite. Thus, in domestic ruminants, a rise in body temperature marks the transition from aversive stage to noxious stage. Factors such as water deprivation, nutritional imbalance and nutritional deficiency may exacerbate impact of heat stress.

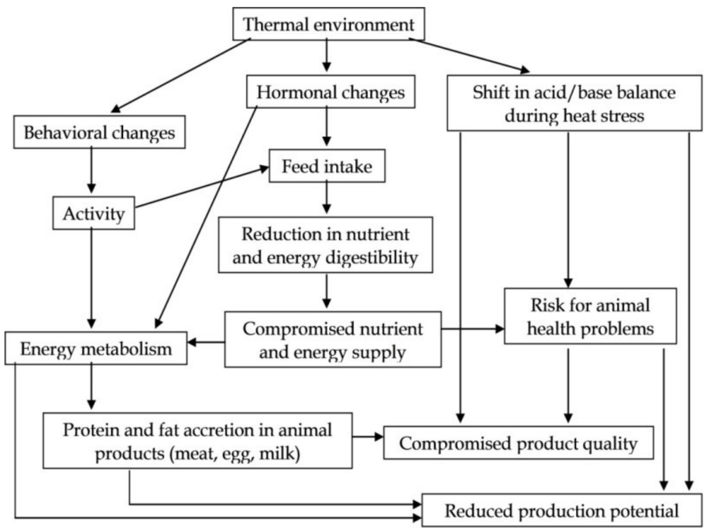

Figure 1.Schematic representation of the potential mode of action of inconvenient thermal environment on the production potential and product quality of livestock.

Stress of hot environment lowers reproductive efficiency in farm animals. Hot weather causes heat stress in animals. Although, effects are more severe in hot climates, dairy cattle in areas with relatively moderate climates are also exposed to periods of heat stress. The resultant decrease in milk production and reproductive efficiency can be offset by implementation of a program consisting of cooling through ventilation, spray and fans. The economic benefit should be determined before the installation of equipment to reduce heat stress.

Gwasdauskas (1975) reported that heat stress will delay puberty in both males and females. Puberty was delayed in Hereford heifers reared at 27°C (80°F) as compared with others reared at 10°C (50°F). Similarly, puberty was delayed in Jersey bulls that were exposed to a 35°C (95°F) for 8 hours a day. Heat stress delays puberty by depressing appetite and slowing growth rate. Hot conditions in most parts of the world are severe enough to lower semen quality resulting in lower conception rate. Spermatozoa in semen collected from bulls during the summer/hot periods show an increase in abnormal morphology and reduce binding to glycosaminoglycans such as heparin.

Skinner and Louw (1966) reported that at a temperature of 40°C, it was found that as little as 12 hours exposure proved critical to optimum spermatogenesis, and a decline in semen quality occurred after a week at this temperature. Field studies by Venter *et al.* (1973) showed that, at temperatures greater than 18°C, eleven out of twelve short horn bulls were culled either on the basis of poor semen quality or abnormalities of the genitalia, while only one of ten Africander bulls was culled.

Hafez (1967) stated that heifers maintained under temperatures of 10°C reached sexual maturity at 10 months, while those kept under temperatures of 27°C matured at 13 months, possibly as a result of reduced growth at high temperatures. Delayed onset of puberty, particularly, in Bos indicus cattle, constitutes a major limiting factor in the breeding of yearling heifers for beef production. Bonsman *et al.* (1972) found that 2 year old Bos taurus heifers, when imported from a temperate region to subtropical region, suffered an overall drop in calving percentage from 80 to 43 percent. The birth weight of calves born to unadapted European breeds following a summer pregnancy in the tropics is often lower than that of indigenous breeds (Hafez, 1967). This effect was quantified by Bonsma *et al.* (1972) who found that with calves born following a summer gestation in the subtropics, 33 percents were classified as dwarfs.

According to Gwasdauskas (1975), European type cattle in subtropic regions have shorter periods of estrus during the hot seasons than during cooler seasons. More estrus, quiet ovulations and missed detection of oestrus have been reported (Gwasdauskas, 1975). Likewise, sows have a longer period of post-weaning anestrus during the hotter months than in colder months. While true anestrus in cows is not likely prevalent. If cows, ewes and sows are bred during the summer/hot periods, lower fertilization rates and higher embryo mortality will result.

A combination of high humidity and high ambient temperature can have profound adverse effect on milk production. Thus, Johnson *et al.,* (1963) found that the milk yield of forty Holstein cows was seriously depressed by high humidity above an air temperature of 27°C. Under hot room in the United States of America, Richardson (1961) found that the butter fat yields of Holstein cows fell at temperatures above 27°C while Rees (1964), working with various crossbred cows in Tasmania, noted a fall in fat percentage at temperature Journal of Agriculture and Sustainability around 28°F, high temperature also results in rise in chloride content of milk and a fall in the milk sugar and total nitrogen content. This, and other works on the effect of increased environmental temperature on milk production of cattle, have been reviewed by Findlay (1954), Hancock (1954) and Bianca (1965).

Many experiments have measured the extent of reduction in feed intake as a result of thermal stress. Bianca (1965) found the dry matter intake of Aryshire steers decreased to 5.2kg/day at 40°C having been 7.4kg at 15°C. A long term experiment conducted between 1942 and 1963 sought to quantify the effects of temperature and humidity on weight gain (Mcllvain and Shoop, 1971). They found that high temperatures in conjunction with high humidity levels substantially reduced weight gain of beef steers.

It is accepted that heat stress is among the major cause of lost in production and lost profits in poultry, swine, beef and dairy cattle. The thermal comfort zone for most animals is between 4°C and 25°C. When temperature exceeds 25°C, animals suffer heat stress. In severe cases of heat stress, the deep body temperature rises, animal cells are affected and productive performance is reduced. The effect is increased when the relative humidity is greater than 50%. Animals typically react to heat stress by eating less food, thus, naturally controlling the rise in deep body temperature caused by digestion. Respiratory rate rises and there is a marked increase in insensible heat loss by evaporation of water from the lungs. They also drink at least five (5) times the amount of water they would, under normal temperate conditions, urine output increases and many mineral ions are lost. The body needs continuous supply of electrolyte which balances the body fluids in and around the cells.

Animal handling and transporting

One stressor which is easily eliminated is the improper handling of calves by caretakers which can cause both behavioral and physiological stress (Webster, 1983). This can sometimes adversely affect reproduction. Rearing gilts in confined pens as compared with group pens has delayed puberty. In a research trial by (Gwazdauskas, 1975) it was reported that rearing gilts in confinement reduced the number cycling at 9 months of age by 14 percent units (71 vs 85%).

Beef cows, isolated and confined in a corral either before or after insemination. Transporting animals to a new location has altered oestrus cycles and delayed ovulation, as has constraints and mild shock. These examples illustrate that animal handling techniques which are psychologically disturbing to animals will sometimes adversely affect reproductive efficiency (Gwazdauskas, 1975).

According to Hemsworth (2011) a stockperson's attitude and behaviour has a significant effect on animals fear, welfare and productivity. Human behaviour eliciting certain animal responses have been measured as positive or negative. A negative handling behaviour, such as slaps, hits, fast movements, shouting and noise will cause an increase in fear in the animal, resulting in avoidance, stress and handling difficulties. Positive stockperson's behaviours such as pats, strokes, talking, hand resting on the back, slow and deliberate movements will reduce the animal's level of fear of human and result in animal, which are less stressed and are easier to handle. These effects have been demonstrated in many farm animal species. Negative handling significantly increases an animal's cortisol response, that is; stress. Animals exposed to positive handing had a much shorter flight distance, acute cortisol responses were significantly lower compared to animals that had received negative handling. A study by Hemsworth (2011) showed that the growth rate of positively handled pigs was 455g/day, whereas it was only 404g/day in pigs negatively handled. The growth rate of inconsistent pigs was 420g/day. In this situation, the growth rate was reduced due to the animal stress response (cortisol concentrations were elevated in inconsistent and negatively handled pigs) (Hemsworth, 2011).

A similar study was carried out in laying hens, looking at the negative effects of negative handling. The corticosterone stress levels were much higher in hens handled negatively, than in positively handled hens. Subsequently, egg production in the hens was 8% higher in hens that had a positive human-animal relationship. The number of studies across species with strong correlation between stress and negative handling leaves no doubt that negative handling evokes stress, affecting animal welfare and production (Hemsworth, 2011).

In a study by Grandin (1998) it was observed that reducing stress during handling will provide advantages of increased productivity and maintaining meat quality. It was indicated that cattle that become agitated and excited in the squeeze chute have significantly lower weight gains, tougher meat, and more borderline dark cutters (Voisnet *et al.,* 1997). Agitation and excitement in the squeeze chute are influenced by both genetic factors and the animal's previous handling experiences. Reports from commercial feedlots indicated that quiet handling methods help improve productivity. Short term stressors that occur during handling and transport have been shown to interfere with the biological mechanisms of both reproduction and immune functions. Electric prods, restraint and other handling stressors will lower female reproductive functions (Stott *et al.,* 1975; Hixon *et al.,* 1981; Stoebel and Moberg, 1982;). In both pigs and cattle, transport or restraint stress lowers immune functions (Kelly *et al.,* 1981; Mertshing and Kelly, 1983). In cattle, the stress imposed by transit has a greater detrimental effect on animals physiology than the stress of feed and water deprivation for the same length of time (Kelly *et al.,* 1981; Blecha *et al.,* 1984;). Transport stress can also lower rumen function compared to controls subjected to feed withdrawal (Fordyce, 1987). In sheep, chasing by dogs, handlings, and sorting, two or three weeks after mating caused early embryonic losses (Belyaev and Borodin, 1982).

Numerous studies showed that fearful pigs that have been treated aversively by humans have few piglets born, lower weight gains and chronic stress response (Hemsworth, 1993; Hemsworth *et al.,* 1989; Hemsworth and Barnett, 1991). It was found that pigs that had been slapped or shocked by their regular caretakers had lower weight gains (Hemsworth *et al.,* 1989). They also found that cows milked by a confident and quiet introvert had higher milk yields (Seabrook, 1972). Quiet handling of market weight pigs at the slaughter plant will help maintain pork quality. Rough handling, pile-ups and excessive use of electric prods prior to stunning will increase pale, soft, exudative pork (PSE) (Barton, 1984). Plant management reported than an additional 10 percent of their daily pork production was suitable for export to Japan because the incidence of PSE was reduced (Grandin, 1998b).

Effect of Novelty

Novelty is anything new or sudden change in an animals environment. Thus, novelty is a very strong stressor of farm animals (Dantzer and Mormede, 1983). A sudden novel event, such as a person stamping his foot in a pen of commercial pigs, is one of the best tests for determining genetic difference in the reactivity of pigs reared under identical conditions (Lawrence *et al.,* 1991). This test was superior to other tests such as willingness to leave a pen or movement eases through a hallway. Other example of sudden novel stimulus would be a stamping of foot, a train passing a pen where newly arrived calves are received, or an auction ring. The paradox of novelty is that it will cause an intense behaviour and physiological reaction when suddenly introduced to an animal with a flighty excitable temperament but the same flighty animal may be the most attracted to a novel object when allowed to approach it voluntarily. The most reactive and excitable pigs with the greatest startle reactions were also the most likely to voluntarily approach a novel bucket placed in their pen (Lawrence *et al.,* 1991). In cattle, breeds with the largest flight zone had the greatest tendency to approach novel objects or a person laying on the ground (Murphey *et al.,* 1980; Murphey *et al.,* 1981).

Temperament

Animal producers and caretakers are probably familiar with the ‘fight or flight’ concept, which is the ability of an animal to react quickly to a real or perceived threat (stressor). The manner in which cattle react to threats, humans, a fearful situation or a novel, stressful environment, is its temperament.

Temperamental animal can be excitable, stress responsive or wild and may injure their caretakers, other animal or themselves, and they may damage facilities. Temperament is a heritable trait; therefore the livestock industry may apply selection tools to improve their herds, protect animal wellbeing and enhance profitability.

Newborn Brahman calves that are prenatally stressed are less competent to survive bacterial disease than non-stressed calves (Randal, 2013).The same author investigate the influence of stress and temperament on performance of beef cattle. Their research team has studied these relationships in weaning age cattle, and is currently studying the effect of prenatal stress on postnatal temperament, health and performance of beef calves. Besides stress response helps an animal maintain balance or homeostasis. Temperamental animals are more stress responsive than their calmer herd mates. Execute

Many production practices such as weaning, ear tagging, branding, castration, vaccination, social mixing, and transportation can be stressful for cattle, Randel said. Furthermore, temperamental cattle have reduced growth rates, carcass traits and immune function.

“Reduction of stress in a herd of cattle should result in improved productivity and profit. Selection of cattle with more easily managed temperaments will result in less stress as well as reduced risk in handling the cattle for routine management,” Welsh said.

Temperament and exit velocity are repeatable, moderately heritable traits. Hormone assay methods were used to demonstrate that the more temperamental cattle have greater peripheral blood concentrations of the adrenal gland derived stress-related hormones cortisol and epinephrine. Cortisol stimulates the production of glucose and stimulates the breakdown of muscle protein. Epinephrine (i.e., adrenaline) increases plasma concentration of glucose and non-esterified fatty acids by stimulating the breakdown of glycogen and triglycerides.

Randel and Welsh (2013) report stress-responsiveness and temperament at weaning were negatively associated with post-weaning immune function, feed intake and carcass traits.Prenatally stressed suckling calves are more temperamental than their non-stressed herd mates.

For example, Welsh said temperamental steers had higher concentrations of stress-related hormones and a lesser degree of dry matter intake which was suggestive of a negative effect of temperament on feeding behavior. Also, the more temperamental steers yielded less tender carcasses (based on increased shear force) and temperamental cattle had less fat stores (marbling, indicative of a negative effect on quality grade). Temperament may affect white blood cells and influence susceptibility to viruses and bacteria.

Disease and parasite

Livestock diseases can cause direct losses (deaths, stunting, reduced fertility, and changes in herd structure) and indirect losses (additional costs for drugs and vaccines, added labor costs and profit losses due to denied access to better markets and use of suboptimal production technology) in revenue (Rushton, 2009). From the point of view of producers, livestock diseases are essentially an economic problem. Diseases that reduce production, productivity, and profitability are associated with the cost of their treatment, disruption of local markets, international trade, and exacerbate poverty on rural, local, and regional communities. At the biological level, pathogens compete for the productive potential of animals and reduce the share that can be captured for human purposes (FAO 2009; Rushton 2009).

Docking and castration were managed as severe stressors that lambs may encounter as a part of routine husbandry (Turner, et. al., 2006).Shearing is necessary for the well–being of sheep as in hot weather sheep with too much wool is extremely susceptible to heat stress. Shearing keeps stained wool and mud contaminated wool separate from new fleece growth, however it could be of negative effect when applied at an inappropriate time.

Another stress factor could result of shearing when animal exposed to wet weather either under severe cold or intense hot sunshine. Shearing itself is a stress on the animal.

Identification of stressed animals and stressful conditions

An animal is under stress when it has to make extreme functional, structural, behavioural or immunological adjustments to cope with adverse aspects of its environment (Gwasdauskas, 1975). According to Reid and Bird (1990) farm animals like humans perform best when the temperature is neither too hot nor too cold. Exposure to direct radiation can dramatically increase heat stress in stock and most will actively seek shade on hot days (Reid and Bird, 1990). The critical factors influencing cold stress of stock are wind speed and rainfall (Cleugh, 1997). Research shows that within a preferred temperature range, animals will not need to expend any energy keeping themselves warm or cool, are under no temperature induced stress and therefore are able to maximize productivity. Reid and Bird (1990) further stated that farmers should aim to keep all their animals within this 'comfort zone' all the time. The depiction of the typical comfort zone for common farm animals suggest that animals grazing in an open paddock may find themselves in less than ideal conditions during much of their life. The range of the comfort zone depends upon the species of the animal, its size, genetic condition, health, energy reserve, and age, condition of its coat and any additional stressful conditions such as pregnancy or lactation. Thus, an environment is stressful only if it puts an animal under stress. And because animals vary, the same environment can be stressful to one and not to another (Gwasdauskas, 1975). Ref. [8] reported that transportation is considered as a major stressor of farm animals. Hemsworth and Coleman (2011) documented that negative handling behaviour such as slaps, hits, fast movement, shouting and noise will cause an increase in fear in the animal resulting in stress. According Burdick et al. (2011) harmful handling as well as restraint during management procedures may cause the animal to injure or stress itself or a worker. Most animal managers consider stress of any nature to be undesirable in relation to reproductive efficiency (Gwasdauskas, 1975). Under prolonged or extreme stressful conditions, the effect on animal health can be significant resulting in irreversible losses in productivity or even death (Reid and Bird, 1990).

Effects of stress on meat and by-product quality

The energy required for muscle activity in the live animal is obtained from sugars (glycogen) in the muscle. In the healthy and well-rested animal, the glycogen content of the muscle is high. After the animal has been slaughtered, the glycogen in the muscle is converted into lactic acid, and the muscle and carcass becomes firm (rigor mortis). This lactic acid is necessary to produce meat, which is tasteful and tender, of good keeping quality and good color. If the animal is stressed before and during slaughter, the glycogen is used up, and the lactic acid level that develops in the meat after slaughter is reduced. This will have serious adverse effects on meat quality.

Pale Soft Exudative (PSE) meat

PSE in pigs is caused by severe, short-term stress just prior to slaughter, for example during off-loading, handling, holding in pens and stunning. Here the animal is subjected to severe anxiety and fright caused by manhandling, fighting in the pens and bad stunning techniques. All this may result in biochemical processes in the muscle in particular in rapid breakdown of muscle glycogen and the meat becoming very pale with pronounced acidity (pH values of 5.4-5.6 immediately after slaughter) and poor flavor. This type of meat is difficult to use or cannot be used at all by butchers or meat processors and is wasted in extreme cases. Allowing pigs to rest for one hour prior to slaughter and quiet handling will considerably reduce the risk of PSE.

Dark Firm and Dry (DFD) meat

This condition can be found in carcasses of cattle or sheep and sometimes pigs and turkeys soon after slaughter. The carcass meat is darker and drier than normal and has a much firmer texture. The muscle glycogen has been used up during the period of handling, transport and pre-slaughter and as a result, after slaughter, there is little lactic acid production, which results in DFD meat. This meat is of inferior quality as the less pronounced taste and the dark colour is less acceptable to the consumer and has a shorter shelf life due to the abnormally high pH-value of the meat (6.4-6.8). DFD meat means that the carcass was from an animal that was stressed, injured or diseased before being slaughtered.

Spoilage of meat

It is necessary for animals to be stress and injury free during operations prior to slaughter, so as not to unnecessarily deplete muscle glycogen reserves. It is also important for animals to be well rested during the 24-hour period before slaughter. This is in order to allow for muscle glycogen to be replaced by the body as much as possible (the exception being pigs, which should travel and be slaughtered as stress free as possible but not rested for a prolonged period prior to slaughter). It is important that the glycogen levels in the muscles of the slaughtered carcass are as high as possible, to develop the maximum level of lactic acid in the meat. This acid gives meat an ideal pH level, measured after 24 hours after slaughter, of 6.2 or lower. The 24h (or ultimate) pH higher than 6.2 indicates that the animal was stressed, injured or diseased prior to slaughter.

Lactic acid in the muscle has the effect of retarding the growth of bacteria that have contaminated the carcass during slaughter and dressing. These bacteria cause spoilage of the meat during storage, particularly in warmer environments, and the meat develops off-smells, colour changes, rancidity and slime. This is spoilage, and these processes decrease the shelf life of meat, thus causing wastage of valuable food. If the contaminating bacteria are those of the food poisoning type, the consumers of the meat become sick, resulting in costly treatment and loss of manpower hours to the national economies. Thus, meat from animals, which have suffered from stress or injuries during handling, transport and slaughter, is likely to have a shorter shelf life due to spoilage. This is perhaps the biggest cause for meat wastage during the production processes.

Bruising is the escape of blood from damaged blood vessels into the surrounding muscle tissue. This is caused by a physical blow by a stick or stone, animal horn, metal projection or animal fall and can happen anytime during handling, transport, penning or stunning. Bruises can vary in size from mild (approx. 10-cm diameter) and superficial, to large and severe involving whole limbs, carcass portions or even whole carcasses. Meat that is bruised is wasted as it is not suitable for use as food.

Injuries such as torn and haemorrhagic muscles and broken bones, caused during handling, transport and penning, considerably reduce the carcass value because the injured parts or in extreme cases the whole carcass cannot be used for food and are condemned. If secondary bacterial infection occurs in those wounds, this causes abscess formation and septicaemia and the entire carcass may have to be condemned.

Summary

Stress is any change in environment; that is alteration in climate or management that is severe enough to elicit a behavioural and physiological response from the animal. Inability of an animal to cope with its environment depicts stress and results in failure to produce and reproduce optimally. Environmental and management stressors erode efficiency and cost livestock production enterprises billions of dollars annually in lost potential profitability. Therefore identifying and understanding stressors of farm animals will effectively guide farmers in raising animals in suitable environments (comfort zones) and in employing proper management practices to improve the reproductive and productive efficiencies of livestock so as to prevent lost to livestock production enterprises. Putting aside financial aspects, exposure of animals to avoidable stress compromises welfare, whether biotechnology is involved or not. The fact that stressors can be deleterious to such an important function as reproduction emphasizes that stress is important and should be minimized whenever possible.

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