

**EFFECTS OF EARLY WEANING CALVES AS A MANAGEMENT TOOL**

By

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A Thesis Submitted to the Faculty of the

SCHOOL OF ANIMAL AND COMPARATIVE BIOMEDICAL SCIENCES

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

WITH A MAJOR IN ANIMAL SCIENCES

In the Graduate College

THE UNIVERSITY OF ARIZONA

2017

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## APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

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Dan Faulkner

**Defense date**

5/10/17

## **DEDICATION**

I would to dedicate this work to Gary Thrasher and Rachel Lohrman for the ways in which you have impacted my life. I could not have done it without you.

## **ACKNOWLEDGEMENTS**

I would like to extend my appreciation to the personnel at the V-V Ranch. I would like to thank my advisor Dr. Faulkner and Sean Limesand for the opportunity to step into this research project and for their guidance along the way. I want to thank to my parents for their continued support throughout my life, including my educational goals.

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## ABSTRACT

The goal of a cow-calf producer is to produce a calf each year per cow. Research suggests that first year heifers struggle breeding back with their second calf because of the adjustments to new range/main herd conditions and the partitioning of nutrients between gaining weight, milk production, and gestation. This study was conducted at the V-V ranch at the University of Arizona for five years and looked at the effects on young cows when calves were weaned from first year heifers at 80 days rather than 205 days. Early weaning allows for gestational benefits because they are given the opportunity to adapt to herd conditions by applying feed resources to the in utero fetus and their own body condition rather than lactation. All first year heifers were included over three years, and were randomly assigned to two groups, normal weaning (NW) or early weaning (EW). This resulted in 122 heifers in the group whose calves were EW and 119 heifers in the group whose calves were NW. Heifers that were in the EW group bred back at a 27% higher rate in their second year, and had 15% greater longevity in the herd. Calves that were in utero when the nursing calves were early EW were 16.4 kg heavier at weaning. Part of this was due to the age of the calf and part to gestational health. EW was an effective strategy for improving reproductive performance of first year heifers as well as their survival rate in the herd to 5 years of age. It also resulted in improved performance for their in utero calves.

## LITERATURE REVIEW

The beef industry is economically important to the United States, as it is a highly ranked income-producing agricultural commodity (Short, Staigmiller & Bellows, 1994). To be profitable, the beef industry needs to maintain a 365-day calving interval – a calf a year from the majority of the breeding herd (Houghton, Lemenager, Horstman, & Hendrix, Moss, 1990). Consistent calf production is the heart of the beef production industry, however, calf production depends on the condition and breeding ability of the cows in the herd. Cow-calf producers struggle the most with second and third year heifers: if these cows do not breed back, or breed back too late in the season, it negatively affects calf production, ultimately lowering the producer's income (Whittier, 2009).

Cows are bred for the first time between 13 and 15 months, and yearly thereafter (Short et al., 1994). First year heifers are often kept separate from the main herd, turned out instead in a smaller pasture with easy access to forage and water. These heifers are usually bred to bulls that are genetically expected to produce low-birth weight calves, meaning the heifer will likely have her first calf more easily. Essentially, first year heifers are treated with extra care. Once a heifer calves, she and her calf are fed a better diet or are placed on higher quality pasture than the cows herd. Heifers are bred back, on average, 80 days after they give birth. Calves are normally allowed to stay on the cow between 180 and 220 days during this time; despite accessible resources, heifers often struggle to put on or maintain weight and body condition because they are nursing a calf (Selk, Wettemann, & Lusby, 1988). Once calves are weaned, heifers are often immediately moved to pasture with the regular herd and calves are sold for profit. Heifers must immediately compete for the available resources with the mature cow herd. Spontaneous abortion is a reality for some heifers because they are not able to quickly adapt, putting them at

risk of being removed from the herd, which is a financial loss to the producer. If a second year heifer is successful in carrying her calf to term, the cycle begins again. It typically takes a cow three calving cycles to adapt to range conditions and integrate into the main herd's established order.

A cow typically has to produce at least two calves before she can pay for her development costs and return income to the producer money. The younger a cow is, the more she struggles with calf production (Houghton et al., 1990). A consistent 365-day interval is influenced by factors such as pre and postpartum nutrition, whether or not the cow is nursing a calf, and how difficult it is for a cow to give birth. Careful attention is typically paid to a first year heifer's nutrition, breeding conditions, and environment. Producers often separate the first year heifers from the main breeding herd, put them on higher quality pasture, and use breeding selection for low calving birth weight. Smaller pastures allow for easier foraging, closer water sources, and the ability to supplement with high-energy feed if necessary. Using low birth weight bulls helps minimize the risk of dystocia, or difficulty giving birth. After a heifer's first calving, research shows that it is difficult to breed her back, but this is a producer's main objective. On average, two and three-year-old heifers require a 70 to 90-day post-partum interval (PPI), or time between calving and ovulation, whereas mature cows only require a 40 to 60-day interval (Short et al. 1994). A longer PPI means a heifer may not be ready to breed until later in the breeding season; if she is bred late, she calves late, and producers run into issue of calf uniformity because the late calves are smaller. The gestation of cattle is 282 days, which leaves 83 days in a calendar year to breed back into order to meet the 365-day interval standard (Long, 2009). The cow does not experience estrous until after uterine involution, or reproductive tract healing, which typically occurs 20 to 40 days' post-birth; this is significant because it closes that 83-day window to about

potentially only 21 days Long (2009). Longer postpartum intervals not only affect the time of conception within the breeding season, but they also mean there are fewer opportunities for the cow to become pregnant and there is the risk that she may not conceive at all. Short et al. (1994) states that “the greatest production loss results from cows not being pregnant at the end of the breeding season.” Breeding late in a season means the cow will calve outside of the optimal breeding season, forcing the producer to sell the calf at a discount. It is important for the purchasers of calves that there is uniformity, meaning that all calves are similar in weight. Even though two-year-old heifers struggle to produce a second calf, it is still economically advantageous for the cow-calf producers to begin breeding beef cattle at 13 months because a cow is able to pay for herself sooner. “Without reproduction, there is no production” (Šárová et al., 2010).

In addition to longer PPIs, younger cows need better feed sources to provide the necessary energy to gain weight and produce milk in tandem, as well as expend energy on reproduction; this is difficult when a second year heifer is suddenly forced to adapt to range conditions that are starkly different than those she experienced as a first year heifer. Houghton et al. (1990) discusses the importance of offering high-energy feedstuffs to younger cows because it can reduce the duration of the heifer’s PPI. The issue is that second year heifers are often turned out with the main herd and they have to compete with mature, territorial cows and an established herd hierarchy. Young cows fall to the back of the herd during travel and must walk further and spend energy avoiding conflict with the dominant cows (Šárová et al., 2010).

In addition to fighting for available resources, cows lose their baby teeth at about two and half years of age and consume less of the available forage for several months. Young cows also tend to have poor nutrient partitioning, meaning the energy a cow gains from nutrients are

allocated to milk production rather than fat deposition (Long, 2009). A cow with a nursing calf can quickly lose weight and body condition.

A cow's body condition depends on access to nutrients, their quality, and the allocation of those nutrients, or nutrient partitioning. Body condition is assessed and scored "based on an evaluation of fat deposits and muscling in relation to skeletal features" (Long, 2009). The beef cattle body condition scale ranges from 1 to 9, with a 1 indicating a cow is extremely thin, and 9 indicating a cow is extremely fat (Herd & Sprott, 1998). For trained evaluators, differences in scoring, which does occur, will typically only differ by a point (Herd & Sprott, 1998). A BCS of 5 is ideal because it describes a cow that is neither thin nor fat (Herd et al., 1998). BCSs taken right after a cow calves are the way in which a producer determines their supplemental feeding program: medium protein, high-energy supplements are typically fed in large quantities for thin cows, or those with a low BCS, whereas cows with a high BCS only require small amount of supplement that are high in protein because they have a higher body weight (Herd & Sprott, 1998). BCSs are deemed more reliable nutritional evaluation tools than live weights because of factors such as gut fill and pregnancy-related products. A cow's BCS score at calving is a strong indicator of her ability to rebreed within 90 days postpartum (Long, 2009). It can also indicate the health of calf and lactation performance and level of dystocia (Herd & Sprott, 1998). A BCS of 6.5 at calving is associated with a 90% chance that the cow successfully became pregnant in the 90 day PPI, whereas a BCS of 4 is associated with a 25% chance of rebreeding (Horn, 2009). BCSs are important to the producer because they indicate the likely reproductive performance of the cow (Story, Rasby Clark, Milton, 2000). Achieving optimal BCS is one reason why early weaning programs are used.

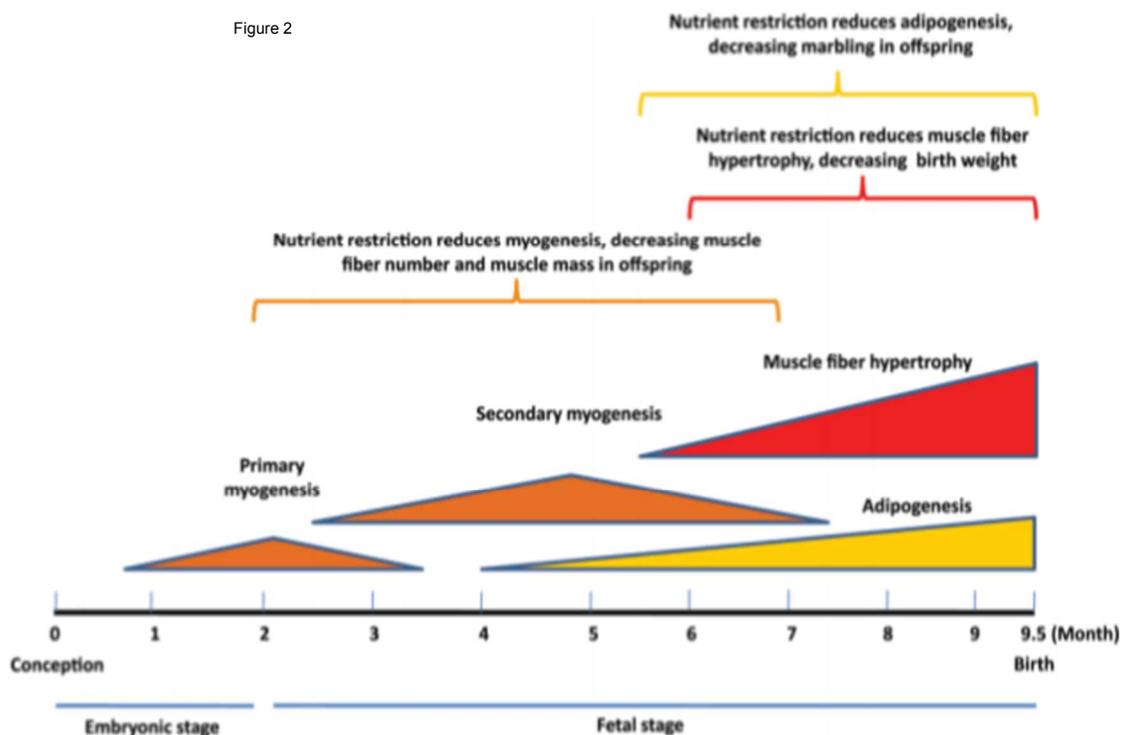
Figure 1

BCS	Detailed Description
1	Clearly defined bone structure of shoulder, ribs, back, hooks and pins easily visible. Little muscle tissue or fat present.
2	Small amount of muscling in the hindquarters. Fat is present, but not abundant. Space between spinous process is easily seen.
3	Fat begins to cover loin, back and foreribs. Upper skeletal structures visible. Spinous process is easily identified.
4	Foreribs becoming less noticeable. The transverse spinous process can be identified by palpation. Fat and muscle tissue not abundant, but increasing in fullness.
5	Ribs are visible only when the animal has been shrunk. Processes not visible. Each side of the tail head is filled, but not mounded.
6	Ribs not noticeable to the eye. Muscling in hindquarters plump and full. Fat around tail head and covering the foreribs.
7	Spinous process can only be felt with firm pressure. Fat cover in abundance n either side of tail head.
8	Animal smooth and blocky appearance; bone structure difficult to identify. Fat cover is abundant.
9	Structures difficult to identify. Fat cover is excessive and mobility may be impaired.

Adapted from Herd and Sprott, 1986

Fetal programming ties the concept of BCS into the issue of health and postnatal development of the calf. This topic is pertinent to the discussion about second year heifers because not only are they introduced into a high stress environment when they are put with the main herd, but their access to forage is often restricted by their position in the herd. Things like poor nutrition and high stress during the first few months of fetal development can adversely affect the calf long term. Essentially, the concept of fetal, or developmental programming, says that a calf from a poorly nourished dam may be negatively “programmed” in their growth, productivity, and susceptibility to disease (Vonnahme, 2007). Critical fetal developments take place during the first trimester, including crucial placental growth (crucial for fetal nutrient transfer), vascularization, and fetal organogenesis, or the development of vital organs (Summers & Funston, 2013). Poor gestational nutrition has been linked to skeletal muscle formation abnormalities, bone mineralization, increased insulin secretion, and obesity (Vonnahme, 2007). Skeletal muscle development is a crucial developmental stage during gestation because muscle fibers can only grow during gestation, and do not increase once the calf is born (Summers & Funston, 2013). Available nutrients are directed to the brain, heart, and other vital organs before muscle fibers, so poor heifer nutrition will limit the muscle fibers that grow prenatally (Summers & Funston, 2013). The number of muscle fibers is related to fat accumulation and the formation of marbling, which is a highly desired trait in finished beef cattle (Summers & Funston, 2013). Fetal programming can not only address the economic value of a finished cow but it can help reduce the economic loss of cattle to disease in the feedlot setting. Bovine respiratory disease (BRD) is a common disease that affects the survivability rate of cattle in the feedlot setting; in fact, 44.1% of feedlot deaths are attributed to BRD (Vonnahme, 2007). It has been suggested that the incidence of BRD can be reduced through proper gestational nutrition (Vonnahme, 2007).

Figure 2



Calves are weaned between 180 and 220 days in traditional beef production systems; when calves are weaned between 60 and 150 days, it is considered EW (Story et al., 2000). The cessation of milk production is the most immediate result of the weaning process, meaning the cow's need for and consumption of nutrients and forage changes. As a management strategy, EW can benefit the producer by reducing the demand for forage when forage is either limited or damaged, increase a cow's reproductive performance if they exhibit a low BCS at calving, and it can help maintain the BCS of cows during pregnancy (Story et al., 2000). Warner, Jenkins Rasby, Luebbe, Erickson, and Klopfenstein (2014) purports that young cows, still growing to their mature weight, benefit the most from EW. With the lactation demand removed, nutrients can be utilized for cow growth and maintenance, thus improving a cow's BCS, and reducing the time she is in postpartum anestrous.

The problem identified overwhelmingly by the beef cattle industry, and backed by research

conducted by the USDA is the dramatic dip in pregnancy rate of second year heifers (Whittier, 2009). Stressors such as age, weight, body condition, suckling status, forage conditions and extreme weather conditions, such as drought and range fires, are typically to blame. Producers can be proactive in minimizing the effects of these stressors in order to increase the net value of their breeding herd. Research is clear that cows in better body condition have healthier calves and breed back sooner, thereby increasing the producer's profitability. It is advantageous therefore to understand the issues affecting body condition and then work to achieve and maintain optimal BCSs.

As early as 1986, research was being conducted on the effects of EW; although it was being practiced, no one was sure if it was cost effective. Available research on EW in the early 1980's, which was almost nonexistent, seems to be as contradictory as it is today. Basarabi, Novak, and Karren (1986) conducted a two-year study in 1982 and 1983 that looked at whether early weaning had any effect on calf gains prior to sale, or on a cow's reproductive performance. This area of research interested them because of the rate of stress, disease, and even death on calves weaned at 6-9 months of age, sold, and shipped to feedlots. They wanted to know whether EW gave calves more time to acclimate to feedlot conditions, something known as preconditioning, making them heavier, better adjusted to feedlot conditions, and less susceptible to the stress of transportation and acclimation prior to harvesting. Contrary to their hypothesis, their results did not show that EW calves gained more than LW calves. In order to make up for the additional costs associated with EW, these calves must be purchased at a premium; stockers, however, are not interested in paying a premium for a calf that does not display improved health and weight gains when compared to a calf weaned normally. They do note a limitation worth presenting: EW calves in this study were placed on a restricted diet, rather than a free choice feeding system.

This is likely to have affected the outcome of the gains of the EW calves. They also reported no change in the reproductive performance of the cows, although in one of the years, they noticed a decrease in the forage requirement of the cows during the winter. They concluded with the need for additional research (Basarab et al., 1986)

Mills (2003) surveyed producers that have been successfully using EW as a management tool. A ranch in Arcadia, FL began using EW 1999 as a way of improving their reproductive efficiency, weaning calves between 105 and 115 days. Producer Pat Pfeil says the effects of EW are cumulative: for the first year heifer, EW gives the cow a reprieve, the second year allows producers to focus on increasing the cow's BCS, and the third year is about BCS maintenance (Mills, 2003). Pfeil reports that EW has shortened their breeding season from 90 to 75 days, but has increased their pregnancy rates in the mature herd to 90-95% (Mills, 2003). Improvement in pasture condition was a side-effect of having fewer cows grazing during times when available grazing is diminished (Mills, 2003). A ranch in Kensington, OH has used EW since 2000 because they have found that it is more efficient to graze and supplement calves than to supplement cows so they produce more milk (Mills, 2003). Without a nursing calf, cows can put on weight to prepare for the next breeding season (Mills, 2003). They had a 70% success rate of pregnancy on first service, and had all but 4% bred by the third service (Mills, 2003). Western Kentucky University weans calves between 120 and 150 days, a management tool they began using because of drought conditions and a lack of grass; the effects of EW were substantial enough to continue using it (Mills, 2003). They saw a 40-50% increase in the number of calves sold to stockers (Mills, 2003). Ohio State University early weans at 105-115 days old to increase marbling, but warns others that its use may not be beneficial for cattle with smaller frames because they would require implants and feed with a higher protein content (Mills, 2003). EW

reduces the weight of calves, and since producers sell by the pound; this needs to be a factor of consideration when deciding to use an EW program (Mills, 2003). Some producers prefer more, lighter weight calves, than fewer, heavier calves (Mills, 2003).

Waterman, Geary, Paterson, and Lipsey (2012) studied EW in the Great Plains as an attempt to address the fact that low forage quality and quantity means a cow will not meet her nutritional requirements, which leads to low BCS and poor reproductive performance. Lactating cows require more feed and feed that provided higher nutritional value. Low availability of forage creates an environment of stress; if a cow is lactating during this period of stress, her nutritional stores will be used for milk production instead of weight gain they wanted to know whether EW increased reproductive performance in young cows, improved the rate of heifer development and improved pasture management (Waterman et al., 2012). They focused their research on how EW affected the cow's BCS, body weight, and rate of reproductive performance. They found EW to be a viable tool in the development and breeding of heifers in that removing lactation from the equation greatly reduces a cow's needed nutrients, allowing the cow to not only consume less but use those nutrients for body maintenance. EW was found to have the same or greater reproductive success than normal weaning.

Warner and Rasby (2014) discuss the importance of projecting forage conditions, or annual forage yield - something they say this can be estimated based on rainfall information and achieved through EW. They focused on EW as a drought mitigation strategy, rather than a consistently used herd management tool, but still state the importance of EW as a resource-sparing concept (Warner et al., 2014; Story et al., 2000). EW has the potential to reduce a cow's required nutrients by 255 lb per month, which allows for "one extra day of grazing for the dry cow in early to mid-gestation for every 2.5 days that the calf is weaned" (Warner & Rasby,

2014). They suggest that producers measure annual forage yield and add it to historical precipitation information from their area in order to determine if EW is needed. They report an absence of research addressing how range conditions are affected by EW. Warner and Rasby also address the question of whether or not it is appropriate to wean a calf from a cow so early. Until they are about three weeks old, calves are considered monogastric, meaning they only use one compartment of their stomach rather than the four-compartment stomach of a mature ruminant and they are incapable of processing forage through fermentative digestion. Previous research has established that calves are fully ruminant by 30 days of age, and no longer need milk or milk replacers. Rasby and Warner are adamant that even though calves can be successfully weaned at 30 days because they are ruminant, they still need to take in a high amount of nutrient.

Faulkner (2016) says that nutrition is the most critical aspect to consider in the growth and reproductive performance of beef cattle. There is a delicate balance between feed costs and proper animal nutrition given that half the cost of a cow-calf operation is feed. Time should be spent on the development of a feed and supplement program that addressed the quality of forage available; for instance, when forage lacks protein and energy, even though a cow had unlimited access to feed, they may suffer from poor body condition. Supplementation programs often require - much to the detriment of the budget - the inclusion of minerals, such as phosphorus, and micro minerals, such as Zn, Cu, and Se; Se because of its immune system support and reduction in white muscle disease, retained placenta, and poor reproduction. Faulkner outlines Arizona forage conditions: except for two periods of good quality forage in the spring and after the summer rains, most of the year, cows graze on poor quality forage, which is inadequate for the nutritional needs of a young cow. This issue can be addressed, Faulkner says, by early weaning

calves. This form of EW involves taking calves off two-year-old heifers before they are rebred, which reduced the heifer's overall nutritional needs and stress of lactation. This also addresses the reality that only 10% of three year heifers are often found in the mature herd as five-year old's; EW improves pregnancy rate and overall herd retention. Faulkner's focus was on EW of first year heifers and its effect on the entire herd, but also notes that EW can be beneficial for the mature herd under drought conditions (Faulkner, 2016).

Odhiambo et al. (2009) also observed a decreased retention of young cows into the mature herd, and found that EW lowered the risk of a young cow being culled from the herd. Lactation stress and inadequate forage conditions contribute to a cow's risk of being culled. If lactation stress is removed, a cow will have more body energy reserves to call upon during calving. Odhiambo et al. concluded that early weaning is an effective strategy to use with first and second year heifers.

Bishop et al. (1994) studied EW to see whether BCS influenced the time between calving and ovulation as evidenced by levels of luteinizing hormone (LH), which is necessary to bring a cow into estrous, and concentrations of IGF-I, which is an indication of the amount of energy a cow has to initiate ovulation. They found that a low BCS is associated with a reduced secretion of LH, and that suckling further reduces the presence of LH. Loss of body weight and low BCS, due to significant restriction in nutrition, was found to result in a decreased concentration of IGF-I in serum. However, cows with greater BCS actually initiated the secretion of LH sooner because they have high body energy reserves. Early weaning allows LH and IGF-I levels to return to normal sooner. According to Bishop et al. (1994), EW addresses the issue of a prolonged PPI, helping cows rebreed sooner in the breeding season.

Houghton et al. (1990) conducted research with EW and found a 24 d reduction in PPI

when calves were weaned at 30 d postpartum. Although reduced PPI is generally expected to increase conception rate because it allows for more opportunities to conceive, it actually adversely affected the rate of conception on first service when compared to normal weaned cows exposed to breeding at 60 d postpartum. The EW cows in the study, however, still became pregnant in that breeding season, and Houghton et al. cannot explain why cows did not have a higher rate of first service conception. They think, based on earlier research, that is has to do with the cow's nutritional status, their BCS, and suckling status, and that these factors reduced the energy needed for reproduction. Houghton et al. talks specifically about EW being an efficient way to manage situation in which there is insufficient forage to support a lactating cow, and especially cows with a low BCS at calving. Economically, they believe it would be better to feed early weaned calves to achieve optimal weight rather than to spend money on supplements for the cow in order to support lactation. They suggest that pre-partum nutrition is necessary to attain a good BCS – without over conditioning – as a way of achieving optimal pregnancy rates.

Story et al. (2000) addresses the financial aspects of EW. Production economics is one aspect of EW they say needs to be accounted for when weaning age is used as a management tool in beef production. They evaluated and analyzed the production costs associated with EW, and documented the various amount of feed and supplements given, and even went as far as to include labor and machine operating costs, and grazing costs. Essentially, they say that EW “shifts costs from the cow herd to the heifer development and feedlot enterprises”<sup>8</sup> For example, they reported a \$37 feed cost reduction in EW cows, but an \$18 increase in heifer development costs. On average, feed costs were \$82 higher for EW heifers than those weaned late.

## INTRODUCTION

Calves are weaned between 180 and 220 days in traditional beef production systems; when calves are weaned between 60 and 150 days, it is considered EW (Story et al., 2000). The cessation of milk production is the most immediate result of the weaning process, meaning the cow's need for and consumption of nutrients and forage changes. As a management strategy, EW can benefit the producer by reducing the demand for forage when forage is either limited or damaged, increase a cow's reproductive performance if they exhibit a low BCS at calving, and it can help maintain the BCS of cows during pregnancy (Story et al., 2000). Warner purport that young cows, still growing to their mature weight, benefit the most from EW (Story et al., 2000). With the lactation demand removed, nutrients can be utilized for cow growth and maintenance, thus improving a cow's BCS, and reducing the time she is in postpartum anestrus. The problem identified overwhelmingly by the beef cattle industry, and backed by research conducted by the USDA is the dramatic dip in pregnancy rate of second year heifers (Whittier, 2009). Stressors such as age, weight, body condition, suckling status, forage conditions and extreme weather conditions, such as drought and range fires, are typically to blame. Producers can be proactive in minimizing the effects of these stressors in order to increase the net value of their breeding herd. Research is clear that cows in better body condition have healthier calves and breed back sooner, thereby increasing the producer's profitability. It is advantageous therefore to understand the issues affecting body condition and then work to achieve and maintain optimal BCSs. The aim of this study is to evaluate whether EW improves the weight and body condition of first and second year heifers and leads to a higher and more consistent rate of subsequent pregnancies. This study will also evaluate potential improvements in performance for the in utero calves when early weaning occurs. Historically, EW has been used as a response

a crisis, rather than a management tool. It is hypothesized that early weaning gives first and second year heifers the ability to better adjust to range conditions and allows them to expend energy on growth and reproduction rather than lactation. This would also potentially improve the nutrient flow to the developing fetus.

## MATERIALS/METHODS

The heifers and cows used in this study came from the V-V ranch, owned and operated by the University of Arizona. The entire herd of heifers was randomly assigned to two groups and any heifers that died or whose calf died were removed from the study along with any heifer who did not breed back. Culling cows from the herd is an industry standard used by producers to achieve maximum productivity year after year; a cow's job is to produce, when that is compromised, she becomes a risk to the herd health and ultimately the producer's income. This resulted in 122 heifers that were early weaned and 199 heifers that were normal weaned in this study. First year heifers were maintained separately from the regular herd from weaning through heifer development. Heifers were brought back to the ranch at 13 months, BCS was assessed and recorded, and the heifers were bred. First breeding was done by artificial insemination with a CIDR/GnRH synchronization protocol. During this 9 day synchronization cycle, CIDRs were put in heifers on a Monday morning and they were given 2cc of GnRH, intramuscular (IM); 7 days later, CIDRs were pulled and heifers were given 5cc of lutalyse IM; finally, 2 days later, between 2-4 pm on Wednesday afternoon, all heifers were inseminated and given 2cc of GnRH IM. Fifteen days following AI, bulls were turned out with the heifers on pasture. The heifers were bred to start calving 30 days prior to the cow herd. This allowed them to have a longer postpartum interval and still breed with the cows. First year heifers remained separate from the main herd, on a separate pasture, until they calved their first calf, nine months later. At 60 days, heifers were brought in and palpated, at which time their BCS was also recorded. Seven months later, two weeks prior to calving, heifers were brought to dry lot. Calving dates were recorded along with body condition scores (BCS, 1-9 scale with 5 being average) at calving. As each heifer calved, they were moved to a new pen; a week later the heifer and her calf were turned out

on range with the rest of the cow herd. Eighty days later, heifers were brought back to be rebred. At breeding, weight and BCS was recorded. Calves from the cows randomly selected for the EW group were weaned and NW calves went back to pasture with their dam. Pregnancy status, weight, and BCS were recorded at fall palpation. Data collected allowed us to evaluate reproductive performance until the heifer was 5 years of age or culled from the herd for not rebreeding. Cows were culled from the herd if the cow was found to be open (not bred) at palpation 60 days following AI, meaning they did not take during AI or from being turned out with a bull.

Data were analyzed as a completely randomized design using the MIXED procedures of SAS (Littell et al., 1996). The model included weaning status, year and the interaction. The interaction was not significant ( $P=.84$ ) so the main effect of weaning status was reported. The reproductive data followed a binomial distribution with zero representing failure and 1 equaling reproductive success.

Table 1

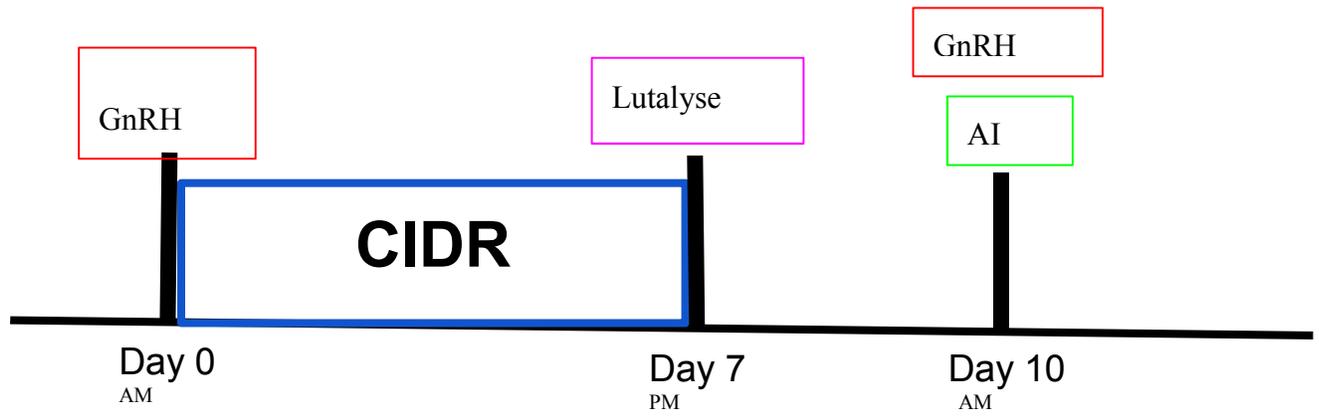
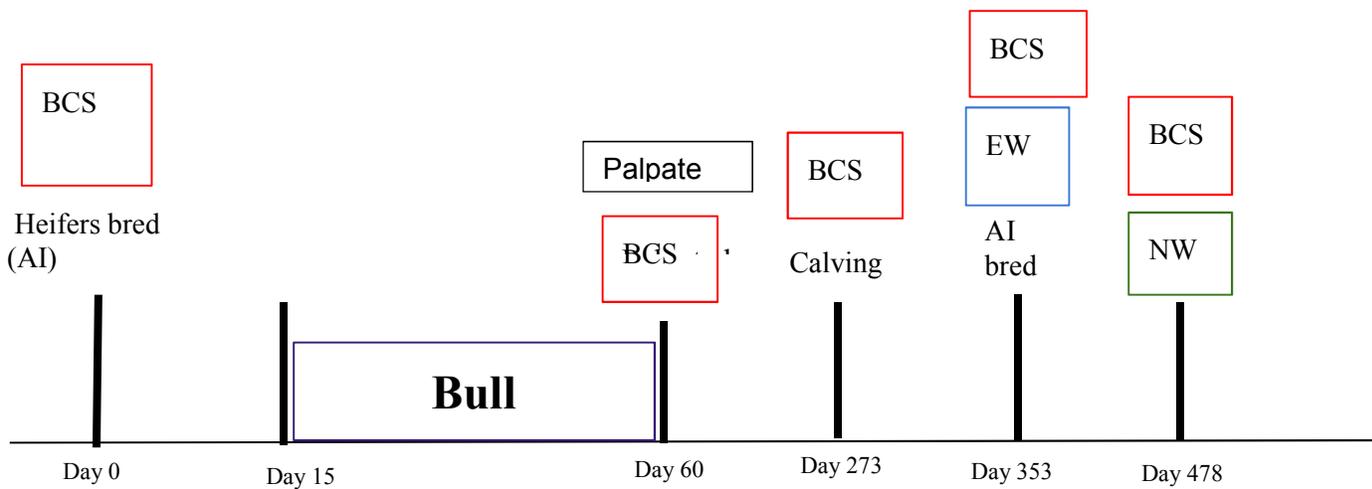
**Breeding Protocol**

Table 2

## Research Timeline



## RESULTS/DISCUSSION

The cow performance for heifers with their first calf EW or normal NW is shown in Table 3. EW first year heifers had a 23.7 kg improvement ( $P=.0001$ ) in weight, when compared to NW first year heifers at palpation. This weight gain is because by EW the first year heifers they were able to use resources to meet their needs for growth and gestation rather than milk production. BCS, on a scale of 1-9, will change based on weight; a gain of 35-45kg will increase the BCS by 1. There was a 0.4% improvement ( $P=.0001$ ) in BCS after calving in year one. Pregnancy rate was improved ( $P=.0001$ ) by 27% for the first year heifers whose calves were EW. This improvement in weight, BCS, and reproduction resulted in a 15% improvement ( $P=.02$ ) in survival to 5 years of age. These results are consistent with Odhiambo et al. (2009), who found that EW lowered the risk of a first year heifer being culled from the herd due to a reduction in stress from lactation demands and fewer forage requirements for cow maintenance.

Cow and calf performance for the year following early weaning are shown in Table 4. This represents differences due to improved gestational nutrients for the in utero calf. The weights and BCS at calving in the second year for the EW and NW cows were not different ( $P=.88$ ). This is due to a loss of 55 NW first year heifers and 22 of the EW first year heifers. They were culled because they were open. This is why there is a reduction in the overall number of heifers with observations in Table 4. It was expected that EW heifers would have higher BCS when compared to NW heifers, but this was not the case because so many heifers were culled from the original numbers. The heifers that were removed were lighter weight and in poorer BC than the heifers that became pregnant. Another factor that contributed to the lack of difference was that the EW heifers lost 25.5 kg more weight ( $P=0.02$ ) over the winter while grazing poor quality winter range. This could be because the first year heifers in the EW treatment had gained

23.7 kg more than the NW first year heifers. EW heifers had a 9 day shorter ( $P=0.03$ ) calving interval when compared to NW heifers, (Table 4). The reduced PPI for EW heifers is due to the heifer's ability to more effectively partition available nutrients. Due to EW the calves, we speculate that the absence in suckling increased the amount of LH needed to come into estrous, which allowed for the reduction in PPI. The data confirms the hypothesis that EW increases pregnancy rates and longevity in the herd. Bishop et al. indicates an association between BCS and LH, stating that suckling decreased the amount of LH needed to come into estrous Bishop et al. (1994). Further research is needed to determine if increased levels of LH is present due to EW. This research is consistent with Bishop et al. (1994) in that cows with higher BCS's came into estrus sooner, thereby reducing the PPI interval.

In the year following early weaning, calves from dams whose calves were EW in year 1 were 16 kg heavier ( $P=.0001$ ) at weaning than those from cows that were not EW in year 1 (Table 3). Part of this difference is due to the 9-day age difference ( $P=.008$ ) in age at weaning. This was due to the shorter PPI. Based on the ADG observed for the calves 7.2 kg of the difference is related to age, the other 8.8 kg is likely due to gestational nutrient availability of the calves in utero when the nutrient requirements for lactation were removed for the EW group of heifers. Summers and Funston found that improved gestational nutrition leads to the development of more muscle fibers during perinatal development, which leads to an increase in fat accumulation and marbling, thus, higher calf weights. This is consistent with this research which shows that the process of EW calves from first year heifers has the effect of increasing the average daily gain of calves from the same heifer in her second breeding year (Summers et al., 2013).

Early weaning was an effective strategy for improving reproductive performance of first

year heifers and their survival to 5 years of age. It also resulted in improved performance for their in utero calves if implemented as a management tool when BCS score and range conditions are poor, producers will see the benefit the following breeding season in their cow's reproductive performance and subsequent calf performance. Improved reproductive performance leads to higher margins of profitability.

Table 3. Cow Performance for Heifers with Their First Calf Early Weaned (EW) or Normal Weaned (NW)

	NW	EW	SE	P =
Number of observations	119	122		
Initial weight at breeding, kg	354	345	3.8	0.10
BCS at breeding	4.2	4.2	0.05	0.78
Pregnancy rate, %	55	82	4	0.0001
Palpation wt, kg	373	387	4.5	0.05
Weight change breeding to palpation, kg	19.5	43.2	2.5	0.0001
BCS palpation	4.9	5.3	0.07	0.0001
BCS <sup>1</sup> change breeding to Palpation	0.7	1.1	0.07	0.0001
5 year survival, %	38	53	4	0.02

<sup>1</sup>Body condition score on a 1-9 Scale with 5 being average

Table 4. Cow and Calf Performance the Year Following First Calf Early Weaned (EW) and Normal Weaned (NW)

	NW	EW	SE	P =
Number of observations	64	100		
Weight year 2 breeding, kg	395	396	15	0.88
BCS <sup>1</sup> year 2 breeding	4.5	4.4	0.1	0.63
Weight change palpation to breeding, kg	-2.7	-28.2	8.6	0.02
Calving interval, d	409	400	3	0.03
Calf birth weight, kg	33.2	33.6	0.5	0.30
Calf weaning weight, kg	169	185	5	0.001
ADG, kg/d	0.78	0.85	0.02	0.05
Calf weaning age, d	174	183	3	0.008

<sup>1</sup>Body Condition Score on a 1-9 scale with 5 being average

## REFERENCES

1. Basarab JA, Novak FS, Karren DB. Effects of early weaning on calf gain and cow performance and influence of breed, age of dam and sex of calf. *Canadian journal of animal science*. 1986;66(2):349-360.
2. Bishop DK, Wettemann RP, Spicer LJ. Body energy reserves influence the onset of luteal activity after early weaning of beef cows. *J Anim Sci*. 1994;72(10):2703-2708.
3. Faulkner DB. Management factors to improve range cow reproduction. . 2016.
4. Herd DB, Sprott LR. Body condition, nutrition and reproduction of beef cows. *Texas FARMER Collection*. 1998.
5. Houghton PL, Lemenager RP, Horstman LA, Hendrix KS, Moss GE. Effects of body composition, pre-and postpartum energy level and early weaning on reproductive performance of beef cows and preweaning calf gain. *J Anim Sci*. 1990;68(5):1438-1446.
6. Littell, R C, G A Milliken, W W Stroup, and R D Wolfinger. 1996. SAS system for Mixed Models. SAS Inst. Inc., Cary, NC.
7. Long PIP. Land & livestock. . 2009.
8. Mills B. Early weaning. *BEEF Magazine*. 2003;40(1).
9. Odhiambo JF, Rhinehart JD, Helmondollar R, et al. Effect of weaning regimen on energy profiles and reproductive performance of beef cows. *J Anim Sci*. 2009;87(7):2428-2436.
10. Šárová R, Špinka M, Panamá JLA, Šimeček P. Graded leadership by dominant animals in a herd of female beef cattle on pasture. *Anim Behav*. 2010;79(5):1037-1045.
11. Selk GE, Wettemann RP, Lusby KS, et al. Relationships among weight change, body condition and reproductive performance of range beef cows. *J Anim Sci*. 1988;66(12):3153-3159.

12. Short RE, Staigmiller RB, Bellows RA, Greer RC. Breeding heifers at one year of age: Biological and economic considerations. *FIELDS, MJ; SANDS, RS Factors affecting calf crop. Boca Raton: CRC. 1994:55-68.*
13. Story CE, Rasby RJ, Clark RT, Milton CT. Age of calf at weaning of spring-calving beef cows and the effect on cow and calf performance and production economics. *J Anim Sci. 2000;78(6):1403-1413.*
14. Summers AF, Funston RN. Fetal programming: Implications for beef cattle production. . 2013.
15. Vonnahme KA. Nutrition during gestation and fetal programming. . 2007.
16. Warner JM, Jenkins KH, Rasby RJ, Luebke MK, Erickson GE, Klopfenstein TJ. Effects of calf age at weaning on cow and calf performance and efficiency in a drylot/confinement production system. 2014.
17. Waterman RC, Geary TW, Paterson JA, Lipsey RJ. Early weaning in northern great plains beef cattle production systems: I. performance and reproductive response in range beef cows. *Livestock Science. 2012;148(1):26-35.*
18. Whittier JC. Profitable cow and heifer pregnancy rates. . 2009:264.