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Meat substitutes: How much should we worry?

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Introduction

Protein demand has increased dramatically in recent years. This demand is expected to continue rising as the global population swells to 9 billion by 2050. Animal protein consumption has grown in developing countries where increased supply is available. However, animal protein is often limited in certain countries. Interest in alternative proteins has grown in highly developed countries due to animal welfare, environmental sustainability, and human health concerns. Today, meat substitutes like plant-based, fermentation-based, and cultured proteins are an area of enormous interest and research. At the same time, numerous questions about these products exist.

Plant-based proteins

Plant-based meat products like tofu, tempeh, and seitan have existed for centuries. However, new technologies and processing methods have made it possible for plant-based products to closely approximate traditional meat. Leaders in the plant-based meat sector (E.g., Impossible Foods and Beyond Meat) seek to develop and commercialize plant-based meat alternatives with flavor, texture, nutrition, and functionality similar to traditional meat. This task is much more complex than it sounds. Plant proteins need to fulfill multiple roles (texture, sensory, colorant, and more) to partially or entirely mimic meat characteristics. Soy, pea, and wheat proteins are the most common raw materials used today to replace animal proteins in meat analog products.

The global pandemic, supply chain disruptions, and panic buying in 2020 created a tremendous opportunity for refrigerated, plant-based meat sales as supplies of traditional meat were uncertain. However, compared to traditional meat and poultry sales, market share of plant-based meat products decreased during the height of the pandemic. Nonetheless, plant-based meat still has enormous investor and consumer interest. In 2021, refrigerated plant-based meat sales reached $481 million, a 1.8% increase over 2020 (Roerink, 2022). However, to put this in context, refrigerated meat and poultry sales were $82 billion in 2021. Therefore, plant-based meat sales make up less than 1% of the current market. Even tremendous growth of this product sector will still make it a small portion of the overall “meat” market.

Cultured animal proteins

The development of cell-cultured proteins are the next frontier of alternative meat products. Cell-culturing has been used in biological research since the 1970s, but has only recently been pursued as a food production technique. The simplified steps used to make cultured meat products include:

- Choosing cells to develop.
- Culturing cells in media.
- Structuring cells onto tissue forms.
- Further cultivating those tissues.

However, each step faces significant technical challenges when scaling up from the milliliter volume needed for research to thousands of liters for commercial production. Although there are dozens of cultivated meat companies worldwide, none have yet reached wide-spread commercialization from a scale or cost standpoint. Experts estimate cultured meats companies are 1 - 5 years away from commercially available products using cultured cells as an ingredient blended into a plant-based meat product. In addition, the timeline is much longer for producing cultured meat products capable of replicating whole muscle tissue like that in steaks or roasts due to the difficulty of imitating muscle structure (Boler et al., 2020; Miller, 2020).

Fermentation-based proteins

Through biomass fermentation, companies can grow large amounts of high-protein microorganisms like yeast. These microorganisms are then used as sources of food protein and as an ingredient in alternative meat products. In the future, precision fermentation may use microorganisms to produce specific proteins for use as ingredients similar to the production of rennet for cheese making that is widely used today. Not limited to proteins, microorganisms could be used to create particular enzymes, pigments, flavor molecules, vitamins, and more.

Nutritional equivalence

The goal of most meat-alternatives from a nutritional perspective is to provide a source of protein in the diet. However, protein quality differs between animal and plant sources of protein. High-quality proteins contain all the essential amino acids needed for human growth, in the right amounts, and are highly bioavailable. Recent studies have shown animal-based burgers have greater protein quality than the plant-based Impossible Burger or Beyond Burger (Fanelli et al., 2021). Protein quality, however, may not be important for the average consumer. Survey data suggest consumers' purchasing decisions are more related to their perception of what a product represents than its essential amino acid or micronutrient profile (The Hartman Group, 2019).

Environmental sustainability

The superior environmental impact of alternative meat products is often cited as a reason for its future adoption. However, the environmental impact of alternative protein production methods is relatively unclear. For example, some life cycle assessments have reported that cultured meat production is more environmentally friendly than beef production (Lynch & Pierrehumbert, 2019). Nonetheless, these studies are challenging to assess because of the fast pace of technology evolution and environmental differences between specific greenhouse gas emissions.

Consumer perception

Younger US and UK consumers (Millennials and Gen Z) show increased interest in buying alternative meat products (Szejda et al., 2021). However, these two consumer groups also purchase the most traditional meat and poultry. Despite consumer worries about traditional meat consumption's environmental and ethical impact, consumers' view of meat consumption remains strong. In comparison, consumers' main concerns about cultured meat products were price, taste and appeal, unnatural perception (Wilks & Phillips, 2017). As a result, experts agree that US consumers will likely try cultured meat products when available. Still, few would replace traditional meat in their diet.

Conclusion

Alternative meat products are a rapidly evolving segment of the food industry. There is little doubt that alternative meat sales will continue to rise, given strong investor support and growing consumer interest. However, in the coming years, it's important to remember that consumers worldwide are projected to eat more traditional meat and poultry than ever as well. As the food industry works to double protein availability by 2050 to feed an expanding world population, there is likely room for the growth of both animal and alternative proteins.

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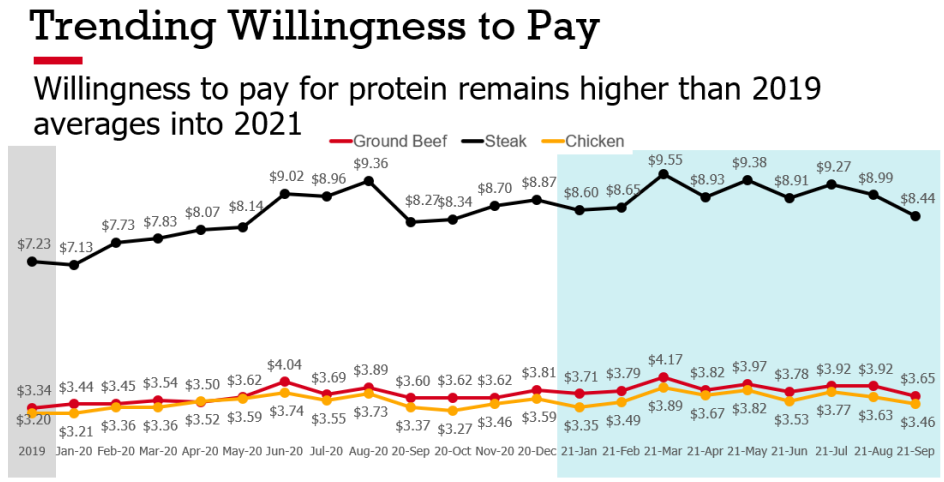
Consumer buying trends and perceptions

Tammy Vaassen, Executive Director, Wisconsin Beef Council; Casey Anderson, Director of Industry Relations, Iowa Beef Industry Council

State of the union

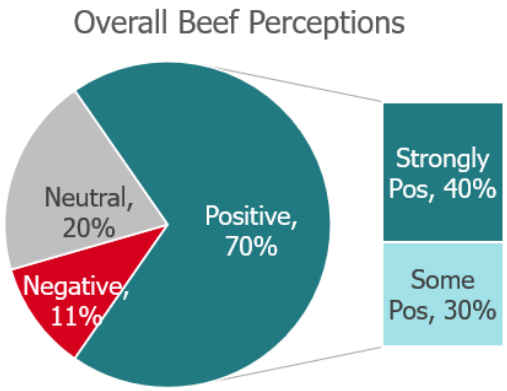
The past two years have been a tumultuous time to navigate the protein sector as COVID has rocked supply chains and challenged protein availability and access to consumers' favorite protein products. Adoption of online ordering services and food delivery service apps are changing the way consumers view their next meal. All the while topics such as sustainability, how cattle are raised and carbon footprint continue to be hot topics as consumers seek food that aligns with their personal values.



Source: Consumer Beef Tracker 2019 – Jul 2021

1.Covid impact

- Covid led to consumers cooking from home more frequently and data shows they intend to continue that trend going forward.
- Foodservice, online meal ordering and online grocery orders continue to trend up
- Beef demand at an 30 year high as consumers still show willingness to pay

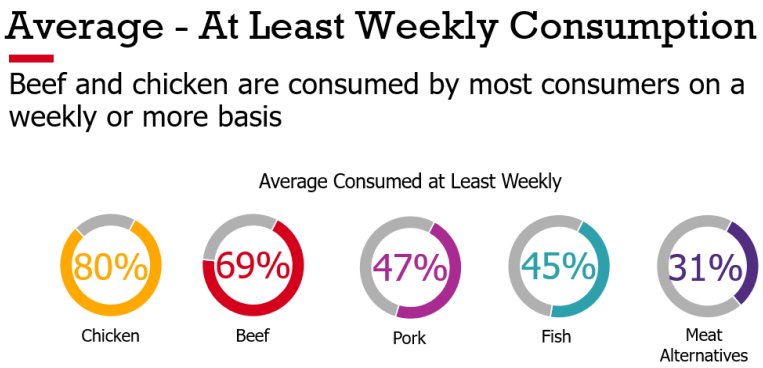


2. Consumer behavior

- Chicken continues to be beef's largest competitor in sales volume and consumer perceptions about how the product is raised
- Regular meat consumers (68% of the study's full sample) are much less likely to select a plant-based item when a beef item is available
- Alternative proteins make up less than 1% of the protein market share

3. Sustainability

- Consumers plan to eat more beef primarily because of it's great taste
- Beef is challenged by other proteins that are viewed as more healthy
- Of consumers who have concerns about how their food is raised, animal welfare is a top indexing concern



4. Demand drivers

- Beef Checkoff target audience is older millennial parents – roughly those in the 25-34 age group
- Eating experience, convenience, versatility, price, raised/grown, nutrition are top driving factors for consumer decision making
- Investing in resources geared toward influential figures who impact consumer decision making is key ie. (dieticians, doctors, pediatricians, lifestyle bloggers, etc.)

Rush Creek Ranch: An intensive rotational grazing stocker operation in Wisconsin

Matt Ludlow, Partner at Rush Creek Ranch

Since 1976, Rush Creek Ranch has utilized the rough terrain of Southwestern Wisconsin to graze stocker calves. Many changes have taken place in the last 45+ years on the operation: from how intensely the animals are stocked to the number of days the animals are able to be grazed in Wisconsin during a given season to the use of supplemental feed that is purchased and fed each year.

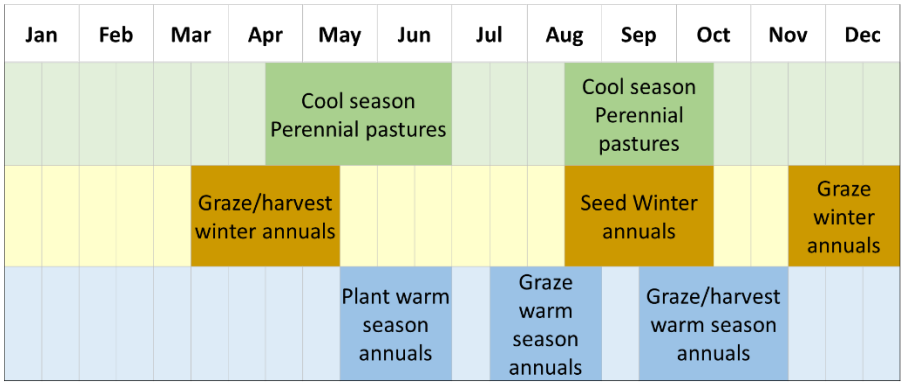
In keeping a focus on their ROI (return on investment), Rush Creek Ranch has been able to increase the overall size of their operation both in regard to grazeable acres and the number of cattle ran each season. Through purchasing and backgrounding lightweight calves in the Southeastern United States, Rush Creek Ranch is able to stock their Wisconsin pastures at the right time in the spring with the correct stocking density.

Matt and his father, Reid, are partners at Rush Creek Ranch. They were featured in BEEF magazine as the 2020 National Stocker Award winners.

Annual forages to fill the grazing gap

Denise Schwab, extension beef field specialist, Iowa State University Extension and Outreach, Vinton, IA

Incorporating annual forages into a cattle operation has many benefits. They can help extend the grazing season with early spring growth, late season grazing, or fill the summer slump of perennial cool season pastures. Typically, annual forages are high in feed value; however, this can vary significantly based on maturity at grazing or harvest. By adding winter and early spring growth when we traditionally have heavy rain fall, annual forages can help reduce soil erosion, and provide additional benefits such as increase soil water infiltration and improve soil health. Summer annual forages can help break up the traditional corn-soybean rotation providing additional options to control weed, disease and insect pressure. However, annual forage production requires annual input costs above perennial forages, and its success depends on weather patterns.



Benefits of annual forages

Annual forages can be categorized into three main types: spring-seeded cool season annuals, summer-seeded warm season annuals, and fall-seeded winter annuals. These should be planted or drilled very early in the spring (March or April) as soon as conditions are fit and are typically harvested in June or early July for forage. All cool-season cereal grains mature quickly, generally maturing from boot to milk stage in less than two weeks, increasing total forage yield but also decreasing feed value. Cool season annuals can be utilized for grazing, hay or silage. Since perennial pastures are growing rapidly at this time of year, these annuals typically fill the need for stored feed as hay or silage.

Warm season annuals such as the sorghum and millet families, crab grass, and teff grass are seeded in the early summer after soil temperatures reach 60-65°F at a depth of 4 inches. They grow best in hot summer conditions and function well to fill the gap during hot summer grazing months, when traditional cool season perennial forages go dormant. Most can be grazed or harvested multiple (typically 2) times throughout the summer, except for foxtail millet which is a single cut forage. Forage sorghums tend to have the highest full-season yield whereas the single-cut foxtail millet tends to yield the least, and the sorghum x sudangrass hybrids, sudangrass, millets and teff grass yield somewhere in the middle. One very important factor for multiple cuttings of the sorghum family is to ensure leaving at least 6-8" of stubble or at least to the second node to provide for regrowth. Foxtail millet and teff work well for hay, but the large stalk size of the sorghum family and other millets do not dry down well for hay. In Iowa, these forages are better utilized for grazing or as silage.

Winter annual forages are often used as cover crops and provide late fall and early spring grazing or harvest. If seeded early (August) they can provide late fall grazing, allowing perennial pastures time to rest going into winter. They also provide very early spring grazing prior to pasture turnout and work great for spring calving pastures. Forage yield is highly dependent on seeding date, fall weather, and maturity at harvest.

Annual forages are not without challenges. The main health challenge is prussic acid poisoning in sorghums, nitrate accumulation especially under drought conditions, and sulfur accumulation in brassicas. More details on

health concerns when grazing annual forages can be found in Managing Cattle Health Issues When Grazing Cover Crops, IBC129, at https://store.extension.iastate.edu/product/15455.

Iowa research

Winter annual forage yields across four Iowa research farms and two winters ranged from less than one ton/acre DM to 2.4 ton/acre DM depending on species, seeding date, harvest date and harvest maturity. Forage quality ranged from 11 to 26% crude protein and 55 to 69% TDN, far exceeding the needs of a spring lactating beef cow.

Summer annual forage yields across four Iowa research farms and two summers ranged from one ton/acre DM to over 5 ton/acre DM depending on species, seeding date, harvest date and harvest maturity. Forage quality ranged from 5 to 23% crude protein and 49 to 68% TDN. Most of the forages sampled exceeded the needs of a spring lactating beef cow, however some very mature samples failed to meet a cow's needs.

Budgets

The ISU Ag Decision Maker Estimated Cost of Production for oat or small grain spreadsheet can be used to calculate annual forage budgets. Annual forages that are grazed, or double cropping a winter annual followed by a summer annual tend to be lower in cost and often are equal to or less than the cost of feeding stored hay.

Summary

Winter, spring and summer annual forages all help fill the grazing gaps in conventional cool season perennial grass pastures and may also provide additional stored feed. Annual forage yields vary by year, species, soil type, fertility and weather conditions. Yield ranges from 1.5-2.5 ton for winter and spring annuals and 2-5 ton for summer annuals in Iowa trials. Yield increases but quality decreases as plants mature. Most annual forages meet or exceed the nutritional needs for lactation beef cows. And annual forages are comparable to or more economical than hay prices in most years.

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Understanding what Influences your ROI

Bill Halfman, UW Madison Division of Extension

There are several different factors that influence return on investment (ROI) of cattle finishing enterprises. These factors can be grouped into two general categories; factors that influence animal growth and performance thereby likely impacting the cost per unit of production, and factors related to the costs of overhead and related inputs used and or allocated to the finishing enterprise. Even small reductions or improvements in cost efficiency per head can add up over time, especially when operations have greater numbers of cattle on feed and when we consider that historically cattle feeding has had narrow margins.

Factors that influence animal growth and performance

Pen cleaning and bedding

Pen cleaning and bedding impact animals in different ways. Clean dry animals with some shelter from wind are less impacted by cold stress than animals with dirty, matted, and or wet hair coats and those exposed to the wind. Several trials have been done with beef cattle being fed out that have shown the impact and value of bedding.

The following examples illustrate how hair coat condition at different temperatures and wind speeds impacts beef and dairy steers. Three typical winter temperature scenarios for the Driftless Region were developed using Iowa State's Beef Ration and Nutrition Decision Software (BRaNDS) to evaluate 700 pound beef steers and 900 pound dairy steers with and without exposure to a 10 mile per hour wind. A 64 MCal NEg finishing ration was used to develop the estimates. The major difference between dairy and beef steers is the difference in maintenance energy requirements needed to cope with the various cold stress levels used in the examples. The feed prices used in the examples to calculate feed cost of gain are from UW Extension 2019 and 2021 fall projections which represent approximate costs of finishing rations in the examples at $3.50/ bu corn ($165/ton D.M. ration) and $5.00/bu corn ($220/ton D.M. ration).

Table 2 shows beef and dairy steers at 20º F with and without a 10 mile per hour wind (average conditions in the region for several months in the winter according to the National Weather Service). Cattle with clean dry coats handle the additional cold stress from the wind, however the animals with the dirty coats, (tag scores of 3 to 4 using the Mud and Manure Scores publication from Iowa State University) had decreased gains and increased feed conversions. The differences may not appear to be very large but it is important to recognize that these conditions likely exist for 3 or more months during the winter and when multiplied over several animals in a pen the differences can quickly add up.

Table 2. The effects of coat condition, temperature and wind speed on gain and feed efficiency of 700 pound beef steer and 900 pound dairy steer at 20º F.

Temperature 20º F	**No wind**		**10 mph wind**	
700 lb Beef	**Clean & dry**	**Heavy Mud**	**Clean & dry**	**Heavy Mud**
Ave. Daily Gain (lb./day)	3.5	3.5	3.5	3.1
Feed: Gain (lb : lb)	5.0	5.0	5.0	5.6
Feed Cost of Gain @$ 165/T d.m ($/cwt)	$41.25		$41.25	$46.20
Feed Cost of Gain @ $220/T d.m. ($/cwt)	$55.00		$55.00	$61.60
900 lb Dairy				
Ave. Daily Gain (lb./day)	3.0	3.0	3.0	2.7
Feed: Gain (lb : lb)	7.6	7.6	7.6	8.6
Feed Cost of Gain @ $165/T d.m ($/cwt)	$62.70		$62.70	$70.95
Feed Cost of Gain @ $220/T d.m. ($/cwt)	$83.60		$83.60	$94.60

Table 3 compares the same animals at 0º F. When there are cold spells that last from a few days to stretches of several weeks. At this more extreme temperature, both types of cattle see bigger decreases in performance when exposed to wind, but the clean open hair coat does help reduce the negative impacts of the cold stress. The response of steers, beef or dairy, will probably be to consume more dry matter (DM) during cold stress, but this response has not been measured for dairy steers. The likely increase in DM consumption may slightly reduce the decrease in gain but will not reduce the increased energy needed for maintenance and increases in cost per gain. Steers eating from feed bunks under roof and sheltered from wind will be less subject to the increase in DM consumption due to cold stress.

Table 3. The effects of coat condition, temperature and wind speed on gain and feed efficiency of 700 pound beef steer and 900 pound dairy steer at 0º F.

Temperature 0º F	**No wind**		**10 mph wind**	
700 lb Beef	**Clean & dry**	**Heavy Mud**	**Clean & dry**	**Heavy Mud**
Ave. Daily Gain (lb./day)	3.4	3.1	3.4	2.4
Feed: Gain (lb : lb)	5.2	5.9	5.2	7.3
Feed Cost of Gain @$ 165/T d.m ($/cwt)	$42.90	$48.68	$42.90	$60.23
Feed Cost of Gain @ $220/T d.m. ($/cwt)	$57.20	$64.90	$57.20	$80.30
900 lb Dairy				
Ave. Daily Gain (lb./day)	2.9	2.5	2.8	2.0
Feed: Gain (lb : lb)	7.9	9.4	8.3	11.5
Feed Cost of Gain @$ 165/T d.m ($/cwt)	$65.18	$77.55	$68.48	$94.88
Feed Cost of Gain @ $220/T d.m. ($/cwt)	$86.90	$103.40	$91.30	$126.50

Excessively wet pen conditions and lack of bedding also contribute to cold stress. Table 4 compares steers at a 30º F average temperature with wet and/or matted coats to dry clean coats with and without a 10 mph wind. These conditions could be common in early and late winter, and possibly throughout a mild winter. The wet and/or matted coat shows even greater decreases in performance at 30º F than the dirty but drier coats do at 20º F.

Table 4. The effects of coat condition, temperature and wind speed on gain and feed efficiency of 700 pound beef steer and 900 pound dairy steer at 30º F.

Temperature 30º F	**No wind**		**10 mph wind**	
700 lb Beef	**Clean & dry**	**Wet/matted**	**Clean & dry**	**Wet/matted**
Ave. Daily Gain (lb./day)	3.6	3.1	3.6	2.8
Feed: Gain (lb : lb)	4.9	5.7	4.9	6.3
Feed Cost of Gain @$ 165/T d.m ($/cwt)	$40.26	$47.03	$40.26	$51.98
Feed Cost of Gain @ $220/T d.m. ($/cwt)	$53.90	$62.70	$53.90	$69.30
900 lb Dairy				
Ave. Daily Gain (lb./day)	3.1	2.8	3.1	2.6
Feed: Gain (lb : lb)	7.6	8.4	7.6	9.0
Feed Cost of Gain @$ 165/T d.m ($/cwt)	$62.70	$69.30	$62.70	$74.25
Feed Cost of Gain @ $220/T d.m. ($/cwt)	$83.60	$92.40	$83.60	$99.00

In addition, mud and manure as shallow as dewclaw deep begins to increase energy needed to move around. Excessive mud and manure depth, usually also associated with higher tag scores, adds more stress on confined cattle. The additional energy used by the cattle to move through deep mud and manure results in decreased gains. In addition to the increased energy expended which reduces feed efficiency and increases cost of gain, poor pen

maintenance will also add additional days to meet the target weight further increasing feed and yardage costs. It can also increase foot and leg injuries.

The decreases in gain shown by the estimates above could easily add an additional 20 to 70 days on feed to reach the same target end weights which would add additional feed and yardage costs to the total cost of finishing the animals.

In summary of pen maintenance, it is important to implement management practices that will protect cattle from adverse weather and excessive mud. Not doing so increases cost of gain both during the time of the stress and due to additional time needed to reach the desired end weight.

Cattle handling and stockmanship

Cattle handling and stockmanship methods impact animal growth and performance. Low stress cattle handling methods have been discussed and promoted for many years. Improved stockmanship and low stress handling methods include utilizing the animals' natural tendencies to the handlers advantage to get them to do what we want. It includes calm and quiet action and movements by the handlers, changing and remodeling facilities if there are problem areas that impede cattle flow, and acclimating the cattle to handlers prior to needing to move the cattle from their pens for routine management practices. It also involves establishing a positive culture on the farm operation of how animals are handled.

Cattle temperament can serve as an indicator of how cattle have been handled. Temperament has a reported inheritance value of approximately 0.4 to 0.5, which indicates that environment (previous experiences) also has a strong influence.

Cattle that are handled using low stress stockmanship practices have been observed to have improved rates of gain. Dewell et al. 2019 observed that abruptly weaned feeder cattle that were acclimated and handled with low stress practices during processing had an increased rate of gain of 2.92 lb/day vs 2.70 lb/day ($P=0.01$) for conventionally handled cattle from day 19 through day 95 and had 29 ($P=0.07$) pound heavier hot carcass weights.

Woiwode et al. in a trial comparing two different handling approaches to moving newly arrived cattle to the working facility observed cattle handled in a calm low stress manner vocalized less during processing, exited the chute slower, and had higher rates of gain compared to cattle that were driven to the working facility in a highly excitable manner. They also observed that calves that were improperly captured by the chute had lower rates of gain, higher exit speeds and increased vocalization.

Reinhardt et al. evaluated disposition (temperament) of cattle on feedlot and carcass traits on over 20,000 head of cattle in the Tri-County Steer Futurity Program between 2002 and 2006. Cattle that were more excitable had a decreased initial and final weight, lower rate of gain, hot carcass weight, yield grade, quality grad and marbling score ($P<0.01$).

Low stress cattle handling and good stockmanship practices can improve feedlot performance and carcass traits, helping increase production efficiency and result in added revenue from higher quality carcasses. In addition, implementing these practices can also reduce risk of injury to both the handlers and the livestock resulting in further savings.

Overhead costs and yardage

Another other area of expense that influences returns is overhead and non-feed related production costs; most of these costs are often grouped together and called yardage. There is also a compounded expense effect with yardage and cattle gain and performance. Poor gain by the cattle results in additional days on feed, which adds more overhead expense to the cost of producing the finished animal.

Caution should be used when yardage costs come up in conversations. For example, custom feeders often charge customers a yardage rate that is less than their actual yardage cost. They have to charge the "going rate" in order to attract customers. They will then make up the difference through mark ups on feed and other inputs, surcharges, chute charges when cattle are worked or pulled for health treatments, and other similar fees. The successful custom feeders do know what their actual yardage cost is, but do not share it to prevent their competition from gaining an edge for attracting customers.

It is also important to recognize there is regional variability in overhead costs. In some parts of the country the weather is mild and dry enough that feedyards are able to utilize dirt lots, no shed, a drive by bunk and feeding slab, and their equipment cost is spread out over thousands of head of cattle every day. However, they have a different set of challenges to manage throughout the year, for example more frequent and longer durations of heat stress. In our part of the country where snow, cold temperatures and mud are problems, buildings for shelter and more concrete pen surface are needed.

It is also important to know what is included in yardage values when they are being discussed. There are no set standards. Often, producers will indicate that their pay is what is left over and not part of yardage, and hauling is also not part of yardage. However, these cost factors were included in a survey distributed to Holstein steer feeders in Wisconsin, which is described below. Another cost factor is bedding which may or may not be included depending on who you ask. The same may be said for other costs depending on the arrangement.

To help get a more substantial estimate of actual yardage costs for dairy steer feeding enterprises, UW Extension conducted a yardage survey, using a standardized procedure, of farms that had dairy steer finishing enterprises (Halfman et al.). Seventeen farms participated that ranged in size from 34 head to 1000 head on feed. The average number of head on feed was 178, and the median was 127. The average yardage was $0.96 per head per day with a range from $0.47 to $1.45 per head per day. The median yardage was $0.85 per head per day. With unpaid labor and management and paid hauling removed, the average and medians were $0.67 and $0.63 per head per day respectively. Economy of scale accounts for part of the variation, but it is not the sole reason for the variability. Overall, labor and management made up the largest percentage of the yardage cost, with unpaid labor and management being the highest. After labor, building and facility depreciation and related costs were next, followed by machinery related costs. The remaining costs of bedding, interest, insurance, taxes, utilities and miscellaneous followed to make up the rest of the yardage costs.

Experienced Extension personnel and ag lenders have indicated that the common themes they observe, when yardage costs are not covered, are higher debt load than the enterprise can carry, excessive machinery and equipment costs for the size of the enterprise, useful life of equipment differences and excessive repair costs from poor use and maintenance.

More valuable than looking at this data is for producers to calculate their own yardage costs using reasonable values for buildings and machinery. UW Madison Division of Extension has a yardage calculator that provides the framework for producers to calculate their own yardage costs. It is also included with the Feedlot Closeout Calculator and the Feedlot Enterprise Budget tool. These spreadsheet tools can be found at the UW-Division of Extension Livestock website: https://livestock.extension.wisc.edu in the Decision Tools and Software section. Iowa State has a software program designed for commercial beef feedyards to monitor animal and financial performance, generate invoices for custom fed cattle and close-outs on finished lots. It can be found at this link: https://store.extension.iastate.edu/product/ISU-Beef-Feedlot-Monitor-Software

Summary

Factors that influence cattle growth and performance and those that influence yardage costs have an impact on return on investment and profits. This document addressed only a few of the many factors. Hair coat condition which is influenced by pen conditions, wind shelter, and stockmanship were chosen as management factors that are under the control of cattle managers, and which can significantly affect the cost of gain. We believe that in this region yardage costs have not been sufficiently recorded and considered in cattle feeding enterprise management. It is important that producers use the available tools to measure and evaluate performance of their cattle, and costs and returns of their cattle feeding enterprises. Doing so will enable them to identify strengths and implement changes where they see opportunities to improve.

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Relationship of beef quality and reproduction in Angus cattle

Dan Loy, University Professor and director, Iowa Beef Center, Iowa State University, Ames, IA

The following is an analysis of the relationship of selection for beef quality and reproductive traits from the ISU McNay herd beef breeding project. This analysis is part of a white paper titled "The Relationship between Carcass Merit and Maternal Traits in Beef Cattle: A Case Study and Literature Review", commissioned by Certified Angus Beef (CAB) and authored by a team at Iowa State University. The full white paper including a literature review of previous research is available at the CAB Cattle website:

https://cabcattle.com/relationship-between-carcass-merit-and-maternal-traits-in-beef-cattle/

The results of the analyses conducted on the ISU McNay Breeding Project herd that has been selected for intramuscular fat or marbling for nearly 25 years are mostly consistent with research reviewed in the literature. These results include:

1. Small, positive relationship between milk and marbling EPDs in the herd
2. A significant positive relationship (r = 0.206) between marbling and heifer pregnancy EPDs in the herd.
3. Positive correlations between marbling EPD and the EPDs for scrotal circumference, heifer pregnancy and maternal calving ease.
4. Marbling EPD of the cows in the herd had a weak negative relationship to total number of calves, a weak positive relationship to number of calves born in the spring herd under the management scheme of the herd, and a weak negative relationship with calving interval.
5. Relationships between ultrasound intramuscular fat phenotypes of the progeny were not significantly related to reproductive EPD (CED, CEM, HP, SC and MILK).
6. A tendency for a positive correlation between yearling bull scrotal circumference and marbling scores indicate that selection for increased marbling in this herd may indirectly impacted SC with marbling having no measurable impact on sperm MOT or MOR.

One interesting and notable result that has not been observed previously is positive relationship between heifer pregnancy and marbling EPDs. This is consistent with the relationship of body composition and heifer growth, as well as the use of intramuscular fat serving as a depot to contribute to the energy demands of pregnancy. Selection for marbling in this herd has also not resulted in a detrimental effect on bull fertility. Overall, we could find minimal data to support the assertion that selection for marbling in Angus cattle would have a negative impact on fertility, reproductive or maternal traits. To the contrary, many of the relationships between carcass quality and cow function, although weak, were positive.

Considerations on receiving calf health

Dr. Michael J. Slattery, DVM, Partner, Risius Family Veterinary Service

Introduction

As a practicing veterinarian I encounter a lot of cases where the health and performance of a group of cattle failed to meet expectations. In a lot of these instances the producers and myself will reflect back on what can be done differently to achieve improved results. These are the commonly implicated issues.

Understanding risk and expectations

In some instances, we discover that the health or performance expectations for the cattle did not fit what is typically expected or experienced for that risk classification of the cattle. We typically try to classify cattle in to 3 risk classes: low, medium, and high. Sometimes a producer will misclassify a group of cattle; for example, commingled calves, regardless of weaning status or how short of a haul, will never be considered low risk. Correctly categorizing a group cattle is pertinent to setting expectations.

Common findings

Sometimes, an issue is discovered. This presentation will discuss the following as possible areas for consideration on your operations.

- When to process new cattle
- Bunk space
- Barn management
- Inherited (or purchased) nutritional deficiencies
- Coccidiosis
- Other parasites
- BVD PI

Summary

What many producers ultimately discover is that they probably didn't do anything wrong, but their receiving programs have holes or weaknesses that need to be accounted for.

Cow systems with limited perennial acres

Mary Drewnoski, Beef Systems Specialist, University of Nebraska

In the Midwest pasture acres can often be difficult to find and/or expensive to procure. This has led to some cow/calf producers to find alternative management strategies that work with limited or no perennial acres. Corn residue, annual forages, cover crops and drylotting can be used as a part of this alternative system. The combinations are almost endless. The "best" system will look different for each individual based on the resources they have available. Producer must start thinking through the potential feed resources available and how they might fit together into a year round system.

Concurrently producers need to ask themselves "When should they calve?" Again there is no one right answer. Asking questions such as:

1. What are the conditions I would prefer to calve in?
2. What is going to be the time of year I can most cost effectively meet the early lactation/breeding cows requirement?
3. How close to home/facilities do I want the herd to be?
4. What window best fits by labor availability?

can help narrow down the options.

Corn residue grazing

One of the lowest cost options in the Midwest is grazing corn residue. Most people are familiar with the idea of grazing dry cows on corn residue. As long as the stocking rate matches the amount of available husk and leaf, a dry cow does not need any protein or energy supplementation. The stocking rate is the key. We recommend that stocking rate of a corn field be tied to corn yield, with 1 cow month for every 100 bushels of corn produced. For example, if you had an 80-acre field that averaged 150 bushels/acre, the field would have 120 cow months of grazing in it. However, corn residue grazing can also be used with summer and fall calving cows as well.

It is clear that the energy demands of lactation necessitate supplementation. However, the amount of supplement that is needed may vary. Summer calving cows that are in good body condition going into winter can lose body condition without having detrimental effects on their subsequent performance. In a study conducted in both eastern and western Nebraska, lactating cows (June/July calving; 1185 pounds) were provided 5.3 lb dry matter of distillers grains in bunks alongside their calves. Cows lost 0.7 units of body condition from November to April, but reproductive performance did not suffer. These cows started in good body condition (5.5) in November. Additionally, they gained condition prior to breeding such that they were BCS of 5.1. Thus, the extra body condition that many summer calving cows gain during summer grazing on pasture or being fed in a drylot can be used as a source of supplemental energy. However, summer calving cows going into the winter at lower BCS would need to be supplemented at greater rates to maintain BCS. If calving in August or later, and cows are being bred when grazing corn residue, it is important to meet their energy and protein needs during the breeding season. A cow in peak lactation, which happens around breeding, would require 7 lbs of distillers dry matter to maintain condition (i.e., meet her energy and protein needs).

When grazing corn residue, regardless of the stage of production, it is key to watch condition of the cows and the condition of the field. In wet years cows may need to be moved earlier due to increased trampling losses. When it becomes hard to find husk, it is time to move. Weather can have a huge impact on the energy requirements of cattle. Cold temperatures increase energy requirements, especially when coupled with a wet hair coat or high winds. Providing wind protection can decrease energy needs by removing wind as a factor, but with extremely cold temperatures or wet hair coats, additional energy supplementation maybe needed to maintain condition.

Confining cows

Cows can successfully be drylotted year round although this is often not the lowest cost option. Often producers with limited or no perennial pasture will use partial drylotting to fill in the gaps between grazing opportunities.

Limit feeding a corn residue and wet by-product based diet is often the lowest cost option for drylotting cows, assuming that the producer has a way to mix diet. The cow's nutrient needs increase rapidly during late gestation and peak at about eight weeks of lactation. To meet the nutrient needs, either increase the energy density of the diet or increase the pounds of dry matter fed during these stages of production. Table 1 has some example diets that have been used but the combination of ingredients and proportions that can be used are numerous. Two- and three-year-old beef females have nutrient requirements. They should be fed separately from mature cows, especially when feeding a limit-fed ration. This allows young cows to consume the feed needed to meet their requirements. It is important to consider not only the cost on a nutrient basis but also the handling and mixing characteristics when developing a diet. For instance when using corn residue sorting will occur if there is not enough of a wet byproduct included in the diet to coat the residue and increase its palatability. It is also important to ensure that minerals and vitamin needs are met. See Mineral and Vitamin Considerations When Drylotting Cows - https://beef.unl.edu/beefwatch/2021/mineral-and-vitamin-considerations-when-drylotting-cows

Table 1. Example diets of byproducts and residues for gestating and lactating mature cows

Diet (DM ratio)	Ingredients	Late gestation cow	Lactating cow
		-------- *Dry matter intake, lb* --------	
57:43	Distillers grains:corn residue	15.0	18.0
30:70	Distillers grains:corn residue	19.2	23.0
40:20:40	Distillers grains:corn residue:corn silage	15.4	18.5

If the cow and her calf are managed together in drylot, be sure to account for the calf also eating feed out of the bunk. Typically at 3 months of age it is suggested to start upping the amount of feed provided by 1 to 2 lb DM for every 100 lb of calf body wt. However, recently we evaluated management options to economically improve young calf performance in these limit-fed confinement systems. One concern with these limit fed diets that contain low quality forage is that we are limited intake of the calf due to the relatively high fill factor. We evaluated increasing the amount of TMR containing 55% wet DDGS and 44% straw fed to pairs vs. feeding a separate TMR containing 51% alfalfa hay, 22% dry rolled corn, and 25% distillers to calves in a creep area vs. early weaning the calf and feeding them the same calf TMR. Gains were much greater for the creep calves and creeping resulted in the most return at normal weaning time (6 months of age) and they retained their increased value even after a 90 day growing period. It is important to note that the creep diet was not a commercial creep and based on feed prices over the past 6 years was estimated to cost $150/ton of DM.

For those without the ability to mix diets, limit feeding ground hay or limiting the amount of access to round bale feeders can help to reduce hay waste and thus feed costs.

For more in depth information on drylotting cows see the NebGuide on Management Considerations for Beef Cows in Confinement - https://extensionpublications.unl.edu/assets/html/g2237/build/g2237.htm

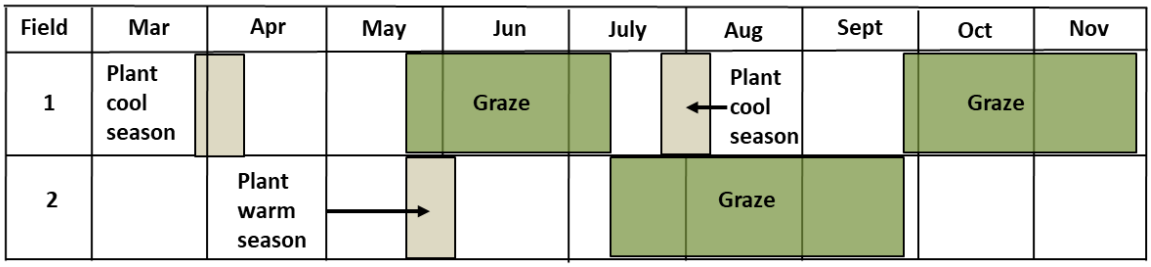
Using annual forages

Annual forages can be planned such that year round grazing is possible using a combination of cool and warm season annuals. Figure 1 shows two possible combinations if near continuous grazing is desired. See Planning Annual Forage Systems (https://cropwatch.unl.edu/planning-annual-forage-systems) for more details of planting times and species combinations.

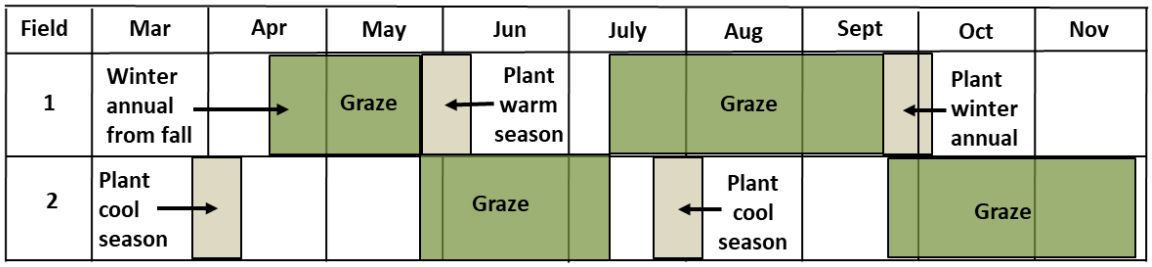
However, there are risks with using annual forages as successful establishment can be highly dependent of the weather and timing of planting. Flexibility is needed to get the most value out of annual forages. For instance if there is an especially cold early spring the turnout on to winter hardy small cereals may need to be delayed. Therefore, it is a good idea to having a backup plan for times when the forage does not produce as expected, such as being able to drylot the herd. On the flip side in a particularly good year the standard stocking rate may not keep up with the forage growth. Being able to pull some of the acres out of the grazing plan and harvesting them to allow for the grazed forage to be maintained in a vegetative state may be required. Typically more acres are

needed for the first grazing than subsequent grazing. Some producers take advantage of this by planning to take some acres out of production after the first round or two of grazing and planting a cash crop or the next forage crop.

Forage system A- Starts with spring planting



Forage system B- Starts with fall planting



Annual forages can be high quality and meet the needs of cows in early lactation/breeding. However, using these annual forages to meet the needs of animals with high requirements require increased management. Annual forages grow rapidly and can easily get mature. Rotational grazing with high stocking densities can help manage forage quality and increase the cost effectiveness. Strip grazing dormant forages when grazing in the fall/winter can also significantly increase harvest efficiency and cost effectiveness. For more tips on using annual forages including suggested seeding rates, see the article Considerations for using annual forages cost effectively - https://beef.unl.edu/documents/FFAR/Annual-forage-options.pdf

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Bunk management: Slick bunk vs. not

Dan Loy, University Professor and director, Iowa Beef Center, Iowa State University; Bill Halfman, agriculture agent and professor, UW Madison Division of Extension

Bunk management is an area where some producers may be able to implement some low-cost management changes and obtain some improved returns. Two common management approaches are ad libitum (free choice) feeding where the cattle always have feed in the bunk, and programmed intake management (slick bunk). The only additional equipment needed between the two feeding approaches when using a tmr and feeding in a bunk is a notebook and pencil to record bunk scores for determining adjustments in feed delivered for the slick bunk program. Several feeding trials comparing free choice feeding to slick bunk management have shown little or no difference in rate of gain and carcass traits, an improvement in feed to gain efficiency from the slick bunk feeding program, and free choice bunk management had greater variability in daily intakes. Increased intake variability can lead to digestive problems such as acidosis that can further reduce performance. Following are the results of one trial, with yearling beef steers, as an example to show how gain, and intakes differ between free choice and slick bunk feeding management.

Table 1. Effect of feed bunk management method on feedlot performance (Bierman and Pritchard)

	Ad libitum	Slick Bunk
Initial wt., lbs.	865	864
Final wt., lbs.	1331	1328
Average daily gain, lbs.	3.85	3.84
Dry matter intake, lbs./hd/day	26.39	23.57
Feed to gain, lbs.	6.9	6.15
Feed Cost/ Gain @ $165/ton DM	$56.93	$50.74
Feed Cost/ Gain @ $220/ton DM	$75.90	$67.65

The per head feed cost difference would be $29.34 per head lower at $165/ton ($3.50/bu. corn), and $38.63 per head less at $220/ton ($5.00/bu. corn) feed for slick bunk compared to ad libitum over the 121 days of this trial and approximately 465 pounds of gain.

In addition, the cattle in the ad libitum groups tend to have a greater range in daily gain compared to the cattle in the slick bunk managed groups. The greater range in daily gains can result in greater difficulty in putting consistent quality loads of market ready cattle together, which could lead to increased price discounts at sale time, or more trips to the sale barn with less head per load.

Modern feed bunk management is systematic approach to providing a consistent nutritious fresh ration in a manner that minimizes waste and spoilage while optimizing feed intake. Inconsistent feed intake can contribute to digestive upsets and potentially poor performance. The most common approach to improve feed bunk management includes a bunk scoring system along with a protocol for making increases or decreases in feed deliveries. Many feedlots will target a slick bunk 3-4 days a week with minimal feed remaining on the other days. Consistency in timing of feed deliveries, patience in making adjustments and following a protocol is important for success. Unlike many management tools, bunk management only costs you your management time and some recordkeeping.

The Iowa Beef Center has a fact sheet on bunk scoring and feed bunk management (https://store.extension.iastate.edu/product/4593) and a companion fillable SOP (https://store.extension.iastate.edu/product/4594) for use in your feedyard.

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Market outlook

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Here are the primary drivers heading into 2022 and their impact on prices received by producers:

Retail

- U.S. economic growth should remain positive, though the rate of gain is expected to moderate from that achieved during 2021's pandemic rebound.
- U.S. consumer demand for beef should remain historically strong, even if it moderates some compared to 2021's.

Wholesale

- U.S. beef (meat) export tonnage in 2022 may slip slightly from the record-high of 2021. Still, beef exports are forecast to be the second highest ever.
- Even with moderating exports, I expect the wholesale-fed cattle relationship to remain outside historical bounds into 2022 due to lingering supply chain and labor issues. But, as the year progresses, the expected trend is toward normalization.

Fed cattle

- A driver will be tightening fed cattle supplies due to a shrinking calf crop but will likely be helped with drought distressed cattle that are placed in feedlots earlier than anticipated.
- Feed costs are likely to be the primary factor limiting the upward price movement in fed cattle.
- The 5-market average fed steer price is forecast to be in the low to mid 130's per cwt. That would be a year-over-year jump of about 10% - Peak prices occurring in April and May.

Feeder cattle

- The U.S. calf crop shrunk during 2021 and the inventory is projected to be the smallest since 2016.
- Expect cull cow prices to moderate beginning in late Summer 2022 and progress towards more historically seasonal patterns. Fall 2021 prices were abnormally high.
- Estimated typical rancher return over cash costs plus pasture rent is projected to be the best since 2017.
- Yearling and calf prices could peak in the fourth quarter of 2022, assuming a typical Midwest corn crop. A 500-to 600-pound steer calf at weaning in the fall of 2022 could easily average $20 per cwt. above 2021's prices. The limiting factor will be the drought during the forage production year.