

# Building resilience in the cow herd with a systems approach

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## Abstract

Veterinarians involved with bovine practice are the main source of information to clients related to animal well-being. To remain relevant and bring value to clients, we must move from the pathogen/disease paradigm to one that encompasses systems thinking, particularly as it relates to building resilience in the system. Systems thinking is the ability to identify related forces that are a part of the business of cattle raising. Animal health can be measured with objective indices such as morbidity and mortality, and inputs spent on antibiotic use and preventive vaccines. When animal health issues occur in well-managed herds, resist the temptation to only search for pathogens related to disease; instead, ask the appropriate questions and seek out information necessary to identify the system of the ranch and look for ways to return to balance. Aspects of the system that must be addressed include genetic selection pressure, nutrition, grazing systems and management, environment, handling facilities, people behavior, competing enterprises, and labor resources. Trust with clients is critical to communication and to implement strategies to regain resilience and balance in the system.

**Key words:** resilience, AUE, system

## Introduction

The online *Merriam-Webster* dictionary defines resilience as an ability to recover from or adjust easily to misfortune or change. A system is defined as a group of interacting bodies under the influence of related forces. Cow-calf operations are complex systems with interacting disciplines responding to the influence of related forces. The ability of the cow-calf system to respond, recover and continue as a system requires a system that is resilient in the face of negative forces, such as drought, price, energy costs, inflation and labor pressure.

Interacting disciplines that require decision-making recommendations include genetic selection pressure, nutritional resources, geographical location, environmental stress and labor pressure, along with their contribution to health and well-being of the herd. Any of these forces for which decisions are made without consideration of the others can lead to long-term consequences and perhaps systemic collapse.

Beef cattle operations in the U.S. are based primarily on the availability of forage, whether the forage is harvested by grazing animals or via mechanical means. Most beef cow operations will graze permanent or annual pastures, cover crops and/or crop residue from 5 to 12 months annually. In periods of limited rainfall, short grazing seasons, or environmental stress such as extreme cold temperatures, cows and calves will be provided mechanically harvested forages, by-product feeds, and even grains to provide the energy, protein and minerals needed for life and well-being.

As graduate veterinarians and upon successful completion of required coursework, we are requested to repeat the veterinary oath:

*“Being admitted to the profession of veterinary medicine, I solemnly swear to use my scientific knowledge and skills for the benefit of society through the protection of animal health and welfare, the prevention and relief of animal suffering, the conservation of animal resources, the promotion of public health, and the advancement of medical knowledge.*

*I will practice my profession conscientiously, with dignity, and in keeping with the principles of veterinary medical ethics.*

*I accept as a lifelong obligation the continual improvement of my professional knowledge and competence.”<sup>1</sup>*

The oath that we take implies that veterinarians are obligated to be lifelong learners, problem solvers and system thinkers. What is a system thinker?

## Systems thinking: Identifying the system

Perhaps the best examples of beef cow-calf systems thinking, is to consider a contrast in beef cow herds. First, consider the beef cow herd that is “well-managed” regarding genetic selection as evidenced by paying for “good genetics”, with heavy calves sold at weaning or following a backgrounding program and bringing top dollar at sale time. Excellent nutrition as evidenced by adequate hay supplies of good quality forage, year around mineral program with organic or chelated minerals, environmental protection as evidenced by excellent facilities for weather protection during the calving season, handling facilities for processing animals and also an excellent preventive vaccine program.

In contrast, in herds we may consider “less well-managed”, genetic selection pressure is not placed on increasing size and pounds of weaned calf, nutrition is not designed for maximum output, but annual cow cost is a priority. Environmental protection is adequate for adult animals and calving seasons are timed for late spring and early summer calving. The preventive health program regarding vaccine usage is limited.

A frustrating experience for veterinarians is the issues in some years that occur in these operations. The “well-managed” herds have periodic episodes related to calf health, such as cases of calf diarrhea, coccidiosis, enterotoxemia, and “summer pneumonia”. In addition, cow herd issues related to pregnancy rates may occur, including high fall-out rates of young cows due to non-pregnant status and disappointing pregnancy rates in yearling heifers. These herds may also experience higher than expected incidence of post-weaning respiratory disease in calves. The occurrence of these issues in the well-managed herd may even exceed those observed in the “less well-managed” herds. With less well-managed herds, with seemingly few issues, veterinarians have often dismissed these scenarios as illusory,

due to lack of good record keeping, lack of inventory control, or simply not being aware of issues occurring in these herds.

In order to provide effective input into these operations, it is worthwhile to consider the system in which these herds exist. At this point, a comparison with systems that produce grain corn may help to edify the different systems. In the Northern Plains, corn farmers have the advantage of mapping fields. This mapping of the fields allows them to determine the soil type and fertility in different areas of individual fields. This allows for different rates of fertilization and herbicide use to be allocated such that expensive inputs are used most efficiently and to achieve the maximum output, i.e., bushels of corn/acre of crop ground. Interestingly, with inputs and outputs, the unit of measure is yield/acre. This level of technology is not used in our permanent pastures, and rarely used in the use of cover crops or crop residue for grazing. Fertilization of permanent pastures is not practiced, except for the droppings and urine of grazing animals. Weed management tends to be selective herbicide application, or some type of biological control or grazing management. Production is dependent upon precipitation, grazing times and stocking rates.

Ranch A, as the “well-managed” operation has 2500 acres of permanent pasture and cover crop property as well as 1000 acres in which corn, soybeans and wheat are in a rotation. The calving season begins for the heifers at the end of February, and the cow herd begins in mid-March. This ranch has 3 persons with ownership involved in the cattle business as well as the grain business, with extra help during the calving season and harvesting season. The calving season covers 90 days, however, the majority (75%) of calves are born in the first 2 cycles. As much cover crop and crop residue as possible is utilized for late-season adult cow grazing, while calves are weaned in mid-October and the heavy steers are sold off the cow at this time. During the grazing season, each cow-calf pair is assigned to a pasture allowing for 8 acres per pair. The grazing season begins approximately mid to the third week in May, and terminates when calves are weaned. The average annual rainfall for the ranch is 18 to 21 inches of moisture. The ground for the permanent pasture is wholly owned, but rent/acre on similar ground would be \$25/acre, thus the cost of summer grazing for the cow and calf (AU) is \$200. Cows are fed during the winter to meet their daily nutritional requirements for 5 months, while 2 months in late-season grazing they are supplemented along with cover crop and crop residue grazing. The period of 5 months for feeding dry cows is considered to be \$2/cow/day, a \$300 annual expense, and the 2-month late season period is expensed as \$1.00/cow/day, a \$60/cow/year expense. The total cost for permanent pasture, supplemental and winter-feeding excluding mineral is \$560. The average mature cow size as measured by weight is 1550 pounds with frame scores ranging from 5.5 to 6.5. Adult cows are pregnancy tested at weaning time, with pregnancy rates averaging 92%.

Ranch B, the “less well-managed” operation, has similar resources, however, calving begins late April for heifers and adult cows. This ranch has 2 persons responsible for the cow business and extra help available for the harvest season. Calving season covers 90 days although most calves are born in the first two cycles. Again, cover crop and crop residue are utilized for late-season grazing and harvested forages are fed for approximately 5 months. Cow costs on a per acre basis and cost/ton of feed are similar to Ranch A. Ranch B cows average 1350 pounds with frame score ranging from 4 to 5. Using the daily cost above, and assuming that this meets all requirements, we

scale the daily costs for Ranch B according to difference in daily energy demand (i.e., metabolic weight ratio).

For this herd, during the birth-to-weaning period, the intake per cow with weight averaging 1350 pounds (614 kg) would be 10.8 kg (23.8 pounds). Calculated intake over this 210-day period is 4998 pounds (2272 kg). AUE is  $614(0.75)/500(0.75) = 1.23$  AUE.  $1.23 \text{ AUE}(8.8\text{kg}) = 10.8 \text{ kg}$ .

While the approach to nutritional management seems similar among these two ranches, primary differences in the energy demand of the cow herds exist. For ranch A, annual energy requirements of the cows is expected to total 6200 Mcal NEM (according to NASEM, 2016 equations), with approximately 2300 Mcal being supplied during the 5 month full-feeding period. For ranch B, cow demands are approximately 7% less. As a result, annual purchased feed costs for Ranch B are \$335 per cow rather than \$360, given the same feed prices. This difference also applies to the grazing periods of the year. Using a metabolic weight-based animal unit equivalent, where the annual demand of a grazing animal is expressed relative to that of a 500 kg reference animal (Allen et al., 2011), cows at ranch A represent 1.29 AUE compared to 1.16 AUE for Ranch B. Because grazing areas are stocked to capacity, and costs are per acre, the effective summer grazing costs for ranch B are \$186 rather than \$200 per cow.

It is important to note that Ranch A cows must wean more pounds of calf per cow exposed than Ranch B cows just to overcome differences in variable costs, but must do so without increases in milk production (as this comparison assumes that milk production is equivalent). Selection for calf growth rate is often an inadvertent selection for larger mature size and/or increased milk yield.

## Systems thinking: Genetic selection/nutrition

When additional milk production is included, the difference in demand among cows from Ranch A and Ranch B is magnified. Assuming a 25% increase in relative peak milk yield for cows at ranch A, total annual energy demand increases to 6385 Mcal per cow. This has the effect of increasing purchased feed expense to \$396 per year and increases the AUE during the grazing period from 1.29 to 1.35. As a result, stocking rate must be reduced to remain within the capacity (or more acres rented), resulting in an increase in grazing costs per cow from \$200 to \$209. Increased milk production may have other effects in the system. Edwards et al., compared different milk production in Angus cows that ranged from 14 pounds of milk (24 hour) to 26.4 pounds (24 hour) at day 58 and 129 postpartum with favorable forage quality conditions. With body condition score (BCS) the same for all levels of milk production, low, moderate and high, AI conception rates were 57, 55 and 44 while pregnancy rates were 81, 85 and 75, respectively.<sup>3</sup> When milk production is emphasized as a trait in genetic selection, higher milking ability may decrease the ability of beef cows to adapt to suboptimal conditions which reduces resiliency.<sup>4</sup> Any reductions in productivity would further increase the costs per weaned calf, amplifying the increase in cow costs.

Along with genetic selection and providing nutrition to meet the needs for reproduction and milk production is the environment. Does the environment and the geographical location provide the conditions necessary for the cow for rebreeding, milk production and the early- to mid-gestation period? In addition,

the calf experiences rapid growth during these favorable forage growing conditions. In the Northern Plains, this is heavily dependent on precipitation and sun radiation during the months beginning in April through June. Although from a resiliency perspective, 30% of the time spring rainfall does not meet the expected average rainfall amounts.<sup>5</sup> Knowing this, it is more important to make genetic selection pressure on traits that are not as sensitive to the fluctuations in rainfall and temperature. However, most production traits such as weaning weight, yearling weight, milk production and pregnancy rates, are indeed very sensitive to this uncontrollable suboptimal forage growing conditions.<sup>6</sup> The sensitivity of these traits to forage conditions is directly related to the differences in nutrient demand that result from selection for larger cows with higher milk yield. With higher demand per cow, any disruption in nutrient supply is more likely to result in disruptions in production, especially in threshold responses like pregnancy.

Scasta et al., demonstrated that smaller cow size < 1400 pounds were more efficient in drier years, which may be due to smaller cows' lower maintenance requirements. Under less-than-ideal conditions, cows with higher requirements will be affected more quickly, especially if a smaller "buffer" in demand relative to capacity exists. The Wyoming study showed that permanent pasture production ranged from 651 kg/ha in dry years to 1431 kg/ha in favorable growing conditions.<sup>7</sup> Thompson calculated cow efficiencies based on body weight and weaning weight, demonstrated that while weaning weight increased with increasing DBW, weaning weight as a percentage of cow body weight decreased by 38%. In addition, due to differences in stocking rates using AUE, with every 100 kg reduction in body weight, weaning increased by 26.38 kg/ha.<sup>6</sup>

The comparison of Ranch A and Ranch B help to illustrate how the drive to increase productivity can have unintended consequences in a systems framework. As costs increase, pressure to select for increased outputs (and revenue) increase, but this may ultimately further increase costs and create a vicious cycle (an example of the fixes that fail archetype). This can be amplified when the variability in the grazing environment is considered; as resource demand escalates, the likelihood that weather disruption results in a nutrient deficit increases, and the system becomes more brittle (less able to cope with shocks). Selection pressure for these traits must be coupled with geographical location and average rainfall, allowing for the years which are common when suboptimal conditions occur. Cattle have the ability to adapt to different environments and nutrient availability. Purchasing genetics that meet the criteria of the resiliency and ranch and that are raised in similar environmental conditions will bring benefits to the long-term resiliency of the ranch business.

## Systems thinking: Animal health

Can genetic selection pressure for resiliency also result in improvements in health parameters? Again, this must be with a systems approach to calf health. Certainly, a biosecurity plan must be in place to reduce the risk of exposure to infectious diseases such as Johne's, trichomonosis, BVDV and even pathogens common to calf diarrhea. Beyond that however, is calf health in a systems approach improved when resiliency in the system is prioritized?

Calf health is dependent upon a system that emphasizes reducing stress, minimizes exposure to potential pathogens, enhances passive transfer, implementing evidence-based vaccine protocols, limits to herd introductions, control of commingling

within herd movements and manages with the seasons of the year regarding forage production and more favorable weather.

As it relates to passive transfer, estimates of failure of passive transfer (FPT) or partial failure of passive transfer (PFPT) range from 6% to 19% in beef cattle and from 4.2% to 33% in dairy cattle. Windeyer et al., demonstrated STP (serum total proteins) < 5.2 were associated with mortality and STP < 5.7 were associated with morbidity due to BRD.<sup>8</sup> In addition, Altvater et al., has estimated heritability of IgG and NAb ((natural antibody) with STP (serum total protein) in dairy and beef cattle. This work suggests that heritability of NAb (IgM) is moderate in dairy cattle and low in beef cattle.<sup>9</sup> This area of work could be an additional trait involving genetic selection to improve calf health.

Within the system there are multiple factors that influence the health protective aspects of passive transfer. Genetically, birth weight and calving ease influence passive transfer through promoting calf vigor and early nursing. In addition, cows that calve without assistance and with excellent mothering ability are able to promote early calf nursing. It also appears likely that moderate milk production leads to consumable amounts of colostrum post-calving with high concentration of immune components. Turini et al., showed that higher quality colostrum results in greater absorption and that birthweight influences absorption; heavier birthweight calves require increased intake to result in adequate passive transfer.<sup>10</sup> Newborn calves within the first 24 hours of life will consume to satiety variable amounts of colostrum. In dairy calves (n = 36) with voluntary intake (bottle feeding) of colostrum varied from 4 liters, 42% of the group, 3-4L, 25%, 2-3L, 11%, < 2L, 22%. Calf birthweight, vigor during nursing, and vigor in the first hour of life explained over 60% of intake.<sup>11</sup> The duration and volume of nursing depend on cow factors in the beef herds. Factors include udder and teat conformation, positive cow behavior toward the newborn calf such as licking, encouraging standing, directing calf to the udder and healthy udder and teats.

Calving in environments with low amounts of weather stress and mud has resulted in a shift of the calving season in the Northern Plains. Murray et al., suggests that mortality from 7 days to weaning was lower by 0.7% when calving season started in April.<sup>12</sup> While calving later in late April, May and early June, reduces the risk of inclement weather, calf stress, morbidity, mortality and additional labor resources, it does not provide the ideal forage conditions for rebreeding and milk production as many cool season grasses have matured at bull turnout time in mid to late July and early August. Moving the calving season will generally result in moving weaning dates to later in the fall and early winter. This is not necessary as weaning calves early in life has been shown to be a positive management decision in terms of calf health and reducing the nutrient requirements of the beef cow due to cessation of nursing and milk production. Moving the calving season will often result in a change to marketing times as well. Producers that calve later in the season may choose to background calves for marketing in the late winter/early spring season, or may choose to overwinter calves on a maintenance- to low-growth plane of nutrition and turn out in the spring in a yearling program. It is important to recognize that a later calving season changes the system and may impact input costs and revenue.<sup>13</sup>

## Systems thinking: Economics

The primary crop in the cow-calf operation is the marketing of calves. The value of calves is determined by multiple factors, including lot size, breed, uniformity, reputation and weight. While unit value (price) tends to decrease as weight increases (ie., the price slide), total value per calf typically increases with increasing weight. This marginal rate of change in calf value with respect to weight is often described as the value of gain. Value of gain is not necessarily a constant; it may be higher for very lightweight calves that are perceived to have high health risk (i.e., there is a risk premium placed on the gain), but may be very low across certain weight ranges given the availability of suitable feed resources for calves in a particular weight class. Using the weekly calf market summary for September 6 out of Nebraska with a group of 45, 558-pound (fancy) steer calves brought \$239/cwt., while a group of 46 steers weighing an average 668 pounds brought \$202/cwt. The 558-pound calves returned \$1334 dollars/head.<sup>14</sup> The 669-pound calves returned \$1351. The difference in dollars is \$17.38, which implies that the added weight was valued at only \$0.156/pound for the extra 111 pounds. If the costs of producing that additional weight (its marginal cost) exceeded its value, it was not profitable for a producer to increase weight. The benefits of a systems approach emphasizing resilience provides evidence that maximizing output may not be economically beneficial.

## Conclusions

Practicing veterinarians must have the depth of knowledge and experience to provide services including recommendations into beef herds of all sizes and geographical locations. The ability to think of beef herds as systems is critical to break free of the pathogen/disease paradigm. When the system is out of balance, the appearance of disease with an identified pathogen is a symptom, not necessarily a cause. Recognize that there are multiple related forces within the system that results in the appearance of symptoms within the system. Genetics, nutrition, environment, labor, capital, land cost and availability are either competing with one another or are complementary to one another. It is important to identify the system of each herd and begin to communicate to clients a different way of thinking, creating resilience and producing live calves per an agreed upon unit of measure, such as the number of calves weaned per the number of cows that were confirmed pregnant, or the number of calves weaned per the number of cows turned out to be bred. Alternatively, the number of weaned calves per acre of available grazing acres although this is limited by regional geographic location and precipitation.

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