Abstract

Reducing stress on livestock during handling will help reduce sickness and enable cattle to go back on feed more quickly. Many detrimental effects of handling stressors on animal performance and health are likely due to fear. Practical experience on ranches and feedlots shows that making cattle accustomed to people both on foot and on horseback will produce calmer and easier to handle cattle. An animal's first experience with a new corral, a person, or pieces of equipment should be made as positive as possible. If a painful or very aversive procedure is done the first time, it may be difficult to persuade the animal to re-enter the facility. The following tips will improve handling: move small numbers of animals at a time, do not overload the crowd pen, eliminate electric prods, open anti-back gates, eliminate visual distractions that make animals balk, use flight zone and point of balance principles, and reduce noise.

Introduction

Reducing stress during handling will provide advantages of increasing productivity and maintaining meat quality. Recent work in our laboratory has indicated that cattle that become agitated and excited in the squeeze chute have significantly lower weight gains, tougher meat, and more borderline dark cutters (87, 88). Agitation and excitement in the squeeze chute are influenced by both genetic factors and the animal's previous handling experiences. The author has observed that cattle with previous experience with quiet handling will be calmer and easier to handle in the future.

Anecdotal reports from commercial feedlots indicate that quiet handling methods help improve productivity. Deaths due to respiratory sickness were greatly reduced in a Texas feedlot when quiet handling procedures were implemented. Handlers moved cattle quietly at a walk both in the processing facility and in the yard. Lee Reeve, manager of Reeve Cattle Co. in Kansas, reports that eliminating electric prods in the processing area enabled reimplanted cattle to get
back on feed faster. (Lee Reeve, Reeve Cattle Co., P.O. Box 1036, Garden City, KS 67846). Bud Williams, a cattle handling expert in Alberta, Canada, stated that lowering stress during receiving at the feedlot reduces medicine costs (Bud Williams, Box 2220, Lloydminster, AB, T9V 1R6, Canada). At another feedlot, toe abscesses were reduced by half when quieter handling methods were used. One cause of toe abscesses is scuffing of the toes when agitated cattle are waiting in line in the chute.

Short-term stressors that occur during handling and transport have been shown to interfere with the biological mechanisms of both reproduction and immune function. Electric prods, restraint and other handling stressors will lower female reproductive function (50, 85, 86). In both pigs and cattle, transport or restraint stress lowers immune function (55, 69). In cattle, the stress imposed by transit has a greater detrimental effect on the animal's physiology than the stress of feed and water deprivation for the same length of time (8, 55). Transport stress can also lower rumen function compared to controls subjected to feed withdrawal (24). In sheep, chasing by dogs, handling, and sorting 2 to 3 wk after mating caused early embryonic losses (17).

Paul Hemsworth and his colleagues in Australia have done numerous studies that show that fearful pigs that have been treated aversively by humans have fewer piglets born, lower weight gains, and a chronic stress response (47, 48, 49). His research group found that pigs that had been slapped or shocked by their regular caretakers had lower weight gains (49). They also found that the attitude of handlers and caretakers affected productivity on commercial hog farms (49), and this is also found in dairy cows (82). Higher milk yields were reported in cows milked by a confident and quiet introvert (82).

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) (4). Resting of pigs 2 to 4 h prior to stunning at the packing plant will also significantly reduce PSE (67, 71). The intensity of pig squeals at a slaughter plant indicated that squealing was associated with lower pork quality and elevated creatinine phosphokinase (CPK) levels (89). Vocalizations in pigs during handling are signs of stress and fear. In two pork plants, the author worked with handlers to reduce electric prods in the stunning chute, resulting in calmer pigs, less squealing, and fewer pile ups. Plant management reported that an additional 10% of their daily pork production was suitable for export to Japan because the incidence of PSE was reduced (Grandin, unpublished data).

The Role of Fear

Many detrimental effects of handling stressors on animal performance and health are likely due to fear. Alain Boissy from the I.N.R.A. Center in Thiex, France was one of the first to fully recognize the importance of fear in determining both an animal's behavior and its physiological reactions to fear-eliciting stimuli (10, 11). The relevance of fear in the analysis of behavior during handling is clear. Fear is a universal emotion (67, 79) that motivates animals to avoid predators.
All vertebrates can be fear conditioned (65, 79). The fear center of the brain is located in the
limbic system in a nucleus of cells called the amygdala. In humans, stimulation of the amygdala
will elicit feelings of fear (25). Over 20 different animal studies show that electrical stimulation
of the amygdala will trigger both behavioral and autonomic responses that resemble fear in
humans (15). In cats and rats, stimulation of the amygdala will increase plasma corticosterone
levels (68, 78, 83). Lesions in the amygdala will block both conditioned and unconditioned fear
responses (15), giving further evidence of the role of the amygdala as the fear center of the
brain. Large lesions in the amygdala have a taming effect on rats and reduce the size of the flight
zone (56).

Fear is a very strong stressor. Fear caused by exposure to novelty can elevate levels of cortisol
higher than many husbandry procedures. For example, in extensively raised beef cattle not
accustomed to handling in a squeeze chute, the psychological stress of restraint raised cortisol
levels almost as high as branding (1, 62, 63), whereas after 20 min of restraint in a squeeze
chute, cortisol levels averaged 30 ng/mL, cortisol levels during hot iron branding averaged 36
ng/mL -- a very small difference in cortisol levels. Inverting cattle onto their backs for 103
seconds raised cortisol levels to the very high level of 93 ng/mL (18). In dairy cows accustomed
to handling, cortisol levels were significantly higher in branded cows than in restrained cows
(62). Restrained Holstein dairy cows had cortisol levels that averaged only 13 ng/mL, reflecting
less fear.

In sheep, fear stress can elevate cortisol levels higher than handling procedures such as shearing.
Six hours of restraint and isolation caused dark cutting meat and very high cortisol levels of
greater than 110 ng/mL (3). Cortisol levels reported in the literature for shearing and slaughter
in a commercial slaughter plant ranged from 61 to 73 ng/mL (23, 42, 58, 77).

Non painful handling or restraint can induce very high cortisol levels in both sheep and cattle.
The amount of stress caused by a handling procedure such as restraint in a squeeze chute is
determined by how the animal perceives it. Handling stresses that are non painful are mostly
determined by the amount of fear. An extensively raised animal that has had little contact with
people is more likely to have more fear stress when it is restrained than an animal that is reared
in close contact with people and trained to handling procedures. Fawns and calves that are raised
with close human contact have lower cortisol levels during restraint than animals that receive
less contact with humans (9, 43).

Research at the Denver Zoo indicates that training an animal to cooperate during minor
husbandry procedures such as injections and blood tests reduced cortisol levels almost to a
(resting) baseline (39). Bongo antelope were trained to enter a box and were fed treats during
husbandry procedures. Cortisol levels measured during this procedure averaged only 6.3 ng/mL
(41), probably due to low levels of fear stress. The antelope entered the crate and was held for
20 min prior to taking a blood sample. This provided sufficient time for cortisol levels to rise.
Antelopes of many different species that were captured in the wild and physically restrained had
cortisol levels that were five to seven times higher (73). We were able to show how training Bongo antelope reduced stress by comparing CPK and glucose levels obtained in trained animals to values obtained from their medical records when they were immobilized with ketamine and xylazine. (41). Glucose levels averaged 61 mg/dL in the trained animals, and 166 mg/dL in immobilized animals. Creatine phosphokinase averaged 71 UI in trained animals and 288 IU in immobilized animals.

Training and Habituating Livestock to Handling

The training methods used for Bongo antelope at the Denver Zoo would not be practical for use with farm animals. Antelope are highly reactive and flighty. Each new step in the procedure had to be introduced gradually to avoid panic. It took a total of 3 months to train the antelope to enter the restraint crate and accept handling by people reaching through holes cut in the sides (39). Only one afternoon was required to train placid Suffolk sheep to voluntarily accept restraint on a tilt table (28). Training a group of cattle, which are somewhat more excitable than sheep, may take about 10 days. With cattle, the author has observed that training sessions should be spaced 24 hours apart to give the animals an opportunity to calm down. A series of training trials in 1 day may result in increasing agitation and excitement.

Practical experience on ranches and feedlots shows that making cattle accustomed to both people on foot and on horseback will produce calmer and easier to handle cattle at the slaughter plant. An animal's previous experiences with handling will affect its reaction to future handling (12, 52). Sheep inverted in a sheep handling machine were more reluctant to re-enter the corrals the following year (52). Researchers in both Australia and Brazil have found that training young calves by walking quietly among them or putting them in a chute and petting them produced calmer adult animals with smaller flight zones (5, 21). The flight zone is the distance an animal will approach a person. Completely tame animals have no flight zone and they will allow people to touch them.

Some of the lean hybrid pig strains are more excitable and difficult to handle (32), and are more likely to panic and pile up when driven through a high speed slaughter plant. Observations by the author also indicate that pigs will balk less and drive more easily at the slaughter plant if the producer walks through the pens every day during finishing. Only 10 to 15 sec/day is required. This trains pigs to get up in an orderly manner and calmly move around the person. It is important to teach the pigs to flow around the person. If the handler stands still and allows the pigs to approach him and chew on his coveralls, they may become more difficult to drive at the slaughter plant because they tend to follow the handler instead allowing themselves to be driven (27). To avoid frightening the pigs, the handler must never kick or slap them. Walking in the pens with the pigs, or walking pigs in the aisles during finishing helps produce calmer animals (39).

Temperament
An animal's temperament is one determinant of how it will react during handling, and this is determined by an interaction between genetic and environmental factors. There is a substantial effect of genetics (38). In cattle, temperament is highly heritable. The heritability estimate of temperament in cattle has been figured at 0.40 (76), 0.53 (16), and 0.45 (80). Several studies have shown that cattle with brahman genetics (Bos indicus) are more excitable than Bos taurus breeds when evaluated by observing their behavior in a squeeze chute (22, 30, 44).

A major component of temperament is fearfulness, which is defined as "a basic psychological characteristic of the individual predisposing it to perceive and react in a similar manner to a wide variety of potentially frightening events" (10, 11). Although temperament has a strong genetic component, it is also influenced by previous experiences and handling. Rearing environment produces long-term temperament differences in goats (66). Hand-reared goats reacted less strongly to changes in their environment than dam-reared goats. Pigs given objects to chew on were less excitable (39).

Animals with a genetically flighty temperament, such as the bongo and nyala antelope, ultra lean hybrid pigs, and excitable breeds of cattle, can be trained to a handling procedure and may appear behaviorally calm. They can learn to behave calmly when they are with familiar people, or in a familiar handling facility, but they can suddenly panic when left alone in a strange place, or exposed to the novelty of a noisy auction or a new farm. Nyala antelope at the Denver Zoo were trained to enter a restraint crate and they were easy to handle, but when they were exposed to the novelty of people fixing the barn roof they panicked and crashed into a fence (38). This phenomenon has also been observed by ranchers. They reported that cattle with a flighty, excitable temperament are often calm and easy to handle on their home ranch, but they may panic and become frenzied when they are suddenly introduced to a novel noisy environment such as an auction ring or a livestock show (36).

Cattle temperament can be rated on a numerical rating scale, measured while they are held in a squeeze chute, or by flight zone testing in a pen (22, 30, 44, 45). To rate cattle temperament in a squeeze chute, the most common rating system is a four-digit scale. Cattle are scored as follows: 1) they stand calmly in the squeeze chute, 2) they are restless, 3) they vigorously shake the chute, and 4) they violently shake the chute and try to escape (berserk). When the flight zone test is used, a person stands in a pen and measures how closely either individuals or groups of cattle will approach them. Compared to chute scoring of temperament, the author hypothesizes that learning plays a larger role than genetics in determining an animal's flight zone. Chute scoring may be more likely to assess the animal's genetic reactivity because restraint in a squeeze chute is a sudden aversive event, and the animal is forced to enter the squeeze chute. When an animal's flight zone is tested, it is allowed to voluntarily approach a human standing in a pen.

Flight zone size may also be affected by a genetic trait that is separate from fear. In Japanese quail, the traits of fearfulness and social reinstatement are governed by different genetic systems (20). In both birds and mammals, social reinstatement is the behavioral tendency of a lone
animal to attempt to get reunited with its mates. In a series of experiments, a treadmill test was used to measure the distance run by an individual bird in an attempt to rejoin its flockmates. The test was conducted in a long narrow enclosure with a treadmill floor. A lone bird was placed on the treadmill and its flockmates were placed in a cage at the far end of the enclosure. High and low social reinstatement lines were developed. Lines of birds with high and low levels of fear were also developed by measuring the duration of the tonic immobility reaction (54). Tonic immobility occurs when a frightened bird becomes immobile. Genetic selection for over 20 generations produced four distinct lines of quail. They were selected for 1) high social reinstatement, 2) low social reinstatement, 3) long tonic immobility-high fear, and 4) short tonic immobility-low fear (20).

The author speculates that purebred Brahman cattle may have more of the social reinstatement trait than the British or European breeds. Purebred Brahmans have an intense tendency to follow people when they are handled quietly. The author has observed that this trait can be so strong that purebred Brahmans may be difficult to drive. It is often easier to move them by having them follow a horse or a person.

**Effects of Novelty**

Novelty is a very strong stressor. Novelty is anything new or sudden in an animal's environment. Examples of sudden novel stimulus would be a stamping foot, a train passing a pen where newly arrived calves are received, or an auction ring. Several researchers report that novelty is a very strong stressor of farm animals (14, 72, 84). 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 differences in the reactivity of pigs reared under identical conditions (61). This test was superior to other tests such as willingness to leave a pen or movement ease through a hallway. The paradox of novelty is that it will cause an intense behavioral 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 (61). In cattle, breeds with the largest flight zone had the greatest tendency to approach novel objects or a person laying on the ground (74, 75). The author has observed cattle that will approach and manipulate a piece of paper lying on the ground when allowed to voluntarily approach it, but they will balk and jump away if someone attempts to drive them over it.

**Temperament and Habituation to Handling**

A review of many studies and practical experience has shown that animals with a more placid temperament will habituate more easily to a forced, non painful handling procedure than animals with a flighty temperament. In cattle, agitation and cortisol levels decreased when the animals were handled in a squeeze chute every day over a series of days (13); e.g., they habituated to being restrained. However, some animals do not habituate easily. In one group of
cattle, some individuals violently shook the squeeze chute and never habituated to being restrained when they were handled every 30 days (30). Even though the cattle were handled quietly, they still struggled violently and became behaviorally agitated every time they were put in the squeeze chute.

Some animals will habituate to a forced handling procedure and other animals will not. Research at Texas A&M University indicated that some pigs habituated when they were forced to swim. The epinephrine (adrenalin) levels in the pig's blood declined over a series of swims to near baseline levels (60). Other pigs remained fearful and never habituated during a series of swims. Their epinephrine levels remained high.

Extremely flighty excitable animals, such as elk, bison, and antelope, are less likely to habituate to a forced handling procedure. Because it is more difficult for flighty excitable animals to habituate, the author hypothesizes that these animals must have novelty introduced slowly and gently to avoid triggering a dangerous flight reaction. Some animals will not habituate to forced handling procedures, even when the procedures are done gently. Bison are highly reactive and flighty and are often injured during handling. Bison ranchers are concerned because it is difficult to handle their mature animals safely. It is the author's opinion that these animals may be so excitable that the only way to handle them in a low stress manner is to train them to voluntarily cooperate from an early age.

**Temperament Testing Methods** - Assessment of Temperament in Cattle and Its Effect on Weight Gain and Meat Quality and Other Recent Research on Hairwhorls, Coat Color, Bone Thickness, and Fertility

**Prevent Fear Memories**

Extensive research with rats shows clearly that if an animal's first experience with a new arm in a maze is aversive or very frightening, the rat would never enter that arm of the maze again (70). If a rat entered a new arm of a maze to receive a food reward and it was given a severe shock, the rat would never enter that arm again. However, if the rat received a mild shock, it would proceed to enter the alley to receive a food reward, and, by gradually increasing the shock, rats can be trained to tolerate increasing discomfort to obtain food. On farms, ranches, and feedlots, observations by the author indicate that an animal's first experience with a handling facility, a new corral, a person, or pieces of equipment should be made as positive as possible. Farm animals can be very frightened in these novel situations and if a painful or very aversive procedure is done the first time, it may become difficult to persuade the animal to re-enter the facility. First experiences are critical in how animals form future responses to similar situations. Several researchers agree that less severe procedures should be done first (14, 53). Some ranchers report success in training cattle by walking them through the squeeze chute a few times and giving them a feed reward, which made future handling in the squeeze chute easier. Providing feed rewards to sheep improved movement through a handling facility (52).
Animals can develop fear memories that are difficult to eradicate (64). They form a subcortical circuit in the brain that allows an animal to quickly flee if it sees or hears the same frightening stimulus. These memories can be suppressed by learning, but never completely erased from the brain's subcortical circuits (65).

**Improve Handling Practices**

Basic principles of livestock handling have been covered in detail elsewhere (19, 27, 29, 31, 57). In this section, some of the most important livestock handling principles will be reviewed, and some new information will be presented. Handlers need to learn basic principles of handling such as the animal's flight zone, and using the animal's point of balance to induce it to move forward or backward. The following tips are based on the author's practical experience.

**Move Small Bunches.** Finishing pigs should be moved in small bunches of three to six during truck loading. On ranches and feedlots, move small bunches of cattle that can be easily handled. The staging alley leading to the truck loading ramp or processing area should only be filled half full.

**Do Not Overload the Crowd Pen.** The crowd pen for pigs or cattle should be filled only half to three-quarters full. Half full is best. It is important to avoid using the crowd gate if possible. On a round crowd pen, the crowd gate should be closed and set on the first notch and left there. It should not be used to push animals. Cattle and pigs need room to turn and should be handled in small discrete bunches, with space in between the bunches. For sheep, the crowd pen may be filled completely, as long as the sheep are not too tightly packed. Sheep should be moved in one continuous stream, never breaking the flow, to maintain following behavior.

**Eliminate Electric Prods.** Use other driving aids, such as plastic paddles or sticks with plastic streamers or flags tied on them. Use these devices to work the animal's flight zone and to turn the animals. These devices work better than plain sorting sticks, because the animals can see them easily.

**Open Anti-Back Gates.** Many chute facilities have too many anti-back gates and movement will often improve if most are tied open. The only place an anti-backup gate may be needed is up close to the squeeze chute. Cattle handled calmly and quietly are less likely to back up. The anti-back gate at the single file chute entrance can be equipped with a remote control rope so it can be held open by a person standing by the crowd pen. This facilitates entry of the cattle into the chute.

**Eliminate Visual Distractions.** Distractions and lighting problems may ruin the performance of a well designed facility and should be removed (34). To locate distractions that impede animal movement, handlers should get in the chute and crouch down to look at them from the animal's eye level. If pigs or cattle balk or refuse to enter the single file chute, look for distractions such
as shiny reflections, a dangling end of a chain, water puddles, drain gratings, a coat hanging on a fence, or people visible up ahead. Cattle, sheep, or pigs moved calmly through a handling facility will look directly at visual distractions, which should be removed. However, when animals are excited and panicky, they may not do this. Pigs and cattle will often refuse to enter a chute that is dark. On one feedlot, the author found it was impossible to eliminate electric prods in the crowd pen until more light was admitted to the processing building by opening a garage door. When new feedlot processing areas are built, skylights are recommended to provide diffuse, shadow-free light, because shadows that fall across a chute can make animals balk (26). However, animals will not approach blinding light, and will not walk directly into the sun. Another distraction that may impede animal movement is air blowing in their faces.

Behavioral Principles of Restraint. There are four behavioral principles of restraint that can be used to keep animals calmer. These are: blocking vision, slow steady movements of the restraint apparatus, optimum pressure, and providing secure footing so that animals do not lose their balance and struggle due to slipping. On squeeze chutes, cover the open barred sides or install angled rubber conveyor belt strips on the side bars to prevent cattle entering the squeeze chute from seeing the operator. Cattle often balk at the entrance to a squeeze chute because they see the operator deep in their flight zone. The crowd pen, the lead up chute, and the squeeze chute should have solid sides. The most important part of the squeeze chute to cover is the back half closest to the tailgate. Covering the sides of the squeeze chute will also reduce sudden lunging at the headgate. Cattle should enter and exit the squeeze chute at a walk.

During restraint, cattle will remain calmer if the squeeze chute is closed with steady strong pressure instead of suddenly bumping the animal (33). However, sufficient pressure must be applied to provide the feeling of being held. Many people make the mistake of squeezing the animal tighter when it struggles. It is important to remember that if an animal is squeezed too tightly, the pressure should be backed off slowly. A sudden release of pressure may scare the animal.

Handler Movement Patterns. Use the patterns shown in Figures 1 and 2 to move cattle and pigs through chutes. In a large commercial feedlot, the author observed that use of these movement patterns enabled handlers to eliminate electric prods in the processing area. Animals will move forward in a chute when a handler walks past them in the opposite direction of desired movement. The handler must pass the point of balance at the shoulder to induce the animal to move away in the opposite direction. To make the animal move forward, the handler must be behind this point of balance. Animals speed up and move faster when a handler inside their flight zone walks in the direction opposite to the desired movement. The same principles also apply to species of animals. Handlers should not put continuous pressure on an animal's flight zone. To induce a cow to walk into a squeeze chute, the handler should stand back out of her flight zone. The cow will usually move forward into the squeeze when the handler steps toward her and walks back past the point of balance at the shoulder (Figure 1).
Reduce Noise. Avoid yelling at animals, whistling, or whip cracking. Cattle are more sensitive to high pitched noise than are people (46). They are most sensitive at 8000 Hz (2, 46), and more sensitive to sound than humans ears at 7000 to 8000 Hz. Clanging noises on steel should be
silenced, and hydraulic systems should be quiet and designed to avoid the sound frequencies for which cattle have maximum sensitivity. On squeeze chutes, the clatter of the side bars should be quieted with rubber pads. The author has observed that reducing a high pitched whine in a hydraulic system resulted in calmer cattle (31). In a pork slaughter plant, engineering conveyor equipment for reduced noise combined with quiet handling resulted in reduced squealing and pig pile-ups.

**Slow is Faster.** Move pigs and cattle at a slow walk. Fearful animals are more likely to balk and are more difficult to handle. Handlers should move slowly and deliberately. Sudden jerky motions frighten the animals. In the wild, sudden movements are associated with predators.

**Use Following Behavior.** When handling cattle and pigs, do not fill the crowd pen until the single file chute is partially empty, because when there is space in the chute, a group of animals in the crowd pen will follow the leader into the chute. Cattle and pigs in the crowd pen will turn around if the single file chute is full. It is important to avoid overfilling the crowd pen. Cattle and pigs should be moved in small separate bunches, but sheep can be moved in a large bunch. When sheep are handled, the crowd pen should be continuously full so that sheep will follow each other in a continuous flow. This is a species difference between sheep and other hoofed animals.

**Avoid Isolating Individual Animals.** A lone animal left by itself will become stressed (58, 90), and can also be dangerous to people. The author has observed that many handling accidents are caused by a panicked lone animal attempting to rejoin its herdmates.

Quieter livestock handling techniques for loading and unloading trucks and handling animals in alleyways and chutes may take up to 2 weeks for handlers to fully learn. They may have to spend several days to learn the most efficient handler movement patterns and to make minor changes in the facility to improve livestock movement. Management has to be fully committed to permanently change handling procedures on a farm, feedlot, or ranch. Top management has to implement the changes and impress upon employees how serious they are about stopping rough handling. Over the years, the author has observed that most employees can be retrained. However, there are a few people that have been rough for so many years that they may not be able to change their ways and they may need to be reassigned to jobs away from animals.

**Objective Scoring of Handling**

In feedlots and slaughter plants, quiet handling has a tendency to become rough unless management maintains constant vigilance. Therefore, there is a need for methods to objectively score handling procedures. The most simple handling procedure to score is electric prod use. The author has observed that trained handlers working in well-designed facilities can move large numbers of cattle without an electric prod. In large beef slaughter plants with line speeds of over 250 animals per hour, it is possible to move 95% of the cattle from the truck unloading all the way through the stunning chute and restrainer without the use of electric prods (35). Only 5% of
the cattle had to be prodded once with an electric prod at the restrainer entrance in order to keep up with the line. In a large commercial feedlot, the processing crew handled over 300 animals and only used an electric prod on 1% of them. Sometimes visual distractions make it impossible to lower prod scores. For example, at one plant 64% of the cattle had to be prodded because they could see a man's hand under a gate. However, in most other plants, a single 15 minute lesson in animal handling made it possible to greatly reduce electric prod usage. The handlers were instructed to fill the crowd pen only half full and to tap an animal on the rear before resorting to an electric prod. After a 15 minute handling lesson, average electric prod scores in four pork and beef plants were reduced from 63% of the animals prodded to 16% (35). The goal is to eliminate electric prod use. The employees kept up with the line at reduced prodding rates.

The percentage of cattle that bellow can be used to assess handling stress (37). In both cattle and pigs, vocalizations are correlated with physiological stress measurements (18, 89). In a slaughter plant survey, the percentage of bellowing cattle was significantly higher where a high percentage of cattle were prodded with an electric prod (35). Bellowing was associated with electric prodding, slipping and losing footing, and excessive pressure applied by a restraint device. At one feedlot, the author observed that the percentage of cattle that vocalized in the squeeze chute dropped from over 50% to approximately 20% when electric prod usage was reduced. In another feedlot with calm, careful handling and no electric prod usage, vocalization was further reduced to about 10% of the cattle.

The author has observed that when cattle are handled quietly in a squeeze chute for vaccinations and implanting, less than 3% of the animals will vocalize during handling in the lead up chute, catching in the squeeze chute, or during vaccinations. Handling the ears and head for implanting and ear tagging will cause some animals to vocalize. Handling of the head appears to be more aversive than carefully applied body restraint and driving cattle without electric prods. Preliminary research in our laboratory by Jennifer Lanier indicates that blocking an animal's vision may reduce animal resistance to having its head manipulated.

Improper use of squeeze chutes can result in cattle injuries (33). The author has observed that hitting the headgate too hard can result in injuries that can be avoided by quiet handling so that cattle walk calmly into the squeeze chute. On some squeeze chutes, the hydraulic pressure is set too high, which can result in internal injuries (33). Many people make the mistake of applying more and more pressure when an animal struggles. There is an optimum pressure for holding an animal. The squeeze chute must be tight enough so that the animal feels held but not so tight that it causes pain (26). Squeeze chutes can be instrumented with load cells and strain gauges to measure the force exerted on them by the cattle (81). An instrumented squeeze chute can be connected directly to the feedlot computer system and used to monitor handling. In a feedlot in which cattle are individually identified, the computer could correlate the squeeze chute force scores to weight gains and sickness, and could measure how hard the animal hits the headgate and the intensity of struggling. Through the use of special software, it would be possible to use the system for both temperament scoring and for assessing how employees are handling the animals.
Genetic Factors

Observations of thousands of cattle and pigs in large slaughter plants indicate that some animals that have been bred for extreme leanness are very excitable and difficult to handle when they are brought to a new place. They become highly agitated when they are subjected to the noise and novelty of a large slaughter plant. The author has observed that the most excitable pigs and cattle have long slender smooth bodies and fine bones (38). Animals bred for leanness with heavy bones and bulging muscles tend to be calmer. For example, in the Charolais breed, the author observed that heavy-boned muscular Charolais were calmer than Charolais with a more slender body shape. However, both types of lean animals are probably more excitable than animals with more body fat. Double-muscled Angus cattle have a more excitable temperaments than normal Angus (51). In dogs bred for military use in Russia, the individuals with slender narrow bodies were more excitable than athletic, wide-bodied dogs (59).

Genes are linked in ways that are not fully understood (6, 7). In long-term selection experiments, Russian scientists selected foxes for temperament (6, 7). For 20 year, they bred the calmest and easiest to handle foxes. Selection for the single trait of calm temperament resulted in a fox that looked and behaved like a Border collie dog. Its coat changed from gray to black and white. However, continued selection for the very calmest fox-dogs resulted in bitches that ate their puppies and in neurological problems such as epilepsy. These results were totally unexpected.

To reduce stress and to improve both productivity and welfare, it is important to breed animals with a calm temperament. One must not make the mistake of over-selecting for any single trait. Excessive selection for calmness may result in some other problems such as lack of mothering ability. To prevent handling and stress problems, it would be advisable to cull the most flighty animals that became extremely frenzied and agitated when they are restrained, but it would probably be a bad idea to select only for the very calmest animals.

Conclusions

Genetics and experience interact to determine how an animal will behave during handling. Quiet, calm handling at an early age will help produce calmer, easier-to-handle adult animals. People working with animals need to understand the behavioral principles of handling.

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