Methods to Reducing Weaning Stress in Early Weaned Spring Beef Calves

Matthew Daniel Hahn
University of Arkansas, Fayetteville

Follow this and additional works at: https://scholarworks.uark.edu/etd

Part of the Animal Experimentation and Research Commons, Animal Studies Commons, and the Beef Science Commons

Citation

This Thesis is brought to you for free and open access by ScholarWorks@UARK. It has been accepted for inclusion in Graduate Theses and Dissertations by an authorized administrator of ScholarWorks@UARK. For more information, please contact scholar@uark.edu.
Methods to Reducing Weaning Stress in Early Weaned Spring Beef Calves

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Animal Science

by

Matthew Daniel Hahn
University of Arkansas
Bachelor of Science in Animal Science, 2019

May 2021
University of Arkansas

This thesis is approved for recommendation to the Graduate Council.

____________________________________
Charles R. Looney, Ph.D.
Thesis Director

____________________________________
Jeremy Powell, Ph.D.
Committee Member

____________________________________
Ken Coffey, Ph.D.
Committee Member
Abstract

Reducing weaning stress in beef calves can have dramatic benefits to the health, growth, and performance to beef calves post-weaning. Studies have shown that providing creep feed to calves during the pre-weaning period can improve their nutritional status, which can better prepare them for the stresses they will be exposed to during the weaning process. Studies have also shown that two-stage weaning can reduce the stresses associated with weaning. Previous research has suggested that this method resulted in dramatic changes in behavioral signs associated with stress. The objective of this study was to evaluate the effects of two-stage weaning with or without creep feed and creep feed without two-stage weaning on early-weaned spring-born beef calves. This study was done at the University of Arkansas SWREC in Hope, Arkansas, and consisted of 253 angus crossbreed cow-calf pairs in a spring-calving system over a two-year study (n = 140 in 2019; n = 113 in 2020). Following calving, all calves were randomly allocated to four different treatments in a 2 x 2 factorial arrangement. Treatment factors consisted of 1) nose flap vs no nose flap and 2) creep feed vs no creep feed. The four different treatment combinations were labeled as CON (control; no creep feed and no nose flap), NFC (nose flap with creep feed), NF (nose flap without creep feed), and CF (creep feed without nose flap). All measurements on performance were analyzed using the MIXED procedure of SAS. Significance was declared at $P \leq 0.05$ and tendencies at $0.05 < P \leq 0.10$. There were no interactions between nose flap and creep feed treatments on any calf measurements. Body weights of CF and NFC calves tended to have greater ($P = 0.06$) average BW one week prior to weaning compared to CON and NF calves. Calf BW at weaning were 16.4 kg, greater ($P < 0.01$) for CF and NFC calves compared to NF and CON calves. Both creep feed treatments averaged 20.1 kg greater ($P = 0.03$) average BW one month after weaning compared to NF and CON
calves. Calf ADG was affected by creep feed from initial BW to weaning BW with calves receiving creep feed tending to have greater \((P = 0.07)\) ADG compared to NF and CON calves. However, NF and NFC calves tended to have lower \((P = 0.08)\) ADG from initial BW to one-month post-weaning BW compared to CON and CF calves. There were no significant differences \((P = 0.49; P = 0.71)\) in creep feed consumption in weeks four and five between the CF and NFC treatments. Although not statistically significant \((P = 0.71)\), average creep feed consumption of pastures containing calves from the NFC treatment in week five was 18.60 kg. greater than the average consumption of calves in the CF treatment. In conclusion, these results suggest that creep feeding prior to weaning can improve calf BW pre- and post-weaning, and two-stage weaning without supplementation prior to weaning can have a negative impact on performance.
### Table of Contents

**Chapter 1: Literature Review**

- Introduction ........................................................................................................... 1
- Literature Review .................................................................................................. 3
  - Feed Efficiency and Performance ........................................................................ 3
  - Stress in Relation to Feed Efficiency and Performance ...................................... 4
- Reducing Stress Pre-weaning ................................................................................ 5
- Common Weaning Strategies .................................................................................. 7
  - Traditional Weaning ............................................................................................ 8
  - Fenceline Weaning ............................................................................................... 9
  - Two-Stage Weaning ............................................................................................ 10
  - Creep Feed ......................................................................................................... 11
- Timing of Weaning ................................................................................................. 13
  - Early Weaning ...................................................................................................... 13
- Weaning Effects on Cow Performance ................................................................... 16
  - Body Condition Score ........................................................................................ 16
  - Impact of BCS on Reproduction ........................................................................ 17
- Early Weaning Effects on Cow BCS and Performance ......................................... 20

**Conclusion** ........................................................................................................... 25

**Tables** .................................................................................................................. 26

**Chapter 2: Reducing Weaning Stress and The Effects on Calf Performance** ....... 28

- Abstract .................................................................................................................. 28
- Introduction .............................................................................................................. 30
- Materials and Methods ......................................................................................... 32
- Results .................................................................................................................... 36
- Discussion ................................................................................................................ 38

**Conclusion** ............................................................................................................. 43

**Tables and Figures** ............................................................................................... 44
List of Tables

Table 1.1. Cow body Condition Score .................................................................26

Table 1.2. Key Points for Condition Scoring Beef Cows ..................................................27

Table 2.1. Bodyweight (BW) and average daily gain (ADG) measurements of early-weaned spring beef calves implemented or not implemented with nose flaps and allowed or not allowed creep feed supplement prior to weaning .........................................................................................47

Table 2.2. Purina SteakMaker® Developer 15-2 B68 2019 pen average weekly consumption between the two creep feed treatments .................................................................................................48
List of Figures

Figure 2.1. Purina SteakMaker® Developer 15-2 B68 Sample Feed Tag……………………..44
Figure 2.2. Purina SteakMaker® 40-20 Sample Feed Tag………………………………..45
Figure 2.3. Purina SteakMaker® BP Formulator R1500 Sample Feed Tag………………….46
Chapter 1: Literature Review

Introduction

Weaning is one of the most stressful times for beef calves in their productive lifetime. Following weaning, calves are exposed to many stressors such as being removed from their dam, calf processing, transportation and exposure to foreign environments, exposure to new calves from other sources, etc. These stressors can have short and long-term effects on health and immunity, gain performance, and economic viability. Due to these compounded stressors, calves often exhibit decreased feed intake, increased vocalization and pacing, and immunosuppression, leaving calves susceptible to post-weaning disease (Sayre et al., 2019). With this, weaning stress plays a big role in the health and immunity of the calf during an important part of growth and production by compromising immune response. Suppressing immune response by weaning stress can greatly affect how well calves mount an immune response to vaccinations. By limiting as much stress in weaning as possible, we can increase overall performance and health of beef calves.

Weaning has many effects on the cow herd as well, and early weaning can be used as a strategy to alleviate many stressors and demands weaning of calves may place on the cow herd. Lactation represents the greatest nutrient demand for cows during production (Lardy and Dahlen, 2017). Weaning calves from their dam is a simple way to reduce the nutrient requirements for the cow herd. Calves at 3 to 4 months of age are already consuming significant amounts of forage, and lactating cows will consume more forage than dry cows. By early weaning calves, this can reduce the demand on forages and improve feed efficiency of the cow herd. Another benefit of early weaning to the cow herd is increasing breeding efficiency by maintaining and/or improving body condition score (BCS). This is especially important during times of drought,
forage shortage and/or poor condition of the herd (Riggs et al., 2011). The objective of this study was to evaluate the effects of two different methods of reducing weaning stress in early weaned spring beef calves from a spring-calving herd located at the University of Arkansas Southwest Research and Extension Center located in Hope, Arkansas.
Literature Review

Feed Efficiency and Performance

A goal for many animal scientists, and others in the beef cattle industry is finding ways to improve the performance and health of beef animals to help producers succeed. Feed costs represent one of the highest production costs for beef producers. Increasing feed efficiency can help producers by lowering input costs and improve beef cattle performance. However, it is important that producers have a better understanding of what feed efficiency is so these producers can improve overall performance. The following is a brief look of three common values that are evaluated for gain performance in ruminant nutrition.

Net feed efficiency, or residual feed intake (RFI), is a measure of feed efficiency and is defined as the difference between an animal's actual feed intake and its expected feed intake based on its size and growth (Arthur and Herd, 2008). For example, a stocker calf may be consuming less than expected based on its weight and growth, which is very similar to the other calves who are consuming more feed but have the same rate of gain. This is an example of an efficient animal because it is consuming less than the other animals to achieve the same rate of gain. Net feed efficiency, or residual feed intake, is independent of the level of production and the lower the value the more efficient the animal is.

Average daily gain (ADG) is considered a measurement of feed efficiency and is defined as a value that shows the weight gain of an animal per day. ADG can be obtained by dividing how much weight an animal has gained by the amount of time spent to accomplish this gain. As a general statement, all feedstuffs used in cattle diets contain some water with the exception of mineral supplements, and all of the components other than water are termed “dry matter” (Simms, 2013). This is important because animal requirements are stated on a dry matter basis.
because the moisture content in feedstuffs are variable. Dry matter intake (DMI) is the amount of feed a beef animal consumes per day on a moisture-free basis. In order to determine an accurate estimate of the nutrient intake and to compare feeds, an animal’s diet must be analyzed on a moisture-free, or dry matter basis.

Although many other terms and measurements are used in regards to cattle feed and gain, residual feed intake, dry matter intake and average daily gain are common measurements for evaluating gain performance and feed efficiency in many animal science studies. With a better understanding of these measurements, producers and others alike in the beef industry can begin to see what factors affect animal performance and use this knowledge to improve overall performance in beef cattle operations.

*Stress in Relation to Feed Efficiency and Performance*

There are many factors that affect feed efficiency including inadequate ration balance, low diet digestibility, inconsistent feed practices, improper bunk management, etc. However, one factor that stands out and can have quite a negative impact on feed efficiency is stress, especially during weaning for beef calves. The weaning process is widely recognized to be one of the most stressful stages within the beef system. Prolonged periods of stress can negatively impact overall health, average daily gains and feed efficiency in beef cattle, especially after transportation or during periods of extreme cold or heat. These losses in gain efficiency can eventually lead to losses in overall profitability. With the knowledge that stress negatively impacts animal health and performance, producers should start focusing on producing resilient calves that can handle the stress of weaning. By minimizing as much stress as possible for cows and calves, producers can improve feed efficiency and health which can improve overall performance. Initiating this
process prior to weaning can prove crucial to the management and profitability of many beef cattle operations.

**Reducing Stress Pre-Weaning**

Pre-weaning management is very important to ensure that calves have the ability to perform and function when exposed to the stressors that are associated with weaning (Riggs et al., 2011). A calf’s nutritional status is very important prior to weaning because that can determine how well that calf will respond to vaccinations, as well being exposed to the other stressors that come from the weaning process. Pre-weaning diets (creep feed) can be essential in this process to not only improve the calf’s nutritional status, but also prepare it for weaning. Milk is rich in energy, protein, vitamins, and minerals, and needs to be replaced with high quality forage and possibly supplement to maintain pre-weaning nutrient intake (Jenkins et al., 2011). Strengthening calves’ pre- and post-weaning diet with essential nutrients such as vitamins and minerals can provide improved immune function, as well as reduce the incidence of post-weaning sickness. Ad libitum access to fresh water is also essential for calves pre-weaning, at weaning and post-weaning. Likewise, unlimited access to fresh water is essential during all stages of cattle production.

Calf processing prior to weaning can also reduce the amount of stressors calves are exposed to during the weaning process. This would include castration, dehorning, ear tag and/or other forms of identification, and vaccinations. Four types of stress commonly affect calves at weaning: 1) physical, 2) environmental, 3) nutritional, and 4) social (Gerrish et al., 1998). Castration and dehorning would coincide with physical stressors if done during weaning. Gerrish et al. (1998) describes environmental stress as being either man-made or climatic. That could mean the weaning pen itself that is barren or muddy, or climatic which could mean bad weather
on the day of weaning. Gerrish et al. (1998) explains that although many environmental stressors are beyond our control, timing of weaning is essential when considering these factors. Social stress is described as the stress of removal of the calf from the dam and its herdmates, which is inevitable by the definition of weaning. All these stressors combined during weaning can very much weaken the immune system of calves and make disease more likely post-weaning. “One goal of our management should be to reduce stress to ensure healthy, productive calves moving on to the next stage of beef production” (Gerrish et al., 1998).

Riggs et al. (2011) suggests that all calves should be castrated, dehorned and branded prior to weaning to alleviate as much physical stress as possible associated with the weaning process. Two experiments by Lents et al. (2006) were conducted to evaluate the effects of timing of castration on bull calves implanted with Zeranol. In Exp. 1, 2–3-month-old bull calves were implanted with zeranol and either left intact until weaning or castrated. In Exp. 2, bull calves were assigned at birth to 1 of 3 treatments; castrated, castrated and implanted, or left intact until four weeks before weaning (all calves were implanted four weeks before weaning). In Exp. 1, Lents et al. (2006) found that the ADG of implanted bulls castrated at weaning was less ($P < 0.05$) during the 50-day post-weaning period compared to bulls castrated and implanted at 2-3 months of age. In Exp. 2, weaning body weights of bulls castrated four weeks prior to weaning was reduced ($P < 0.01$) compared with bulls castrated at birth. It was concluded that intact bulls did not have an advantage in pre-weaning growth compared with bulls castrated and implanted at less than 3 months of age, and castrating bulls at greater than 6 months of age decreased BW gains during the next 30 d prior to weaning (Lents et al., 2006). Along with Riggs et al. (2011), the Canadian Beef Codes of Practice (National Farm Animal Care Council, 2013) also recommend that castration be performed in bull calves as early as possible to minimize distress.
Riggs et al. (2011) also explains that immune responses to vaccination are not immediate; therefore, it is suggested that ranchers vaccinate calves 2-3 weeks prior to weaning in order for the calf to be immunologically prepared for the stress of the weaning process. Lippolis et al. (2016) performed an experiment that compared three vaccination schemes against bovine respiratory disease for feeder cattle: 1) vaccination at weaning (d-0) and a booster at feedlot entry (d-30; CON), 2) vaccination 15 days before weaning (d-15) and a booster 15 days before feedlot entry (d-15; EARLY), and 3) vaccination 15 days after weaning (d-15) and a booster 15 days after feedlot entry (d-45; DELAYED). The results from this study showed that the EARLY calves had less ($P < 0.09$) ADG before weaning but had greater ($P < 0.01$) ADG during feedlot receiving compared with calves from the other treatments. EARLY calves also had greater plasma concentration of antibodies against the evaluated pathogens at weaning ($P < 0.05$) and collectively at feedlot entry ($P < 0.04$) compared to the other treatments. It was concluded that providing the initial and booster vaccinations prior to feedlot entry can be a valid strategy to improve cattle health and performance during feedlot receiving (Lippolis et al., 2016).

Every cow-calf operation may be different, and timing of calf processing can vary anywhere from the day of birth, all the way to post-weaning. By processing calves during the pre-weaning process, producers can reduce the amount of stressors calves are exposed to during the time of weaning and improve performance post-weaning.

**Common Weaning Strategies**

There are many different weaning strategies and/or combinations that producers utilize for their operations. Separating calves from their dams causes behavioral changes and stress which include vocalization, walking fences, and reduced intake, all of which can result in reduced performance and health concerns (Jenkins et al., 2011). Certain weaning strategies can
help minimize the stress before, during and after weaning to ensure the health and well-being of both the calf and cow. Producers should choose the separation method that works best for their operation while taking precautions to maintain performance and reduce illness (Jenkins et al., 2011). There are three main types of weaning: total separation, or traditional weaning; fenceline weaning; and two-stage weaning. Although two-stage weaning is a more recent method of weaning beef calves, all three methods are commonly utilized by cattle producers in the United States.

*Traditional Weaning*

Total separation, or traditional weaning, is a method used by many cow-calf operations that is defined as the complete separation of the calf from its dam in an abrupt time. This is done by moving the calf and dam to two separate areas with no contact. Calves can either be removed from the ranch, placed in dry lots, or allowed onto a small pasture. Cows are removed from the immediate area to ensure no contact is made. Riggs et al. (2011) says that a benefit from this method is that traditional weaning can allow the rancher to immediately sell the calf straight off the mother. However, Riggs et al. (2011) also explains that this is a very high stress method to the calves because it does not allow them an adaptation period prior to weaning. Calves are immediately exposed to the stressors of weaning without any preparation. Behavioral responses to this event are predictable and remain detectable for several days after separation (Haley et al., 2005). Cows and calves vocalize repeatedly and spend more time walking, while spending less time eating and resting (Veissier et al., 1989). Haley et al. (2005) expresses these deviations from normal behavior provide evidence that the traditional method of weaning by separation has a negative effect on the well-being of beef cattle.
**Fenceline Weaning**

Fenceline weaning is a weaning method where calves are removed from their dams and placed on opposite sides of a fence. This prevents calves from suckling without separating the pairs completely to allow them to have some form of contact. Providing fence-line contact for cows and calves by separating them into adjacent pens or pastures, where they can see and hear one another, decreases vocalizing and time spent walking, increases time spent eating, and increases ADG (Price et al., 2003). When implementing the fenceline weaning method, Jenkins et al. (2011) encourages producers to make sure the fence being used to separate the pairs is adequate to keep them contained in their separate pastures, and long enough to allow all the pairs to spread out and maintain relatively close physical proximity. Calves are then removed to a new pasture or feedlot after 5 to 7 days. Fenceline weaning is best accomplished by removing cows from the pasture that the pairs were occupying, rather than moving the calves to a new pasture (Jenkins et al., 2011). Jenkins et al. (2011) says that this step in fenceline weaning helps because the calves are accustomed to the watering location and feeding facilities of the pasture, rather than the calves having to acclimate to a new pasture while also being separated from their dam.

Fenceline weaning is a common weaning method for many cattle producers, and studies have shown this weaning strategy can help reduce the stress of weaning by improving ADG and reducing behavioral patterns associated with weaning stress during the post-weaning period compared to traditional weaning. In a study examining the effects fenceline weaning had on calf behavior and performance, Price et al. (2003) found that fenceline weaned calves and control non-weaned calves spent more time eating (grazing or eating hay) in the days following weaning than the other treatments ($P < 0.05$), and total separation calves spent more time pacing than the other treatments ($P < 0.05$). Price et al. (2003) also found that post-weaning cumulative body
weight gains for fenceline weaning calves were greater than gains from the total separation treatments at 2 weeks post-weaning, and at 10 weeks post-weaning ($P < 0.05$). It was concluded that providing fenceline contact between beef calves and cows for 7 days following weaning reduces behavioral indices of distress seen in the totally separated calves and minimizes losses in weight gain in the days following separation (Price et al., 2003). Boland et al. (2008) found similar results when comparing fenceline weaning to nose flap and traditional weaning, with higher ADG than the other two groups ($P < 0.05$). These studies, and many others included, suggest that fenceline weaning is an alternative method to traditional weaning.

Two-Stage Weaning

Two-stage weaning is a more recently developed method of weaning that includes two stages and begins in the pre-weaning process: (stage 1) calves are implemented with a plastic anti-nursing devise (sometimes referred to as a “nose flap” or “weaner”) roughly a week before weaning and returned to their dams; (stage 2) the nose flaps are removed from the calves and the pairs are permanently separated. Depending on the type and manufacturer of the nose flaps, the plastic nose pieces can remain on calves anywhere from 4 to 14 days prior to weaning (Riggs et al., 2011). These nose flaps prevent the calf from being able to nurse but allow them to remain with their dam for an adaptation period prior to weaning. This method of two-stage weaning may decrease behavioral disruption to calves more than providing fenceline contact (Haley et al., 2001).

Haley et al. (2005) reported that two-stage calves vocalized 96.6% less ($P = 0.001$) and spent 78.9% less time walking ($P = 0.001$), 23.0% more time eating ($P = 0.001$), and 24.1% more time resting ($P = 0.001$) than control calves. Haley et al. (2005) also reported ADG was greater ($P < 0.001$) 7 days following separation, as well as growth rates ($P < 0.05$) 7 weeks after
separation. Although studies comparing two-stage weaning to other methods have produced results favoring the two-stage method, there are other studies that had many different results. Both Haley et al. (2005) and Freeman et al. (2016) found lower ADG during the nursing deprived week. Freeman et al. (2016) observed lower ADG 42 days post-weaning of the two-stage calves compared to control and late weaning calves. Nutritional management of two-stage weaned calves during the nursing-deprived period should be evaluated in future research because poor pasture conditions may have decreased gains by calves weaned by the two-stage method in this study (Haley et al., 2005).

Sayre et al. (2019) conducted a study that compared the use of nose flaps, with (NFC) or without (NF) short term creep feed, and traditional weaning with (TRADC) or without (TRAD) creep feed. In this study, Sayre et al. (2019) observed NFC calves had greater ($P \leq 0.0001$) ADG than NF and TRAD calves and tended to have greater ($P \leq 0.10$) ADG compared with TRADC calves during the 7-day period that nose flaps were placed. Both creep feed treatments tended to have greater body weight ($P < 0.07$) at weaning than the non-creep feed treatments. This may suggest that the use of high quality forages and/or supplements in combination with nose flaps could result in improved calf performance and better reduce stress compared to fenceline weaning and traditional weaning.

**Creep Feed**

As discussed earlier in the pre-weaning process, calves’ nutritional status is very important in relation to how well the calves will perform when exposed to the stressors of weaning. By providing calves high quality forages and/or supplements before weaning, producers can prevent post-weaning sickness, pre-condition calves to bunk feed and improve calf performance post-weaning (Jenkins et al., 2011) and (Riggs et al., 2011). Studies have shown
that the use of creep feeds during pre-weaning can improve the nutritional status of calves prior to weaning and can be used in combination with the common weaning methods used by cattle producers. Providing short-term creep feed prior to placing nose flaps can improve preweaning calf and cow performance compared with traditional and nose flap weaning without creep feed supplementation (Sayre et al., 2019).

A study by Moriel et al. (2013) was conducted to observe the effects of pre-weaning limit-fed creep feed (LFC) with (MIN+) or without (MIN-) trace mineral fortification on trace mineral status and pre- and post-weaning performance of beef calves. At weaning, 2 groups of heifers/treatment in Exp. 1 and 2 were randomly selected to be transported (Exp. 1) or to receive an intramuscular injection of porcine red blood cells (PRBC; Exp. 2), each immediately preceding a 28-day feedlot receiving evaluation. The researchers observed LFC calves having increased weaning body weights ($P = 0.05$) compared to the control, non-supplemented calves in Exp. 1 but not in Exp. 2. Moriel et al. (2013) also reported that trace mineral fortification of creep feed decreased DMI of LFC ($P < 0.001$ and 0.11 in Exp. 1 and 2), and LFC calves had greater ($P = 0.040$) DMI during the first week postweaning, which was the result of greater ($P = 0.040$) voluntary DMI of concentrate, compared with non-supplemented calves. In addition, MIN+ increased ($P \leq 0.04$) liver concentrations of Co, Cu, and Se compared with MIN– calves in Exp. 2 but not Exp. 1. Limit-fed creep-feed supplements increased calf weaning BW in Exp. 1, enhanced trace mineral status of weaned calves when supplements were fortified with trace minerals (Exp. 2) and increased voluntary DMI during the first week of the feedlot receiving period (Exp. 2). These results suggest that the use of creep feed can better prepare beef calves for weaning and post-weaning by improving their nutritional status during the pre-weaning period.
**Timing of Weaning**

One of the main goals for any cow-calf operation is for each cow to produce a calf each year. The cows in the herd may go through a lot of stress to accomplish this goal but weaning the calves can instantly lower many of these stresses on the cow. Therefore, the objective of weaning beef calves is to permit the cows to calve every year by allowing them to regain condition after weaning to prepare them for the next calving season. The typical age of weaning for beef calves in most production systems is 6 to 8 months of age (Pate et al., 1998). However, this can depend on many factors including feed availability, condition and age of dam, type of production and environmental factors such as drought. Forage intake of calves increases as lactation decreases, resulting in a higher demand in forage availability for the cow-calf pairs. Total feed costs can account for as much as 70% of the annual costs to keep a cow, so management opportunities that decrease cow DMI and optimize productivity will be important to the sustainability of cow-calf production systems (Arlington and Minton, 2004). Although weaning at 6 to 8 months of age can prove to be successful and is the most common weaning age for most beef cattle operations, weaning at an earlier age can prove to have benefits as well.

**Early Weaning**

Weaning calves earlier than the conventional 6-8 months can prove to be a very useful alternative in situations of drought, poor cow herd condition and/or low feed availability. Lactation roughly doubles the daily energy and protein requirement for a typical beef cow (Lardy, 2017). By weaning early, the cow's nutrient requirements for lactation are eliminated and cows are able to maintain or increase body condition prior to the fall and winter-feeding period. Studies have reported other advantages to early weaning such as similar calf performance compared with normal timed weaning, increased pregnancy rates and improved forage
availability for the cow (Lardy and Dahlen, 2017). Early calf weaning is a management option usually promoted in unique situations related to severe shortages in available forage, such as drought; however, early weaning may also improve the efficiency of calf growth, as well as cow performance (Arlington and Minton, 2004).

Studies have shown that feed:gain ratios of early weaned beef calves are highly efficient. Peterson et al. (1987) conducted an experiment to evaluate the effects of two different calf weaning ages (110 days or 222 days) on cow and calf performance, and to determine the economic differences between cows that weaned calves at two calf ages. Cows with early weaned calves gained 2.5 ± 3.3 kg, while cows with normal-weaned calves lost 18.2 ± 2.9 kg between early and normal weaning ($P < 0.01$). Early weaned calves were 25.2 ± 4.4 kg heavier at normal weaning and gained 29.0 ± 3.0 kg more from early to normal weaning than normal weaned calves. Compared with normal weaned calves, Peterson et al. (1987) reported that early weaned calves had lower ($P = 0.05$) BCS at early weaning, had greater improvement ($P < 0.05$) in BCS from early to normal weaning, but similar body condition ($P = 0.30$) at normal weaning. Peterson et al. (1987) also reported that cows with early weaned calves consumed 45.3% less ($P = 0.13$) hay, on total digestible nutrients basis, than cows with normal weaned calves, and early weaned cow-calf pairs consumed 20.4% ($P = 0.36$) less total digestible nutrients than normal weaned cow-calf pairs. Peterson et al. (1987) concluded that the early-weaned cow-calf pairs were 43.0% more ($P = 0.01$) efficient in converting total digestible nutrients into calf gain than were normal-weaned cow-calf pairs.

Depending on season and management style, studies conducted evaluating the effects of early weaning on calf performance are variable. Performance of early-weaned calves compared to pasture reared calves will depend on the growth potential of the calves, the level of milk
production of the dams and the level of management (Lalman, 2017). However, most studies on early weaning beef calves have reported either similar or improved body weights of early weaned calves compared with traditional timed weaning calves during the post-weaning phase. The overall objective to early weaning is to remove the calf earlier to allow the dam to improve condition which in turn can lead to improved reproduction, while maintaining calf gains similar to traditional timed weaning.

Blanco et al. (2009) conducted an experiment in Spain that assessed the effects of age at weaning (early weaning at 90 days or traditional weaning at 150 days) and breed (Parda de Montaña or Pirenaica) on calf performance and carcass and meat quality in autumn-calving beef cattle. Blanco et al. (2009) found no significant interaction between age at weaning and breed for any of the parameters studied. From early weaning (90 days) to traditional weaning (150 days), early weaned calves had greater ADG ($P = 0.001$) than traditionally weaned calves. During the finishing phase, performance, daily feed intake, and efficiency did not differ between treatments. Early weaning did not affect age at slaughter, carcass weight, fatness score, fat color, and meat quality, but improved carcass conformation ($P = 0.04$). Blanco et al. (2009) also reported that early weaned calves had greater total DMI ($P = 0.002$) with greater accompanying feed costs ($P = 0.001$) and yielded a slightly greater income than traditionally weaned calves; therefore, economic margins did not differ. It was concluded from this experiment that in both breeds weaning strategies had similar effects on performance and carcass and meat quality (Blanco et al., 2009).

Another early weaning experiment from Warner et al. (2015) was conducted to evaluate the effect of calf weaning age on cow-calf performance and feed utilization. Over 2 years, 156 cows with summer-born calves were randomly assigned to 1 of 4 treatments. The experiment
was a randomized complete block design with a $2 \times 2$ factorial arrangement of treatments. Factors were (1) location; Agricultural Research and Development Center (ARDC) or Panhandle Research and Extension Center (PHREC); and (2) calf weaning age; early weaned (EW) at 91 ± 18 days of age or conventionally weaned (CW) at 203 ± 16 days of age. All cows and calves were fed a common diet from early to conventional weaning time within each year and location. Cows with weaned calves were limit fed (6.9 kg of DM/cow daily), and EW calves were offered ad libitum access to feed (4.0 kg of DM/calf per day). Nursing pairs were fed an equivalent amount of DM per day. Warner et al. (2015) reported that initial cow body weight and BCS were similar ($P \geq 0.26$), but body weight change from early to conventional weaning was 17 kg greater ($P \leq 0.01$) for EW cows. Cow BCS and conception rates were not affected ($P \geq 0.38$) by weaning. Calf body weight at conventional weaning was greater ($P \geq 0.05$) for CW than EW at ARDC location but greater ($P \geq 0.05$) for EW than CW calves at PHREC location. Calf ADG per unit of total feed energy intake was greater ($P \geq 0.05$) for nursing pairs at ARDC location but not different between EW and CW at PHREC location. These results indicated that early weaning may have minimal effect on reducing feed energy requirements (Warner et al., 2015). The results from these experiments suggest that early weaning beef calves can have minimal, if any, negative effects on calf performance and can produce similar gain performance compared with traditional timed weaning.

**Weaning Effects on Cow Performance**

**Body Condition Score**

For many producers in the beef industry, it is difficult to determine with certainty how much of a feed source grazing cattle are actually consuming and the nutrient content of that feed source. This in turn makes it difficult to determine whether or not the diet is meeting their
nutritional requirements. Observing the body condition of each cow can be an essential tool for producers to evaluate the effectiveness of the herd’s nutritional regimen. This system of judging body condition is not a recent concept and has been used for many years. This system is known as the Nine Point Beef Cattle Body Condition Scoring System, or BCS.

Body Condition Scores (BCS) can be defined as numbers used to estimate energy reserves on the body of a cow in the form of fat and muscle (Eversole et al., 2009) and is based on a nine-point system. For example, a condition score of 1 indicates that the cow is emaciated, with the bone structure of the shoulders, ribs, spine, hooks and pins of the cow are sharp to the touch and easily visible with little evidence of fat deposits or muscling. A BCS of 9 describes the cow as being extremely fat, with the bone structure not seen or easily felt, the tail head is buried in fat, and the animal’s mobility can be impaired by this amount of fat. A complete description of the nine-point BCS system can be found in Table 1.1. (Table 1.1. Cow Body Condition Score) and a slightly altered table describing key physical signs in scoring body condition in Table 1.2. (Table 1.2. Key Points for Condition Scoring Beef Cows).

Impact of BCS on Reproduction

Cow body condition can be a major influence on reproduction. The relationship between cow body condition and reproduction has been known for many years (Simms, 2013). Rae et al. (1993) conducted a study to observe the relationship of cow parity and body condition score to pregnancy rate (PR) in 8 Florida beef cattle herds. Rae et al. (1993) found significant associations between pregnancy rate, parity, BCS and herd ($P < 0.001$); and between the variable interactions, parity with BCS, herd with BCS, and herd with parity ($P < 0.001$). Cows with a BCS ≤ 4 had a pregnancy rate of 59%; those with a BCS ≥ 5 had a pregnancy rate of 90%. Cows having a parity of < 4 had a PR of 80%, while cows having a parity ≥ 4 had a PR of 85%. It was
concluded that body condition, parity, and the interaction of body condition and parity play important roles in the reproductive performance of beef cows (Rae et al., 1993).

On average, most beef cows in the industry score within the range of 3 to 7, with the optimal body condition being a BCS of 5 to 6 (Eversole et al., 2009). Amundson (2020) says that the ideal body condition score for a cow prior to calving is a BCS of 5 to 6, and first-calf heifers should have a BCS of no less than 6 due to the stresses of calving, lactating for the first time, and because heifers are still growing animals. Heifers and young cows can be the most troublesome females to maintain body condition during lactation (Arthington and Minton, 2004). Studies have shown it is crucial that first-calf heifers meet their nutritional requirements, and monitored/judged by body condition prior to calving, because calving for the first time can take a tremendous toll on them and affect future reproductive performance.

An experiment by DeRouen et al. (1994) was performed to evaluate changes in prepartum BCS and body weight of first-calf heifers when fed varying energy levels, and to determine the influences of prepartum BCS and body weight changes and BCS at calving on postpartum traits. All heifers were allocated to one of three diet energy levels; low, recommended, or high energy levels based on TDN requirements from approximately 90 days prepartum to parturition. After calving, cows were placed on annual ryegrass pasture and managed similarly at each location. DeRouen et al. (1994) reported weight and BCS at calving were greater ($P < 0.05$) for females with higher BCS at 90 days prepartum (IBCS) and for those assigned to higher energy levels. Calving and calf growth traits were not affected ($P > 0.05$) by IBCS, energy level, prepartum changes in BCS and body weight, or BCS at calving. Prepartum changes in BCS and body weight regulated by varying energy levels had no effect ($P > 0.05$) on postpartum reproduction; however, BCS at calving influenced ($P < 0.03$) pregnancy rate and
days to pregnancy. Cows with BCS 6 and 7 at calving had higher ($P < 0.05$) pregnancy rates (87.0 and 90.7%) than those with BCS 4 and 5 (64.9 and 71.4%). Interval to pregnancy for cows with BCS 4 at calving was 10 to 18 days longer ($P < 0.05$) than for those with BCS $\geq 5$.

DeRouen et al. (1994) concluded that the results from this experiment indicate that body condition of primiparous cows at calving can be a reliable indicator of subsequent reproductive performance regardless of prepartum BCS and body weight changes.

Simms (2013) describes a similar recommendation to Eversole et al. (2009) and Amundson (2020) and says that cows should calve with a BCS of at least 5. However, Simms (2013) also states that if the goal is to maximize profitability, the optimal score may be lower. The two major considerations in establishing the optimal body condition score are the time of calving relative to the availability of green grass and the cost of providing supplemental feed. If cows have access to high-quality forage before the start of breeding, they can be in a lower BCS than will be required without access to plentiful green pasture. For example, the optimal BCS may be a 4 at calving for cows that calve 30 days prior to availability of green forage, and a 5 for cows that calves 60 days prior to availability of green forage (Simms, 2013).

Eversole et al. (2009) suggests that cow BCS should be evaluated and recorded at weaning, 60 to 90 days prior to calving, and at calving. It is very beneficial to evaluate BCS during these times because it provides a system for producers to help guide management decisions. For example, if cows are very thin at weaning, that may mean the feed sources are not meeting the nutrient requirements during the lactation period, and the producer must establish the nutritional requirements from weaning to calving to reach an acceptable score at calving. Simms (2013) suggests also assessing body condition scores at breeding to observe the relationship between BCS and reproduction for a specific production system. Evaluating BCS 60 to 90 days
prior to calving allows the producer to still have time to improve the herd body condition prior to calving. Cows that are thin at calving shows that their feeding program from mid- to late-gestation needs to be altered. This is a key time to score body condition because it allows a producer to change body condition prior to breeding season. However, changing body condition from calving to breeding can be difficult because the cows are lactating and using the additional nutrients to produce milk rather than improving body condition. This strengthens the importance of having cows in good body condition prior to calving (Eversole et al., 2009; Simms, 2013; Walker et al., 2020).

*Early Weaning Effects on Cow BCS and Performance*

As discussed in previous sections of this literature review, the nutrient demands of lactation on the cow directly affect their body condition and can negatively impact their performance if the cow’s nutrient requirements are not being met. Weaning calves from the dam eliminates the nutrients required for milk production, thus allowing nutrients from feed sources to be available for maintenance, body condition gain, and reproduction. Early weaning calves from their dam removes the nutrient demand of lactation at an earlier date than conventional timed weaning, which in turn permits the cows more time from weaning to the next calving season to either maintain or improve body condition. This can be of greater importance for mature cows and/or heifers bred for higher milk production. With a greater milk output comes increased nutrients demands, therefore making it more difficult to keep females in adequate body condition with possible impacts on reproduction to follow. Dams of early weaned calves should be in better condition at calving and cycle earlier during the next breeding season (Rasby and McGee, 2011).
Considering calf age at early weaning and its effects on reproduction, many researchers suggest early weaning calves prior to or during the breeding season to observe the best results on cow reproductive performance. Rasby and McGee (2011) indicated that calves weaned prior to breeding at 45 to 90 days of age is the required calf age to encourage the cows to cycle and rebreed, and 3 to 5 months of age is too late and therefore does not contribute to the improvement of reproduction. Rasby and McGee (2011) also explain that weaning this early, 45 days, should only be used as a “last resort” when cows are too thin prior to the start of the breeding season.

Lardy and Dahlen (2017) have similar beliefs and state that in order to improve pregnancy rates, calves should be weaned prior to or during the breeding season (at 45 to 105 days of age), and later than this is too late to cause early cycling. Weaning at 3 to 5 months of age is a management strategy to provide the dam with more available nutrients when forages are scarce (Rasby and McGee, 2011). Whether calves are early weaned at 45 days of age or 5 months, this will still benefit the dam by removing the nutrient demand of milk production and additional nutrients can be used for improved body condition and can have a positive impact on overall performance.

In a study reviewed previously by Peterson et al. (1987) that evaluated differences in cow-calf performance and economic considerations of early weaning, it was reported that cows with early weaned calves gained 2.5 ± 3.3 kg, while cows with normal weaned calves lost 18.2 ± 2.9 kg between early and normal weaning ($P < 0.01$). In another experiment by Story et al. (2000), they used spring-calving cows over a 5-year period to observe the effects of calf age at weaning on cow and calf performance and production economics at three different weaning ages; early (150 days, EW), traditional (210 days, NW), and late (270 days, LW). Cow BCS and body weights at the last weaning date were different ($P < 0.05$) for all three management groups. Story
et al. (2000) reported the EW cows having the highest average BCS and body weights (5.8, 583kg) at the last weaning date compared to NW cows (5.5, 560kg) and LW cows (5.2, 541kg). Pregnancy rates among all three groups were similar, and annual cow costs were greater (P < 0.10) for the LW ($443.45) than for the EW ($410.09) and NW ($421.35) groups. From the results of this experiment, Story et al. (2000) concluded that the age of the calf at weaning can in fact affect cow BCS and body weight, but no significant affects were found on pregnancy rates and net income.

A similar study was conducted by Merrill et al. (2008) to determine the influence of early and traditional weaning on cow performance, grazing behavior, and winter feed costs over a 2-year period. Each year, 156 cow-calf pairs were used and stratified by calf sex, BCS, and age and assigned randomly to 1 of 2 treatments: early weaning (EW, 130 days of age), and traditional weaning (TW, 205 days of age). After the traditional weaning date, EW and TW cows were separated and allotted to 1 of 6 pastures based on previous blocking criteria for winter feeding and were fed to attain a similar BCS by 1 month prior to parturition. TW cows lost 0.8 BCS and 40 kg body weight whereas the EW cows gained 0.1 BCS and 8 kg body weight from early to traditional weaning (P < 0.01). After winter feeding, there was no difference between EW and TW cow BCS (P = 0.52). Winter feed costs were $29 greater (P < 0.01) per cow for TW compared with EW. Merrill et al. (2008) reported that the results indicated early weaning improved cow BCS entering the winter-feeding period, thereby decreasing winter feed costs.

The results from these three studies show that not only can early weaning have a positive impact on cow body condition, but also improve feed:gain ratio of cows after early weaning by reducing the amount of nutrient intake required for body weight gain. As discussed in previous sections, these effects from early weaning may be most beneficial to young cows and/or heifers.
who are the most troublesome females to maintain body condition during lactation (Arthington and Minton, 2004).

The study conducted by Arthington and Minton (2004) investigated the effects of early weaning on productivity of primiparous Brahman crossbred cows. Following calving, 12 primiparous cows were randomly allotted to be early weaning (EW, day 0, 93 days of age) or were left with their calves to be normal weaned (NW). All cows were maintained in separate, individual pens: NW cows with their calves, and EW cows without their calves. Following early weaning, all cows were provided free choice access to hay and supplemental concentrate at an amount required to support a targeted ADG of 0.57 kg/d. Individual cow body weight and BCS were measured on days 0, 21, 42, and 70. Postpartum interval was calculated by the determination of plasma progesterone concentrations. The NW cows had a lesser ADG (0.51 vs 0.66 kg/d; SEM = 0.02), but body weight differed ($P < 0.05$) only on day 21 (382 vs 322 kg for EW and NW cows, respectively). Cow BCS increased similarly for cows on both treatments and did not differ throughout the study. Throughout the study, NW cows and their calves consumed 59% more ($P < 0.001$) TDN than did EW cows. Although body weight was similar at the end of the study, more ($P = 0.08$) EW cows were cycling than NW cows (EW: 5 of 6 cows cycling; NW: 2 of 6 cows cycling). Compared with NW cows, the initiation of postpartum estrus occurred 8 weeks earlier ($P < 0.005$) in EW cows. By 2 weeks following early weaning, 5 of 6 EW cows were cyclic. It was concluded that early weaning thin, primiparous cows results in a substantial reduction in the amount of TDN required to support cow body weight gain, and early weaning can also be effective in initiating postpartum estrus in these cows (Arthington and Minton, 2004).
It is well known that weaning calves from their dams will eliminate the nutrient requirements for lactation and place significantly less stress for maintenance on the dam. Prior to weaning, changing cow body condition can be difficult since cows will use additional nutrients to produce more milk rather than improving body condition; the biological priority for nutrients at work (Simms, 2013). The results from these studies show that weaning calves at an earlier age increases the amount of time between weaning and next calving, allowing the cows to maintain and/or improve body condition much more efficiently, and may improve reproductive performance. By having cows in good body condition throughout production, producers place less stress and overall demand on the cows by enabling them to continue and grow healthy beef calves.
Conclusion

The weaning process is widely recognized to be one of the most stressful stages within the beef system (Roberts, 2020). Following weaning, beef calves are exposed to many stressors that can have short and long term effects on overall health and immunity. Cow-calf producers can reduce the amount of stress associated with weaning on beef calves by taking action prior to weaning. This can include preconditioning diets to improve the calves’ nutritional status prior to weaning, calf processing before weaning to reduce physical stress during weaning and administering vaccinations prior to weaning in order for the calf to be immunologically prepared for the stress of the weaning process. During weaning, producers can also help mitigate stress by using weaning strategies such as fenceline weaning, two-stage weaning, and/or the combination of creep feed with these strategies. By limiting as much stress in weaning as possible, we can increase overall performance and health of beef calves which can minimize production costs for beef producers.

Weaning can also have major impacts on the cow herd as well, and the timing of weaning can be crucial to maintaining a healthy cow herd. Lactation represents the greatest nutrient demand for cows during production (Lardy and Dahlen, 2017). Weaning calves from their dam is a simple way to reduce the nutrient requirements for the cow herd, and early weaning can be used as a strategy to give the dams more time from weaning to next calving season to improve body condition. Early weaning calves can also improve reproductive performance by increasing pregnancy rates if calves are weaned 45 to 105 days of age. Overall, whether calves are early weaned at 45 days of age or 5 months, early weaning can be used to maintain and/or improve the body condition and feed efficiency of the cow herd be eliminating the additional nutrient requirements of lactation.
<table>
<thead>
<tr>
<th>Condition Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCS 1 = Emaciated</td>
<td>No palpable fat is detectable over the spinous processes, transverse processes, ribs, or hooks. The tail head and ribs appear very prominent.</td>
</tr>
<tr>
<td>BCS 2 = Poor</td>
<td>Animal is still somewhat emaciated but the tail head and ribs are less prominent. Individual spinous processes are still sharp to the touch. Some tissue cover is present over the ribs toward the top of the back.</td>
</tr>
<tr>
<td>BCS 3 = Thin</td>
<td>Individual ribs including fore ribs are easily identified but are not quite as sharp to the touch. Some fat can be felt along the spine and over the tail head. Some tissue cover is present over the ribs toward the top of the back.</td>
</tr>
<tr>
<td>BCS 4 = Borderline</td>
<td>Individual ribs may not be visually obvious. Individual spinous processes can be felt when palpated but feel rounded rather than sharp. Some fat cover is present over the ribs, transverse processes, and hooks.</td>
</tr>
<tr>
<td>BCS 5 = Moderate</td>
<td>Overall appearance is generally good. Fat cover over ribs feels spongy. Palpable fat cover is present on either side of the tail head.</td>
</tr>
<tr>
<td>BCS 6 = High moderate</td>
<td>A high degree of palpable fat exists over the ribs and around the tail head. Firm pressure is needed to feel the spinous processes.</td>
</tr>
<tr>
<td>BCS 7 = Good</td>
<td>Considerable fat cover is present with a fleshy overall appearance. Fat cover over the ribs and around the tail head is very spongy. Fat &quot;pones&quot; or &quot;rounds&quot; may be starting to form along the tail head.</td>
</tr>
<tr>
<td>BCS 8 = Fat</td>
<td>The animal is very fleshy and appears over conditioned. Palpation of the spinous processes is near impossible. Large fat deposits are present over the ribs and around the tail head. Fat pones around the tail head are obvious.</td>
</tr>
<tr>
<td>BCS 9 = Extremely fat</td>
<td>The overall appearance is blocky with extremely wasty and patchy fat cover. The tail head and hooks are buried in fatty tissue with fat pones protruding. Bone structure is no longer visible and barely palpable. Large fatty deposits may even impair animal mobility.</td>
</tr>
</tbody>
</table>

Adapted from Waters and Amundson (2012)
Table 1.2. Key Points for Condition Scoring Beef Cows

<table>
<thead>
<tr>
<th>Reference Point</th>
<th>Condition Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Physically Weak</td>
<td>Yes</td>
</tr>
<tr>
<td>Muscle atrophy a</td>
<td>Yes</td>
</tr>
<tr>
<td>Outline of spine visible</td>
<td>Yes</td>
</tr>
<tr>
<td>Outline of ribs visible</td>
<td>All</td>
</tr>
<tr>
<td>Fat in brisket and flanks</td>
<td>No</td>
</tr>
<tr>
<td>Outline of hip and pin bones visible</td>
<td>Yes</td>
</tr>
<tr>
<td>Fat in the udder and patchy fat around tail head</td>
<td>No</td>
</tr>
</tbody>
</table>

a Muscles of loin, rump and hindquarter are concave, indicating loss of muscle tissue.
Adapted from Pruitt and Momont (1988)
Chapter 2: Reducing Weaning Stress and The Effects on Calf Performance

Abstract

The objective of this study was to evaluate the effects of two-stage weaning with or without creep feed and creep feed without two-stage weaning on early-weaned spring-born beef calves. This study was done at the University of Arkansas SWREC in Hope, Arkansas, and consisted of 253 angus crossbreed cow-calf pairs in a spring-calving system over a two-year study (n = 140 in 2019; n = 113 in 2020). Following calving, all calves were randomly allocated to four different treatments in a 2 x 2 factorial arrangement. Treatment factors consisted of 1) nose flap vs no nose flap and 2) creep feed vs no creep feed. The four different treatment combinations were labeled as CON (control; no creep feed and no nose flap), NFC (nose flap with creep feed), NF (nose flap without creep feed), and CF (creep feed without nose flap). All measurements on performance were analyzed using the MIXED procedure of SAS. Significance was declared at $P \leq 0.05$ and tendencies at $0.05 < P \leq 0.10$. There were no interactions between nose flap and creep feed treatments on any calf measurements. Body weights of CF and NFC calves tended to have greater ($P = 0.06$) average BW one week prior to weaning compared to CON and NF calves. Calf BW at weaning were 16.4 kg. greater ($P < 0.01$) for CF and NFC calves compared to NF and CON calves. Both creep feed treatments averaged 20.1 kg greater ($P = 0.03$) average BW one month after weaning compared to NF and CON calves. Calf ADG was affected by creep feed from initial BW to weaning BW with calves receiving creep feed tending to have greater ($P = 0.07$) ADG compared to NF and CON calves. However, NF and NFC calves tended to have lower ($P = 0.08$) ADG from initial BW to one-month post-weaning BW compared to CON and CF calves. There were no significant differences ($P = 0.49; P = 0.71$) in creep feed consumption in weeks four and five between the CF and NFC treatments. Although
not statistically significant \((P = 0.71)\), average creep feed consumption of pastures containing calves from the NFC treatment in week five was 18.60 kg. greater than the average consumption of calves in the CF treatment. In conclusion, these results suggest that creep feeding prior to weaning can improve calf BW pre- and post-weaning, and two-stage weaning without supplementation prior to weaning can have a negative impact on performance.
**Introduction**

In the beef industry, beef calves are highly susceptible to illness and disease due to the stresses of the weaning process. Weaning is considered to be one of the most stressful times for beef calves in their productive lifetime. The stresses invoked during the weaning process may include separation from dams, calf processing, exposure to new environments, commingling with unfamiliar calves, transportation, and so on. All of these events compounded can have major effects on the health and performance of beef calves post-weaning by compromising immune response. Suppressing immune response by weaning stress can greatly affect how well calves mount an immune response to vaccinations (Riggs et al., 2011).

Along with immunosuppression due to weaning stress, beef calves also often exhibit decreased feed intake, decreased ADG and/or body weight, and increased behavioral responses such as pacing and vocalization. These effects can have short and long-term impacts on health and immunity, gain performance, and economic viability. By limiting as much stress in weaning as possible, producers can increase overall performance and health of beef calves post-weaning. This can be accomplished through pre-weaning management and particular weaning strategies that pre-condition calves for the stresses of weaning (Riggs et al., 2011).

Pre-weaning management is very important to ensure that calves have the ability to perform and function when exposed to the stressors that are associated with weaning (Riggs et al., 2011). Procedures included in pre-weaning management could be calf processing (forms of calf ID, castration, dehorning, vaccination, etc.) and improving nutritional status. Processing calves before weaning can limit the number of stressors they will be exposed to during weaning. Prior to weaning, the nutritional status of calves is very important because that can affect gain performance post-weaning and determine how well calves will react to vaccinations. Moriel et
al. (2013) reported limit-fed creep-feed supplements increased calf weaning BW ($P < 0.05$) and increased voluntary DMI ($P < 0.040$) during the first week of the feedlot receiving period. Pre-weaning diets such as creep feeds can be essential in this process to not only improve the calf’s nutritional status, but also prepare it for weaning.

Weaning methods used are very important to consider when attempting to reduce stress. Total separation, or traditional weaning, has been shown to be one of the most stressful weaning methods on beef calves, but is very common because it allows the producer to sell the calves right off the cow. Fenceline weaning is a method that allows cow-calf pairs to have face-to-face contact with each other but are in separate pastures and are not able to nurse. Compared to traditional weaning, fenceline weaning decreases vocalizing and time spent walking, increases time spent eating, and can increase ADG (Price et al., 2003). Two-stage weaning is another method that involves implementing a nose flap on calves to prevent them from nursing about one week (stage 1) prior to weaning, and then removing the nose flaps and separating the cow-calf pairs (stage 2). This method of two-stage weaning may decrease behavioral disruption to calves more than providing fenceline contact (Haley et al., 2005).

Although the two-stage method of weaning may decrease stress-induced behaviors more than traditional or fenceline weaning, some studies have reported ADG and body weight setbacks due to the nursing-deprived week during two-stage weaning, and that the nutritional management during this time should be evaluated in future research (Haley et al., 2005). A possible solution to this may be the use of creep feeds in combination with two-stage weaning. Sayre et al. (2019) compared nose flaps with (NFC) or without (NF) creep feed to traditional weaning with (TRADC) or without (TRAD) creep feed and reported greater ($P \leq 0.0001$) ADG from NFC calves than NF and TRAD calves and tended to have greater ($P \leq 0.10$) ADG
compared with TRADC calves during the 7-day period that nose flaps were placed. This may suggest that the use of high-quality forages and/or supplements in combination with nose flaps could result in improved calf performance and better reduce stress compared to fenceline weaning and traditional weaning.

This study from Sayre et al. (2019) showed that creep feed in combination with two-stage weaning is an alternative method of reducing stress and increasing performance in beef calves weaned at traditional weaning ages (6-8 months). Early weaned beef calves (< 5 months of age) can be more susceptible to decreased performance and immunosuppression than beef calves weaned at a conventional age because early weaned beef calves are exposed to the same stressors as conventional weaning age calves but at a younger age (as low as 45 days of age). Therefore, the objective of this study was to evaluate the effects of two-stage weaning with or without creep feed and creep feed without two-stage weaning on performances of early-weaned spring-born beef calves.

**Materials and Methods**

This study was conducted at the University of Arkansas Southwest Research and Extension Center Cow-Calf unit in Hope, Arkansas and consisted of 253 Angus crossbreed cow-calf pairs in a spring-calving system over a two-year period (n = 140 in 2019; n = 113 in 2020). All methods and procedures were approved by the University of Arkansas’ Institutional Animal Care and Use Committee (approval # 20030).

In the first year of the study, cows were stratified by age and body weight (BW) and randomly allocated to twelve separate pastures consisting of roughly ten to twelve head per pasture group. Due to weather conditions for the second year of the study, there were not enough pastures to separate all groups. Therefore, cows were stratified by age and body weight (BW)
and randomly allocated to six separate pastures consisting of roughly fifteen to twenty-four head per pasture in 2020. The pastures consisted of primarily bermudagrass (Cynodon dactylon) and bahiagrass (Paspalum notatum) that were overseeded with wheat (Triticum aestivum) and annual rye grass (Lolium multiflorum) using a no-till drill in October of both years for spring grazing. Bermudagrass/bahiagrass hay was offered ad libitum to all groups during early spring, along with continuous access to fresh water.

Cows began calving the first of February and ended mid-April in 2019, and late-January to the first of May in 2020. During the calving season of both years, calves were caught and processed 24 to 48 hours after birth. Calf processing consisted of applying ear tags for individual identification, birth weights, bull-calf castration via scalpel, as well as recording birth date and weight, dam number and calf number.

Following calving, all calves were randomly allocated to four different calf treatments in a 2 x 2 factorial arrangement. Treatment factors consisted of 1) nose flap implemented vs no nose flap and 2) creep feed vs no creep feed. The four different treatment combinations were labeled as CON (control; no creep feed and no nose flap), NFC (nose flap with creep feed), NF (nose flap without creep feed), and CF (creep feed without nose flap). The approximate sample size of calf treatments in each year are as follows; CON (n = 32), NFC (n = 32), NF (n = 33), and CF (n = 31).

Roughly one month prior to weaning, NFC and CF groups began receiving Purina SteakMaker® Developer 15-2 B68 creep feed on a weekly basis. A sample feed tag of the creep feed used in this study can be found in Figure 2.1. (Figure 2.1. Purina SteakMaker® Developer 15-2 B68 Sample Feed Tag). From the start of providing creep feed to the NFC and CF groups, amounts were weighed back weekly and if all was consumed by a particular pasture group by
weeks end, an additional 100lbs was added to that group. If the creep feed was consumed by a pasture group prior to weekly weigh back, the amounts provided to that group was increased by 50lbs increments.

Approximately one week prior to weaning, the NFC and NF groups were implemented with Neogen® orange plastic nose flaps (Neogen Animal Safety Inc. Lexington, KY) and placed back into their designated pastures with their dams. The average calf age at weaning of both years was roughly 3 to 5 months of age. On the day of weaning, NFC and NF calves had the nose flaps removed, and all calves were vaccinated with a 7-way Clostridial antigen plus tetanus (Covexin-8, Schering-Phlough Animal Health Inc., Elkhorn, NE) and treated with injectable doramectin (Dectomax, Zoetis Inc. Parsippany, NJ) and permanently separated from their dams.

Following separation in 2019, all calves remained in their original 12 pre-weaning pasture groups and placed in 12 separate feedlot pens. Following weaning in 2020, calves were sorted into ten separate feedlot pens. All calves in 2020 were sorted for their feedlot pens based off which groups received creep feed. Therefore, five feedlot pens consisted of calves from the CON and NF treatments, and the remaining five feedlot pens consisted of calves from the CF and NFC treatments.

In both years of the study, each of the feedlot pens immediately began receiving a daily total mixed ration that consisted of 10% ground hay, 20% soyhull pellets, 25% ground corn, 15% cottonseed meal, and 30% corn gluten pellets, along with ad libitum access to fresh water from automatic waterers. Included in the daily TMR was Purina SteakMaker® 40-20 as a feed supplement, and Purina SteakMaker® BP Formulator R1500 as a medicated mineral supplement. A sample feed tag of the feed supplement can be found in Figure 2.2. (Figure 2.2. Purina SteakMaker® 40-20 Sample Feed Tag), and a sample feed tag of the mineral supplement can be
found in Figure 2.3. (Figure 2.3. Purina SteakMaker® BP Formulator R1500 Sample Feed Tag). Calves remained in the feedlot for approximately six weeks in both years of the study before being separated by sex and moved onto pasture. Booster vaccinations were given 2 weeks after the day of weaning when initial vaccinations were given.

Body weights were measured on all calves in each treatment group roughly one week prior to the start of creep feeding, one week before weaning when nose flaps were implemented, at weaning, roughly one month following weaning and at one year for yearling weights. Calf body weights that were measured and recorded approximately one week prior to the start of creep feeding in both years served as initial body weights for all calves in the study. Weekly creep feed consumption was also recorded in both years of the study. All cows and calves were observed daily for any signs of sickness or morbidity, and records were kept of any medications administered throughout the duration of the study.

Statistical Analysis

Body weights, average daily gain and feed intake were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). The random statement for bodyweights and average daily gain was used to incorporate gender variation in all body weight analysis. The subject for the random variable was pasture by block. Means were separated using the F-protected t-test. Pasture by block was the experimental unit with creep feed, nose flap, and the interaction between creep feeding and nose flap utilization serving as the fixed factors for growth performance in all body weight analysis. Since creep feed consumption data consisted of only CF and NFC calf treatments, nose flap served as the lone fixed variable for creep feed consumption. All data are reported as least squares means, and for all analyses of the study, significance was declared at $P \leq 0.05$ and tendencies at $0.05 < P \leq 0.10$. 
Results

Calf Body Weight and ADG Performance

There were no interactions between creep feed and nose flap treatments on any body weight measurement periods, as well as no interactions between creep feed and nose flap treatments on any average daily gain results. Body weights of calves in the creep feeding treatments tended to have higher ($P = 0.06$) average body weights one week prior to weaning than calves who were not supplemented with creep feed (Table 2.1. Bodyweight (BW) and average daily gain (ADG) measurements of early-weaned spring beef calves implemented or not implemented with nose flaps and allowed or not allowed creep feed supplement prior to weaning). Because nose flap treatment calves were not implemented with nose flaps until one week prior to weaning, nose flaps did not have any affect ($P = 0.17$) on average body weights at the time of nose flap insertion. Calf body weights at weaning were roughly 16.4 kg. greater ($P < 0.01$) for calves supplemented with creep feed than calves who were not receiving the creep feeding treatment. Body weights at weaning did not differ ($P = 0.78$) between calves implemented with nose flaps vs those who did not receive nose flaps.

Creep feed also had an effect on calf body weights measured one month after weaning, with calves who received creep feed having higher ($P = 0.03$) average body weights than non-creep feed supplemented calves by around 20.1 kg. Nose flaps did not have an effect ($P = 0.79$) on body weight measurements one month following weaning. Yearling body weights of calves did not differ between creep feed vs non-creep feed calf treatments ($P = 0.12$) and did not differ ($P = 0.70$) between nose flap vs no-nose flap calf treatments.

Calf average daily gain was affected by creep feed from initial body weight to weaning body weight with calves who were supplemented with creep feed tending to have higher ($P =
0.07) ADG than non-creep feed calves. Nose flap treatment did not have an effect ($P = 0.11$) on ADG at weaning. However, calves implemented with nose flaps tended to have lower ($P = 0.08$) ADG from initial body weight to one-month post-weaning body weight measurements than calves who did not receive nose flaps. Both creep feed and nose flaps did not have an effect ($P = 0.40$ and $P = 0.36$) on ADG from weaning to one-month post-weaning. Both creep feed and nose flaps also did not have any effect ($P = 0.45$ and $P = 0.32$) on ADG from weaning to the yearling BW measurement.

**Creep Feed Consumption**

Due to weather conditions for the second year of the study, 2020, there were not enough pastures to separate all groups. Therefore, only six pastures were used in 2020 that contained cow-calf pairs prior to weaning, compared to the original twelve pastures containing cow-calf pairs prior to weaning in 2019. However, cow-calf pairs that were allocated to the CF and NFC calf treatments in 2020 were not separated in separate pastures by treatment and were combined in the same pastures for creep feed treatment. Due to this error, there is no way to determine creep feed consumption by calves in each treatment in 2020. So only creep feed consumption in 2019 was evaluated for the following results.

In 2019, there were three pastures per creep feed treatment (CF and NFC). Therefore, weekly creep feed consumption between the two creep feed treatments was evaluated by the average consumption of all pastures per treatment (*Table 2.2. Purina SteakMaker® Developer 15-2 B68 2019 pen average weekly consumption between the two creep feed treatments*). Because nose flaps were not implemented until the start of week five of creep feed supplementation, one week before weaning, only consumption during weeks four and five were analyzed to observe possible differences between treatments. In week four, the means did not
differ \((P = 0.49)\) in consumption between CF and NFC calf treatments. Week five displayed similar results, showing no differences \((P = 0.71)\) in consumption between CF and NFC calf treatments. Although it is not statistically significant \((P = 0.71)\), average creep feed consumption of pastures containing calves from the NFC treatment was roughly 18.60 kg. more than the average consumption of calves in the CF treatment in week five.

**Discussion**

In the second year of the study (2020), body weights were not recorded on the day nose flaps were placed on calves. Therefore, only 2019 weights at nose flap-in day were analyzed. Also in 2020, the creep feed treatment groups (CF and NFC) were not in separate pastures during the creep feeding period, so only the 2019 calf consumption results were analyzed in this study. Due to these errors, the results of this study should be interpreted with caution.

The results from this study suggest that calves supplemented with creep feed prior to weaning can increase overall calf body weights, producing heavier calves for the weaning process. These results also suggest that creep feeding can improve average daily gain during the pre-weaning period prior to weaning. Both creep feed calf treatments (CF and NFC) in this study resulted in higher body weights and ADG than CON and NF treatments. The effects creep feed had on calf performance observed in this study are similar to those reported by Moriel et al. (2013), where they saw heavier weaning body weights of calves supplemented with creep feed vs calves without creep feed prior to weaning. These results suggest that creep feed supplementation during the pre-weaning period may better prepare beef calves for weaning and post-weaning by improving their nutritional status during the pre-weaning period.

In this study, the only statistically significant effect nose flaps vs no nose flaps had on calf performance was average daily gain from the initial body weight to one-month after
weaning. Calves not implemented with nose flaps (CON and CF) tended to have greater average daily gains from the start of the study to one-month post-weaning than calves who were implemented with nose flaps (NF and NFC). With this being the only statistically significant difference between nose flap vs no nose flap, the results from this study suggest that implementing two-stage weaning appeared to have a negative effect on ADG. This could be due to the additional stress of working calves prior to weaning to place nose flaps on the calves. Another stress factor that may have been caused by nose flaps in this study were the particular nose flaps themselves. After nose flap removal in both years of this study, we found that the nose flaps created nasal abrasions on almost all calves implemented with nose flaps. Some nasal abrasions were more severe than others. However, it was evident that these particular nose flaps caused a considerable amount of irritation in the calves’ nostrils. In 2019 of this study, nose flaps were left on calves for approximately six days before weaning. In the second year of the study, the duration of nose flaps being left on was lowered to approximately four days to possibly decrease nasal abrasions. However, after shortening the duration of nose flap use in 2020, nasal abrasions were still apparent in most of the calves in the nose flap treatments. Lambertz et al. (2015) observed similar results with nasal abrasions caused by nose flaps and suggested that the design of the nose flaps and duration they are left on should be modified to minimize nasal abrasions.

The nose flaps used in this study were one solid plastic piece that is designed as a “one size fits all” devise. These nose flaps are designed to be somewhat tight on the calves because some customer reviews and previous studies have mentioned nose flaps coming out of the nose before weaning due to the nose flap not fitting tight enough or not fitting correctly. This could be a reason why nasal abrasions were more severe on some calves than others due to different body
types such as larger or differently shaped nose, bigger/older calves, etc. However, there are other nose flap designs on the market that consist of adjustable nose pieces to fit all calves more appropriately. From evaluating nasal abrasions caused by the nose flaps in this study, it may be suggested in future research to consider a different or modified design of the nose flaps to minimize the incidence of nasal abrasions, or any other type of nasal irritation.

Although all other body weight and ADG analysis of nose flap vs no nose flap treatment were not statistically significant, calves implemented with nose flaps and not allowed creep feed (NF calves) appeared to continuously have lower body weights and average daily gain from the 7-day nose flap period to one-month after weaning. These observations are comparable to the results reported by Freeman et al. (2016) and Haley et al. (2005), where both studies reported lower calf performances in calves given nose flaps vs other weaning methods. Haley et al. (2005) suggested that nutritional management of calves in two-stage weaning should be evaluated in future research. The results in this study suggest that implementing nose flaps without a supplemented nutrition program during the pre-weaning period may have a negative effect on performance of calves in two-stage weaning.

In this study, NFC and CF calves showed greater body weight performance throughout the study than CON and NF calves. However, there was no interaction throughout the study between nose flaps and creep feed, suggesting that creep feed alone may have improved calf performances. Considering two-stage weaning with or without creep feed supplementation, the results from this study suggest that the use of creep feed with two-stage weaning may improve overall calf performances compared to two-stage weaning without creep feed. Similar observations were found by Sayre et al. (2019), where it was reported that NFC calves showed better body weight and ADG performance than NF and CON calves, and both creep feed...
treatments had better calf performances than calves in two-stage weaning without creep feed and CON calves.

The creep feed consumption results in this study suggest that the nose flap treatment did not have any significant effect on creep feed consumption. In week four of creep feeding, there was less than a 1.1 kg. difference in consumption between the CF and NFC treatments. However, even though it is not statistically significant, NFC calves consumed roughly 18.6 kg. more creep feed in week five than the CF calves. This was the week nose flaps were implemented. Although not significant, this observation may suggest that nose flaps caused these nursing deprived calves to increase their creep feed intake. In the two-stage weaning study by Sayre et al. (2019), significant differences were observed in the ADG during the 7-day nose flap-in period. Sayre et al. (2019) reported that NFC calves tended ($P \leq 0.10$) to have greater ADG during the nose flap period than CF calves, which might also suggest that calves with nose flaps may have increased creep feed consumption during the nursing deprived period prior to weaning.

Beef calves in this study in the CF and NFC calf treatments were allowed unlimited creep feed intake during the duration of the creep feeding period. Previous studies have shown that unlimited creep feeding has been associated with decreased feed efficiency (Arthington et al., 2004; Faulkner et al., 1994). Cremin et al. (1991) suggested that this could be avoided if creep feeding supplements are limit fed. Faulkner et al. (1994) found that limit-fed creep feed supplements increased pre-weaning ADG of calves and improved concentrate intake in the feedlot compared to unlimited creep feed intake during the pre-weaning period. The results from this study showed no significant differences in yearling body weight between any calf treatments, which may or may not have been affected differently if calves supplemented with creep feed in this study were limit-fed creep feed vs unlimited intake. For future research of two-
stage weaning supplemented with creep feed, it could be considered to use limit-fed creep feeding to observe possible differences in calf performance.

Another possible consideration for future research of two-stage weaning supplemented with creep feed could be to compare normally timed weaning vs early weaning on calf performance of calves in two-stage weaning with creep feed. All calves in this study were early weaned and used to compare different methods of improving calf performance pre- and post-weaning. Comparing two-stage weaning of beef calves that are early weaned vs traditional weaning could possibly give researchers and producers a better understanding of how two-stage weaning may affect calves at different ages, and whether or not those effects show positive or negative results.
Conclusion

In conclusion, the results from this study indicate that creep feeding prior to weaning can have a positive effect on beef calves by improving their nutritional status which can overall prepare them for the stressors that are associated with the weaning process. Although there were no statistically significant differences in interaction between nose flaps and creep feed, the observations from this study suggest that supplementing creep feed along with two-stage weaning may improve the performance of beef calves that are implemented with nose flaps. The results from this study also indicate that implementing two-stage weaning without some form of supplementation can reduce beef calf performance post-weaning.

There is still need for future investigation of two-stage weaning to observe its effects on beef calf performance. This future research may include comparing two-stage weaning on early weaned calves vs traditionally timed weaning, limit-fed vs unlimited creep feed, and comparing different nose flap designs to see their effects on beef calves. Weaning methods are different for every cow-calf producer, and methods that may work very well for some will not always work well for other operations. Therefore, cow-calf producers must make their own decisions to determine what styles and methods work best for their operation. The results from this study, others like it and future investigations on methods to reduce weaning stress and improve beef calf performance can ultimately lead to producers making the best management decisions for their cow-calf operations.
SteakMaker® Developer 15-2 B68

Species: Beef  Type of Feed: Complete  Form of Feed: Pellet

General Description:
This pelleted, high-energy feed is designed to grow and develop replacement heifers and bull calves.

PURINA®
STEAKMAKER® DEVELOPER 15-2 B68
MEDICATED
SUPPLEMENT FEED FOR CATTLE ON PASTURE
For the improvement of feed efficiency in pasture cattle (slaughter, stocker, feeder cattle, and dairy and beef replacement heifers).

CAUTION: FEED AS DIRECTED

ACTIVE DRUG INGREDIENTS
Lasalocid (as Lasalocid sodium) 68.00 g/ton

GUARANTEED ANALYSIS
Crude Protein, (Min) .................................................. 15.00 %
(This includes not more than 2.00% equivalent crude protein from non-protein nitrogen).
Crude Fat, (Min) .................................................. 2.00 %
Crude Fiber, (Max) .................................................. 20.00 %
Calcium (Ca), (Min) .................................................. 1.00 %
Phosphorus (P), (Min) .................................................. 0.50 %
Salt (NaCl), (Min) .................................................. 0.75 %
Potassium (K), (Min) .................................................. 0.50 %
Copper (Cu), ppm (Min) .................................................. 40
Selenium (Se), ppm (Min) .................................................. 0.8
Zinc (Zn), ppm (Min) .................................................. 140
Vitamin A, I.U./lb, (Min) .................................................. 5,000
Vitamin D, I.U./lb, (Min) .................................................. 2,000
Vitamin E, I.U./lb, (Min) .................................................. 10

INGREDIENTS
Note: ingredients differ by manufacturing plant
Grain Products, Roughage Products, Plant Protein Products, Molasses Products Calcium Carbonate, Salt, Urea, Dicalcium Phosphate, Monocalcium Phosphate, Sodium Selenite, Vitamin D3 Supplement, Vitamin E Supplement, Vitamin A Supplement, Cobalt Carbonate, Manganese Sulfate, Ethylenediamine Dihydriodide, Zinc Sulfate, Basic Copper Chloride

FEEDING DIRECTIONS:
Feed continuously at a rate of 1.76 to 5.88 lbs. to provide 60 to 200 mg lasalocid per head per day.
Intakes of lasalocid in excess of 200 mg per head per day have not been shown to be more effective than 200 mg per head per day. The drug must be contained in at least one pound of feed.

CAUTION:
Store in a dry, well-ventilated area protected from rodents and insects. Do not feed moldy or insect-infested feed to animals as it may cause illness, performance loss or death.

WARNING:
A withdrawal period has not been established for this product in pre-nourishing calves. Do not use in calves to be processed for veal.

Available Options:

<table>
<thead>
<tr>
<th>Product No.</th>
<th>Package</th>
<th>Size Diameter</th>
<th>Feeding Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>3004089-200</td>
<td>Bag</td>
<td>5/32-11/64</td>
<td>1 – 2 % of BW</td>
</tr>
<tr>
<td>3004089-201</td>
<td>Bulk</td>
<td>5/32-11/64</td>
<td>1 – 2 % of BW</td>
</tr>
<tr>
<td>3004089-401</td>
<td>Bulk</td>
<td>Cube 5/8</td>
<td>1 – 2 % of BW</td>
</tr>
</tbody>
</table>

Figure 2.1. Purina SteakMaker® Developer 15-2 B68 Sample Feed Tag
Figure 2.2. Purina SteakMaker® 40-20 Sample Feed Tag
Figure 2.3. Purina SteakMaker® BP Formulator R1500 Sample Feed Tag
Table 2.1. Bodyweight (BW) and average daily gain (ADG) measurements of early-weaned spring beef calves implemented or not implemented with nose flaps and allowed or not allowed creep feed supplement prior to weaning

<table>
<thead>
<tr>
<th>Item, kg</th>
<th>Treatments&lt;sup&gt;a&lt;/sup&gt;</th>
<th>SEM&lt;sup&gt;b&lt;/sup&gt;</th>
<th>SEM</th>
<th>P-value&lt;sup&gt;c&lt;/sup&gt;</th>
<th>NF</th>
<th>CF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes Flap</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NFBW&lt;sup&gt;d&lt;/sup&gt;</td>
<td>181.8</td>
<td>190.4</td>
<td>4.45</td>
<td>191.9</td>
<td>180.3</td>
<td>4.45</td>
</tr>
<tr>
<td>WeanBW</td>
<td>192.9</td>
<td>194.4</td>
<td>4.05</td>
<td>201.9</td>
<td>185.5</td>
<td>4.44</td>
</tr>
<tr>
<td>1monthBW</td>
<td>210.6</td>
<td>212.2</td>
<td>5.75</td>
<td>221.5</td>
<td>201.4</td>
<td>6.79</td>
</tr>
<tr>
<td>YearBW</td>
<td>276.6</td>
<td>274.3</td>
<td>4.97</td>
<td>281.6</td>
<td>269.4</td>
<td>5.59</td>
</tr>
<tr>
<td>ADG_1mth</td>
<td>0.72</td>
<td>0.77</td>
<td>0.04</td>
<td>0.80</td>
<td>0.69</td>
<td>0.06</td>
</tr>
<tr>
<td>ADG_Wean&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.92</td>
<td>0.97</td>
<td>0.04</td>
<td>1.00</td>
<td>0.89</td>
<td>0.04</td>
</tr>
<tr>
<td>ADGW_1mth&lt;sup&gt;f&lt;/sup&gt;</td>
<td>0.45</td>
<td>0.51</td>
<td>0.09</td>
<td>0.55</td>
<td>0.41</td>
<td>0.11</td>
</tr>
<tr>
<td>ADG_Year&lt;sup&gt;g&lt;/sup&gt;</td>
<td>0.42</td>
<td>0.40</td>
<td>0.02</td>
<td>0.40</td>
<td>0.42</td>
<td>0.02</td>
</tr>
</tbody>
</table>

<sup>a</sup>Treatments: Nose flap -yes = nose flap implemented, -no = not implemented; Creep Feed -yes = received creep feed, -no = did not receive creep feed.

<sup>b</sup>SEM = pooled standard error of the mean for the main effects of nose flap or creep feed.

<sup>c</sup>NF = the main effects of nose flap vs. no nose flap; CF = the main effects of creep feed vs. no creep feed.

<sup>d</sup>NFBW = BW 1 week prior to weaning.

<sup>e</sup>ADG_Wean = ADG from initial BW to weaning BW.

<sup>f</sup>ADGW_1mth = ADG from weaning BW to 1-month BW.

<sup>g</sup>ADG_Year = ADG from weaning to yearling BW.

There were no Nose Flap x Creep Feed calf treatment interactions for the above observations and is therefore not reported.
<table>
<thead>
<tr>
<th>Avg Intake, kg&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Treatments&lt;sup&gt;a&lt;/sup&gt;</th>
<th>SEM&lt;sup&gt;b&lt;/sup&gt;</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CF</td>
<td>NFC</td>
<td></td>
</tr>
<tr>
<td>Week 4</td>
<td>226.49</td>
<td>225.44</td>
<td>0.99</td>
</tr>
<tr>
<td>Week 5</td>
<td>268.68</td>
<td>287.27</td>
<td>33.21</td>
</tr>
</tbody>
</table>

<sup>a</sup>Treatments: CF = calves supplemented creep feed without nose flap; NFC = calves supplemented with creep feed and implemented with nose flap.

<sup>b</sup>SEM = pooled standard error of the mean.

<sup>c</sup>Avg Intake, kg: weekly average consumption of all pens in each calf treatment.
References


Appendix

The Division of Agriculture Institutional Animal Care and Use Committee (Ag-IACUC) has APPROVED your protocol & 20050 Methods to Reducing Weaning Stress in Early Weaned Beef Calves.

In granting its approval, the Ag-IACUC has approval only the information provided. Should there be any further changes to the protocol during the research, please notify the Ag-IACUC in writing (via the Modification form) prior to initiating the changes. If the study period is expected to extend beyond September 26th, 2022 you must submit a newly drafted protocol prior to that date to avoid any interruption. By policy, the Ag-IACUC cannot approve a study for more than 3 years at a time.

The following individuals are approved to work on this study: Charles Looney, Whitney Rook, Colby Shelton, and Matt Helm. Please submit personnel additions to this protocol via the modification form prior to their start of work.

The Ag-IACUC appreciates your cooperation in complying with University and Federal guidelines involving animal subjects.

BMB/imp