REPEATABILITY OF MOVEMENT ORDER
AND DISPOSITION OF BEEF CALVES

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h	hours
EPD	Expected Progeny Difference
sec	seconds
h^2	heritability
r	repeatability
R	correlation coefficient
LSD	Least Significant Difference

CHAPTER I

INTRODUCTION

Beef cattle production and research requires constant movement and handling of livestock. Beef cattle improvement schemes require that many measurements be taken on live animals. Measurements such as body conditions scores, frame scores, scrotal circumference, pelvic areas, blood constituents, milk yield and ultrasounds are routinely taken. Castration, dehorning, branding, palpation, dipping, tagging, weighing and artificial insemination are part of beef cattle management norms. All of these require constant handling of cattle, thus the need to understand animal behavior

Animal behavior in response to their environment has been well studied in both dairy and beef industries (Erf et al., 1992; Grandin, 1993). Animals learn routine movements and handling with time. Understanding animal behavior may reduce the risks involved in handling cattle (Craig, 1981). Arave and Albright, (1981) reported the possibility of increasing economic margins and improving experiments' precision through good behavior management. An animal's learning experiences can be utilized in management thus they can be handled without effecting their welfare.

Movement orders of animals under voluntary and involuntary situations has been studied in most species (Arave and Albright, 1981; Fordyce et al., 1988; Sherwin, 1990). Species like sheep, goats and dairy cattle have been found to have a specific order of movement (Fordyce et al., 1988; Sherwin, 1990; Hughes *et al.*, 1996; Hargreaves *et al.*, 1990). However the specific orders of movement differed when animals were moved under familiar and unfamiliar situations (Graig, 1981; Lamb, 1975).

Because most beef cattle producers and researchers consider temperament as an important management trait, temperament as a factor that influences the ease of handling cattle as individuals has been well studied in the beef industry (Sato, 1981; Hearnshaw and Morris, 1984; Fordyce *et al.,* 1985; Grandin, 1995; Fordyce *et al.,* 1996). The studies found that temperament heritability and repeatability to be moderate in most beef breeds.

Moderate repeatability shows that temperament differences persist in beef cattle. Beef cattle managed under extensive systems go through handling facilities very few times in their lifetime so they have little opportunity for learning. Very few studies of movement order in beef cattle have been reported (Fordyce *et al.*, 1988). None of these studies determined the repeatability of order of movement in suckling beef calves on range. Research on beef calves disposition has also been sparse. This may be due to lack of an accurate way to measure both disposition and movement order. The extent to which these characters are repeated in calves needs to be known.

The objectives of this study were to determine if the order in which calves entered the weighing scale was repeatable, estimate repeatability of calf disposition within and between the weighing period of weigh-suckle-weigh procedure, investigate calves' ability to learn, and examine the relationship between calf and dam disposition.

CHAPTER II

LITERATURE REVIEW

Cattle Behavior

The scientific study of an animal's behavior in response to its environment, both animate and inanimate, has been going on for years within schools of Agriculture and Veterinary medicine (Lamb, 1975; Arave and Albright, 1981; Fordyce *et al.*, 1985; Grandin, 1993). Many behavioral studies were through secondary observations to main research projects. Few of these studies were designed with the aim of applying findings to management. Arave and Albright (1981) identified the following objectives of most animal behavior studies:

To evaluate the behavioral response stress resulting from management systems.

To determine the adaptive range within genetic groups to changing ecological restrictions.

To determine and utilize learning experiences of animals in management.

To document normal animal behavior so that persons with different backgrounds may supplement their experiences.

To determine physical mechanisms regulating behavior.

To increase validity to their research results.

Over the years, research on livestock behavior was done to address one or several of these objectives (Lamb, 1975; Fordyce *et al.,* 1985; Sato *et al.,* 1993; Grandin, 1995; Hasegawa *et al.*, 1997).

Temperament, competition, aggression, dominance order, milking order, leader-follower relationship, grazing behavior, resting behavior, sexual behavior and learning have been well studied in cattle industries, especially dairy production (Tulloh, 1961; Roy and Nagpaul, 1984; Kilgour, 1975; Arave and Albright, 1981; Hearnshaw and Morris, 1984; Sato *et al.*, 1993; Grandin *et al.*, 1995; Hasegawa *et al.*, 1997).

Inter-individual behaviors may be categorized as agonistic and non-agonistic behavior (Sato *et al.*, 1993). Agonistic behaviors are associated with fear, pain and aggression. Non-agonistic behaviors are friendly behaviors within animal's societies. Many agonistic behaviors of beef and dairy cattle such as aggressive behavior, escape behavior and avoidance have been studied (Arave and Albright, 1981; Hearnshaw and Morris, 1984; Fordyce *et al.*, 1988). This is because agonistic behaviors have clearer social and management functions than non-agonistic behavior (Sato *et al.*, 1993).

Leader-Follower Relationship

In general, non-agonistic behavior has been studied less with the exception of leading and following relationship (Mcphee *et al.*, 1964; Lamb, 1975; Arave and Albright, 1981). Arave and Albright (1981) refer leadership as to the ability of an individual to influence the pattern of the group when changing locations, whether due to free or forced movements. Leading evaluations include grazing, going to and from milking, parlor entrance and management activities such as weighing (Mcphee *et al.*, 1964; Lamb, 1975; Arave and Albright, 1980).

Allogrooming

Sato *et al.* (1993) defined allogrooming as when one cow licks the body surfaces of another, excluding the anal regions. Arave and Albright (1981) found that cattle spend several minutes grooming daily. Sato *et al.* (1993) suggested that allogrooming might have a cleaning effect, tension reducing effect and a bonding effect in growing calves. They emphasized that it might be an important factor in the establishment of cattle society. Arave and Albright (1981) saw that culling good social groomers in dairy herds resulted in decreased milk yield and higher mortality. However the importance of allogrooming in cattle societies is yet to be established due to lack of studies in this aspect. Other behaviors such as sniffing, head play, body contact and licking solicitation have been observed (Neindre, 1989). These behaviors are not easy to measure, thus, difficult to study.

Social Order

Social order is also referred to as peck order, rank order, dominance order or a hierarchy (Lamb, 1975; Arave and Albright, 1975; Beilhart *et al.*, 1982; Mench *et al.*, 1990; Hasegawa *et al.*, 1997). These names have been used for a situation in which the behavior of one individual within a group of animals may be inhibited by another, resulting in complex relationships amongst the individuals. Social order is a natural phenomenon that occurs in animals (Lamb, 1975). It has been well studied in cattle industries (Lamb, 1975; Arave and Albright, 1981; Beilhart *et al.*, 1982; Tennessen *et al.*, 1985; Mench *et al.*, 1990; Hasegawa *et al.*, 1997). Socially dominated animals within a group have been found to be distressed (Lamb, 1975). Changes in social members by regrouping or castrating may lead to injuries due to fighting to reestablish the order (Tennessen *et al.*, 1985, Mench *et al.*, 1990). Fordyce (1982) observed that it takes approximately one a week of fighting to reestablish the disturbed social order when new animals are introduced. Studies of dominance seek to find which animal shows respect or submission towards which other animal (Beilhart *et al.*, 1982; Arave and Albright, 1981). There was no relationship found between an animal's social rank and its order of movement into the weighing scale, crush or milking parlor (Mcphee *et al.*, 1964; Arave and Albright, 1981; Beilharz and Zeeb, 1982).

Temperament

Temperament is the underlying factor of animal disposition and an important factor concerning the easiness of handling cattle as individuals. Some researchers define temperament based on their main interest. Boissy *et al.* (1995) stated that all definitions express the way the individual cattle perceived and reacted to fear-eliciting events. Fordyce *et al.* (1988) defined temperament as the behavioral response to handling by man. Boissy *et al.* (1995) defined temperament as the individual's basic stance towards environmental change and challenge. Kilgour (1975) defined temperament as the behavioral characteristics resulting from individual physical, hormonal and nervous organization which contributes to the unique disposition of one animal in contrast to other specie members.

Temperament is considered by cattle producers to be an important trait (Dickson *et al.*, 1969; Sato, 1980; Bessel, 1984; Fordyce *et al.*, 1988; Erf *et al.*, 1992; Boivin *et al.*, 1994; Grandin *et al.*, 1995). Cattle with poor temperament are more difficult to handle. They create a safety hazard for handlers, themselves and they waste time (Hearnshaw *et al.*, 1984; Boivin *et al.*, 1992; Grandin, 1993; Boissy *et al.*, 1995). They also cause serious management problems and economic losses (Fordyce *et al.*, 1988). Stronger fences, yards, skilled and extra labor are required. Fordyce (1985) found that animals with poor temperaments had higher bruise scores than the calm animals, indicating that the bruising of an animal is a function of the individual's own temperament rather than that of the whole herd.

Measurement of Temperament

Little scientific research has been conducted on temperament in cattle, in particular that of beef cattle. This is mainly due to the lack of simple meaningful measurements of temperament. Several methods for testing temperament have been reported (Tulloh, 1961; Hearnshaw et al., 1979; Fordyce et al., 1981; Boivin et al., 1992).

The scoring systems were designed to reflect the difficulties experienced by cattle handlers when handling cattle. Different researchers rated temperament out of different scoring systems because some believed it was easier to score fewer ratings while others believed more ratings improved accuracy (Sato 1981; Hearnshaw and Morris,1984).

The following are methods of measuring temperament that are commonly used:

Tulloh (1961) measured behavior of cattle in yards and described a temperament score. He rated the temperament of beef cattle on a scale of one to six. Hearnshaw *et al.* (1979) scored cattle temperament in bail and described six scores. Sato (1981) categorized temperament into four scores, measured while the animal was on a scale:

Score 1: Mild, an animal which stands very quietly on the scale.

Score 2: Slightly restless, an animal which stands quietly but moves frequently.

Score 3: Restless, an animal which moves almost continuously and is difficult to weigh.

Score 4: Nervous, a restless animal which struggles violently and is very difficult to weigh.

Dickson *et al.* (1969) used a one to four scale scoring system. Burrow *et al.*(1988) scored temperament based on the observation that docile animals vacate a weigh scale at a slower rate than agitated animals. They were assessed by electronically recording the speed taken by each animal to cover a predetermined distance after vacating a confined area.

Hearnshaw and Morris (1984) scored seven behavioral responses for 30 to 60 seconds while standard management practices were applied to animals (ie. condition scoring and measures of height). The seven responses were 1) Tail swishing. 2) Straining back 3). Backward and forward movement 4) Paddling with back feet in an attempt to escape. 5) Kicking. 6) Kneeling and 7) Jumping.

Fordyce *et al.* (1982) developed a crush and paddock temperament test. Scores were taken while the animals were handled on the shoulders and head. The movement response was rated on a seven point scale as on Sato's (1981) method. The degree of audible respiration (BLO) was assessed on four levels: 0-no audible respiration. 0.5-heavy breathing. 1-very heavy breathing. 1.5-snorting. Bellowing, kicking and kneeling down were scored as 1 for each occurrence and zero if not. Scores were added to produce a temperament score.

Kilgour (1975) used an open field test in which the time taken to fasten an animal to a post was recorded. Grandin (1993) scored cattle temperament, out of five when held in a squeeze chute.

Boivin *et al.* (1992) used a sorting test, recording the time taken to isolate an animal from its social group. Grandin *et al.* (1995) reported that cattle with a long hair whorl above the eyes had worse temperaments than those without. This brought the opportunity of measuring calves hair whorl length as a prediction of temperament. This could be effective when used on beef cattle under extensive management (Grandin *et al.*, 1995). Erf *et al.* (1992) scored the disposition of dairy cattle on a scale of three: 1) No trouble. 2) Slight trouble. 3) Definite trouble.

Temperament Effect on Performance

Earlier reports showed that temperament had no effect on performance. Hearnshaw and Morris (1984) found that temperament of bulls did not affect growth rates, food utilization or carcass quality. No relationship was found between fat thickness and temperament score, though the heaviest animals tended to have the lowest scores (Fordyce *et al.* 1988).

Murphy *et al.* (1994) later reported that animals of good temperament grew faster and were better producers than animals that were restless, nervous or aggressive within a breed. Fordyce *et al.* (1988) found evidence of less tender muscles in animals with a worse temperament score, though the pH did not vary with temperament. Carcass bruising increased with increasing temperament score (Fordyce *et al.*, 1988). Most carcass bruising was found in areas from which expensive high quality meats are taken eg. M.longissimus dorsi, M.gluteaus medias (rump), M. biceps femoris (rump) M.semimembranosus (topside) and M.semitendonosus (Fordyce *et al.*, 1988), thus causing serious economic loss.

In lactating cows, Roy and Nagpaul (1984) reported that milk letdown was significantly affected by temperament score. The poor performance of the nervous type animals might be due to disturbance in the neuro-humoral mechanism (Roy and Nagpaul., 1984).

Docile animals in artificial insemination programs demonstrated estrus in the presence of an observer more often than did their more temperamental contemporaries, though they did not differ on any of the other associated reproductive traits (Burrow *et al* 1988). This implies that cattle producers on artificial insemination programs without teaser bulls, or any heat detecting aids should consider the temperament of their animals.

Factors that Affect Temperament

In cattle, numerous studies have revealed wide temperamental variability displayed by individuals of the same breed and reared under the same conditions

(Dickson *et al.*, 1969; Kilgour, 1975; Sato, 1981; Roy and Nagpaul., 1984; Hearnshaw and Morris, 1984; Fordyce *et al.*, 1985; Fordyce *et al.*, 1988; Erf et al., 1992; Grandin, 1993). These differences reflect constitutional bases of individual animals or breeds. Hearnshaw and Morris (1984) reported that environment and genetics influence cattle temperament.

Genetic Effects

Many studies indicated differences in temperament between different cattle breeds (Tulloh, 1961; Fordyce *et al.,* 1985, 1988, 1996). Hearnshaw *et al.* (1979) realized that genotype influences temperament. This could be a direct or maternal effect (Fordyce and Goddard, 1984).

Bos taurus breeds were found to be more docile than *Bos indicus* breeds (Hearnshaw and Morris., 1984). Grandin (1993) found that *Bos indicus* cross cattle were more difficult to handle than were pure or crossbred *Bos taurus* cattle.

In *Bos taurus* breeds, temperament problems have been reported in Charolais, Limousin and Salers (Grandin, 1993). Brahman cross cattle were found to be more temperamental than Africander cross cattle though both are *B. indicus* (Hearnshaw and Morris, 1984). Dairy breeds were found to be much easier to approach than beef breeds without respect to their prior handling (Boissy *et al.*, 1987). Highly restless lines within a breed were also observed (Grandin, 1993). Horned cattle tended to have lower temperamental scores than did polled cattle (Fordyce *et al.*, 1988).

Environmental Effects

Cows have memories and the ability to learn. This shows that effects of early handling have long lasting effects on the animal's behavior (Grandin, 1993). Heifers that had contact with humans during pre-puberty were less reactive to handling compared to those not handled (Boissy *et al.*, 1987; de Passille *et al.*, 1995). Cows were found to have a strong influence on the temperament of their calves (Fordyce and Goddard, 1984).

Heritability and Repeatability of Temperament

If breeds, lines within breeds, and crossbreeds have different temperaments, it would be of interest to breeders to know if they can breed docile animals by selection or crossbreeding. Improvement of breed temperament from one generation to another requires genetic variation (Fordyce *et al.*, 1982). Estimates of heritability for temperament are rare and mostly imprecise (Visscher and Goddard ,1995). Methods used in scoring temperament are one of the main sources of variation in these estimates (Fordyce *et al.*, 1996). Training of animals also has an effect on cattle temperament and thus affect heritability estimates, especially breeds with low genetic variation e.g. *Bos taurus* (Fordyce *et al.,* 1988). Some heritability estimates for temperament documented over the years and methods used to measure temperament are presented in Table 1.

Table 1: Heritability Estimates of Temperament

STUDY	BREED	$h^2 \pm$ se
New Zealand Dairy Board 1961*		0.06
Dickson *et al* 1969	Holstein	0.5 ±0.30
Shrode & Hammack 1971*	Brahman	0.40
Brown 1974*	Angus	0.17
	Hereford	0.32
Mishara *et al* 1975*	Karan Swiss	0.19
Pearson 1978*	Swedish Frisian	0.12-0.18
	Swedish Red & White	0.16-0.45
	Swedish polled	0.24
Gilsilcido & Eugenio 1979*	Brahman	0.04
Stricklin *et al* 1980 *	Brahman	0.44 ±0.18
Fordyce *et al* 1982,1988	*Bos Indicus* cross	0.25 ±0.20
	Bos taurus cross	0.17±0.21
	all combined	0.67± 0.26
Hearnshaw and Morris, 1984	*B.indicus*	0.46 ±0.37
	B.taurus	0.03± 0.28
	all combined	0.44 ±0.25
Sato 1981	Japanese Shorthorn , Japanese Black and Cross	0.44
Visscher and Goddard,1995	Holstein Frisian	0.18 ±0.11
Burrow *et al.*,1988	Africander	0.44±0.21
	Shorthorn-Hereford Cross	0.26 ± 0.18

*from (Hearnshaw and Morris ,1984).

Temperament must also be repeatable so that producers could be confident in their culling procedures. Repeatability provides the measure of the expression of a trait later in the animal's life. Grandin (1993) reported that some animals are agitated throughout their lifetime. Hearnshaw and Morris (1984) found that repeatability of temperament varies between breeds (Table 2).

Table 2: Repeatability of Temperament

Breed	Repeatability
Hereford	0.35
Simmental	0.42
Frisian	0.20
Brahman	0.59
Braford	0.03
Africander	0.83
Combined	0.37

From Hearnshaw and Morris, (1984) , measure done on heifers at 8 and 22 months.

Fordyce and Goddard, (1984) found repeatabilities of between 0.28 and 0.52 for measures taken on cows while Hearnshaw and Morris, (1984) found repeatabilities between 0.80 to 0.84. Repeatability of temperament seems to be moderate to high which means that temperament differences persist in cattle.

CHAPTER III

MATERIALS AND METHODS

Source of Data

All calves that were used were part of the beef cattle breeding research herd located at the North Lake Carl Blackwell Research range near Stillwater, Oklahoma .

The study was done in May, July and September of 1996, just after spring calving. The cows used in this study were from the base cows that were crossbred, bred in 1988 as follows: group one was ½ Hereford - ½ Angus, group two was ¼ Brahman, ½ Hereford, ¼ Angus and group three was ¼ Brahman, ½ Angus, ¼ Hereford. These cows were mated to polled Hereford and Angus bulls that differed widely in milk EPD (Buchanan *et al.*, 1996).

Calves used in this study were born from cows that were born in1989 through 1993. They were sired by Charolais, Limousin and Angus bulls. Data were collected from 117 calves (52 steer calves and 65 heifers) that were going through the weigh-suckle-weigh procedure to estimate 24 hours milk production of beef cows. Cows and their calves were maintained on separate pastures determined by calf sex. Groups of cows and their calves were gathered from pasture camps and placed by groups in holding pens the afternoon prior to measurement. Calves were separated from cows at 1800 h. The following morning at 0545h calves were placed with dams and allowed to suckle.

Groups were then randomly separated into smaller pens (approximately 25 cows per pen). Calves were separated from dams as soon as most had finished nursing (15 to 30 minutes). This procedure was repeated at 1145h and 1745h with the exception that calves were weighed prior to and after suckling. The difference between these two weights was considered to be the amount of milk produced by the dam in six hours.

Measurements

The order of entering a weighing scale within a subgroup was recorded as calves went through the weigh-suckle-weigh procedure. This was done once in May, July and September. Calf subgroups differed every month. Calves were driven through the alley to the weighing scale four times (Figure 1). Calves moved freely through the alley to the tub where some moved voluntarily to the weighing scale through the narrow alley while others had to be forced.

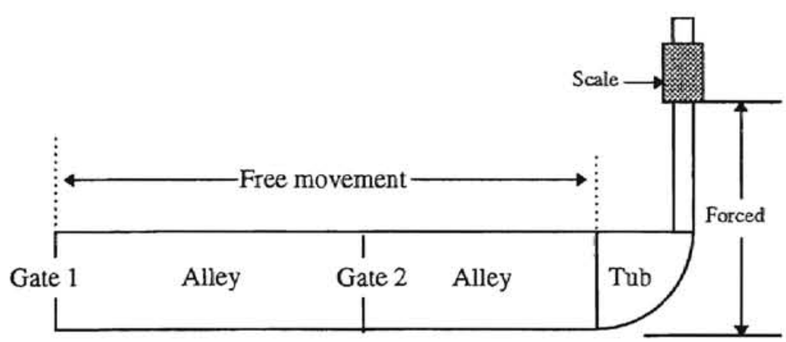

Figure 1: Crush pen depicting calf movement to the scale

They were forced to move by either using the pushing gate or crowding. Most calves moved freely to the scale. Each calf's position was recorded within its group. The calf that was leading was ranked number one and the last was ranked the last number in its group.

Time taken to weigh each calf and their dams was used as the measure of disposition. Time taken to weigh each cow was recorded to the nearest hundredth of a second using a timer. The timer was started once the cow entered the scale and its identity number was located on the recording sheet and was stopped once the scale stabilized and the weight could be read. Each cow's behavior on scale was also recorded. The scale reading for cows was taken by the same person throughout the experiment.

Time taken to weigh each calf was recorded as calves went through a weigh-suckle-weigh procedure. The timer was started as described above. This was done four times for each calf (before suckling and after suckling at 1145h and 1745h). Calves behavior on scale was also recorded. The manner in which calves entered the scale, be it forward or backward, was also recorded. The timer readings were taken by the same person. The weights were read by the same person (except in September at 1745h.

Statistical Analysis

Percentiles of each calf position within a group were calculated. Least squares procedures were used to determine whether the order in which calves entered the scale within groups was random or non random. The following general linear model was used:

$Y_{ijk} = \mu + A_i + B_k + E_{ijk}$

where Y_{ijk} = observed calf weighing position

μ=mean of calf weighing position

A_i = effect of ith calf on jth record

B_k = effect of kth calf disposition score (time to weigh) on jth record

E_{ijk} = random temporary environmental effect

The least significant difference (LSD) method was used for each month to identify leaders in each group. Percentiles were used to make up for unequal groups.

Least squares procedures were used to determine if calves time to weigh differed within the weighing period. This was done for data collected in May , July and September. The following general linear model was used:

$Y_{ijk} = \mu + A_i + C_k + E_{ijk}$ Where

Y_{ijk} =observed disposition measurement

μ = mean of disposition measurement

A_i =effect of calf on jth record

C_k = kth cycle effect on jth record

E_{ijk} =random temporary environmental effects

Least significant difference (LSD) was used to determine the differences of calves disposition means during the four times they went through the scale. This procedure was also used to determine mean differences of calf disposition at 1145h and 1745h. This was done to determine if calves learned the procedure every time they went through the scale.

Means of each calf disposition were calculated for each month. Least square analysis of variance was used to determine if there were differences in calf disposition between weighing periods during the month of May, July and September. This was done to compare differences of means at different ages in order to determine if calves were learning.

The following model was used:

$Y_{ijk} = \mu + A_i + M_k + E_{ijk}$ Where all others are the same as above,

M_k =kth age effect on jth record

Calf weighing time means and cow weighing time were used to calculate correlation between the two. This was done for each month to determine if there was a relationship between calf and dam disposition.

Estimation of Repeatability

Repeatability was derived from analysis of variance components as in Doolittle (1988). Within individuals component of variance ($\hat{\sigma}^2_A$) was estimated. This is the expected value of the mean square among measurements within individuals. The between individual components of variance ($\hat{\sigma}^2_B$) was estimated as follows: between sum of squares minus within sum of squares and then divide by number of records on each calf. Repeatability of order of movement for each month and each group was calculated using the following formula:

$$\hat{r} = \frac{\hat{\sigma}_B^2}{\hat{\sigma}_B^2 + \hat{\sigma}_A^2}$$

where $\hat{\sigma}_B^2$ = variance between individuals

$\hat{\sigma}_A^2$ = variance within individuals

Repeatability of disposition for measures taken within a weighing period was calculated from the same formula. The same method was used to calculate repeatability of disposition when measures were taken in different months.

Each calf month weighing time mean was taken as a measure recorded in May, July and September. Calf month weighing time mean was used to calculate correlation coefficient of calf and their dams disposition score for each month.

CHAPTER IV

RESULTS AND DISCUSSION

Calves Movement Order

It was found that the way calves were entering a weight scale was non-random. Similar results were reported from earlier studies (Mcphee et al., 1964; Fordyce et al., 1988). This was significant for all months May, July and September ($P<0.001$).

During the month of May two groups did not show significant order of entering the scale while three groups did ($P<0.05$). This could be due to the fact that some calves were still very young and most of their movement was mainly forced while others moved freely (Table 3). In July all groups had significant order of entering the scale see (Table 3). This could be attributed to the fact that calves at this stage were older and most of them moved voluntarily. During the month of September all groups order of weighing was significant ($P<0.05$). These results show that calves have leaders and followers within each group. Arave and Albright (1980) observed a similar relationship in dairy cattle. This relationship seemed to be more established as calves got older. The order of movement seemed not to be affected by whether or not calves were forced to the weighing area. This is illustrated in Table 3, in which groups 3, 4 and 5 in May showed significant order of movement though they were forced to the scale.

Results from LSD showed the actual position of calves in their established sequences. Some calves led throughout. Repeatability of order of movement for all months increased from May (r =0.158), July (r =0.26) to September (r =0.35). This indicated that as calves got older their movement order became more established. Repeatability of movement order for each group varied with levels of how significant the order was in each group (Table 3). There are no documented repeatability estimates for cattle movement order. Studies done in dairy cattle, sheep and goats only show that farm animals have specific movement order (Graig, 1981; Sherwin, 1990). Order of movement was found to be moderately repeatable. Repeatability varied with the age of the calf at the time the measurements were taken. Disposition score affected on calf weighing position only in May ($P<0.1$). This was also seen in the study done by Fordyce et al. (1988). This shows that disposition scores indicate calf response to humans, which influence order. Calf weight had no significant effect on observed weighing positions, which was also seen in other studies(Fordyce et al., 1988).

Table 3: Repeatability of Movement Order within each Group

Month	Group	Level of significance	Repeatability
May	1	0.1842	0.18
	2	0.1255	0.09
	3	0.0112	0.27
	4	0.0368	0.15
	5	0.0064	0.22
July	1	0.0240	0.17
	2	0.0308	0.17
	3	0.0025	0.34
	4	0.0001	0.49
	5	0.0252	0.17
September	1	0.0001	0.35
	2	0.0001	0.44
	3	0.0018	0.36
	4	0.0002	0.34
	5	0.0007	0.29

Calf disposition

Time taken to weigh calves differed significantly within weighing periods in all months ($P<0.001$). Some calves took less time to weigh than others. This showed that calf disposition differed during each weighing cycle. The repeatability estimate of weighing time within the period of May was 0.25, July 0.33 and September 0.40. This illustrates that calf disposition became more consistent as calves grew older. When repeatability was estimated from means of weighing time taken between months it was found to be 0.46. This compared well with the repeatability of 0.41 for disposition found by Erf et al., (1992) in dairy cattle, though a scoring method was used to measure disposition. This showed that disposition was moderately repeatable. Considering that temperament was the underlying factor of disposition it also compared well with repeatabilities estimated by Hearnshaw and Morris (1984) for temperament of beef cattle (Table 2). Their overall estimate was 0.43 which compares well with our study, though they used the scoring method to measure disposition .

Differences in weighing time when calves were weighed for the first, second , third and fourth were significant (Table 4). Weighing time was significantly longer when calves were weighed for the first time than the second, third or fourth($p<0.05$). Table 5 illustrates that measures taken at 1145h were longer than those taken at 1745h. This shows that calves were becoming accustomed to the procedure every time they went through the cycle of measurements, five hours later they were still familiar with the procedure. Measures taken in May and July showed no significant correlation between calves and dams disposition (Table 6). There was a positive correlation between calves and cows disposition from measures taken in September ($r=0.198$). Hearnshaw and

Morris (1984) found calf-cow correlation for temperament of 0.18 in studies done when calf temperament was scored at weaning. Calf disposition was found to be significantly affected by dam disposition ($p<0.05$). This indicated that the disposition of calves was influenced by their mothers. Calves were learning some experiences from their mothers that affected their disposition which was becoming more expressed as they got older. They learned more when they spent more time with their dams.

Table 4: Calf Disposition Means for each Cycle of Weighing(1/100th SEC)

CYCLE	MAY	JULY	SEPTEMBER
1	974.68*	767.02*	815.59*
2	630.11	429.35	464.03
3	679.23	400.47	413.08
4	579.10	301.37*	388.14

*significantly different at $p<0.05$

Table 5: Daytime Calf Disposition Means (1/100th SEC)

Daytime	May	July	September
1145h	802.39*	596.18*	601.86*
1745h	629.16	350.92	438.55

significantly different at $P<0.05$

Table 6: Disposition Correlation Coefficients between Calves and Cows

Month	N	r	level of significance
May	116	-0.10	0.2807ns
July	117	0.11	0.2237ns
September	117	0.20	0.0320*

CHAPTER V

CONCLUSION

Calves established order in their movements. There were leaders and followers within groups of calves. These orders were more distinct and repeatable as calves got older. Weighing order was moderately repeatable. More studies need to be done to check whether the leader-follower relationship has an effect on post-weaning calf performance.

Results from this study also indicated that calf disposition was moderately repeatable, thus culling decisions based on measures of disposition taken on calves are accurate. Calf weighing time within each weighing period was also moderately repeatable. Calves seemed to have been learning and their disposition improved whenever they went through the same procedure. Cows have some influence on their calves disposition. Maternal environmental effect of cows on their offspring need to be researched. Further studies need to be done to determine how much influence on calves disposition is due to environment and genetics

CHAPTER VI

SUMMARY

Two sets of data were collected to study whether calves had a specific order in which they enter the weighing scale and variation of calf disposition. In addition repeatability of calf weighing order and calf disposition was estimated. One hundred and seventeen calves born in the spring of 1996 and their dams were used. Measures were taken in May, July and September.

In the first part of the study, calves order of entering the scale within small groups was recorded. Percentiles of each calf position were calculated and order of weighing was evaluated. Calves order of entrance was significant, it became more distinct as they grew older. Repeatability of weighing order was found to be moderate. Repeatability will provide a measure of how stable this movement order will be over time. The ease with which they can be moved depends upon how much the manager understands their movements. Potentially difficult cattle handling situations can be transformed into orderly and efficient ones. The order of movement might also give indications that some individuals may have access to limited resources.

The second part of the study was to study calf disposition. Time taken to weigh each calf on a digital scale was used as a measure of calf disposition. As calves were being weighed in the weigh-suckle-weigh procedure time taken to weigh each calf was recorded in hundredth of a second. Time taken to weigh dams was also recorded. Least square method was used to determine differences in calf disposition, which was found to be significant. Disposition was found to decrease as calves were weighed several times. This decrease was significant within a day and also between months. This indicated that calves seemed to have been learning the weighing process. There was a positive correlation between calves and cows disposition. This indicated that cows have influence on their disposition. Repeatability of disposition was found to be moderate.

Moderate repeatability of behavior traits like disposition provide necessary information needed for culling decision for management traits. Calf learning ability should be used to make them more manageable.

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