THE INTERSECTION OF SUSTAINABILITY AND PROFITABILITY WHEN UTILIZING NON-TRADITIONAL METHODS IN THE RAISING OF BEEF CATTLE

by

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Abstract

Jon Taggart has been finishing cattle on his ranch in Grandview, Texas since 1999, but his approach to finishing grass fed cattle for his own Burgundy Pasture Beef brand is drastically different from traditional methods. His approaches to rotational grazing, managing pastures, brush control, stocking rates, sales, and more all give lead to his own profitability as well as sustainability. Texas Christian University's Institute of Ranch Management's Living Laboratory has been visiting and collecting data on Taggart's approach to profitable and sustainable ranching for a few years. This data details what a difference these non-traditional methods can make in the cattle business compared to traditional business methods. The aim of this study is to examine traditional and non-conventional approaches to raising cattle, their benefits, and explain how Taggart's ranching methods create an intersection of profitability and sustainability that may be transferable to other ranches worldwide.

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Introduction

As our population continues to exponentially increase and our planet warms, cattle ranching practices must change to match with a rising demand in food while also reducing its impact on our planet. It is also important that the change from more conventional to non-traditional practices maintain or increase ranchers' profitability to allow operations to continue. It has become increasingly obvious that the triple bottom line (profit, environmental sustainability, and community) needs to be considered in emerging non-traditional methods and that the intersectionality of profitability and sustainability is of utmost importance for cattle ranchers around the world.

Throughout the United States, industrial agriculture has created a set of traditional methods used to raise beef cattle, including the use of continuous grazing, planting of introduced forages, finishing cattle on corn based rations, and selling cattle to commercial packing plants to be harvested and processed for the consumer. These traditional methods have large adverse effects on the environment as well as profitability for several reasons, whether it be through the degradation of ranch assets, environmentally harmful practices, increased input costs, or the loss of potentially captured value with the traditional supply chain.

Compared to the average United States beef supply chain producer, non-traditional suppliers that utilize holistic management practices have been identified as benefiting the health of cattle, improving water quality, increasing stocking rates, enhancing native plant recovery, and increasing the profitability of ranches. Non-traditional producers accomplish this through the use of rotational grazing, controlled burning, reduced or no use of chemical pesticides and herbicides, supporting native pastures, and direct to consumer marketing. These practices allow

the ranch to be sustainable environmentally as well as increase the potential profits of the rancher. This is achieved through the protection of the ranch and its natural resources and reducing input costs.

Literature Review

Traditional Methods

Raising beef cattle traditionally can be defined by a set of practices including conventional continuous grazing systems, the use of chemical pesticides and herbicides, planting of introduced forages, and a standard supply chain (Kumar et al.; Bidwell and Woods; O'Quinn et al.; Hiranandani; Harmel et al.). Each of these practices have the potential to be detrimental to the environment and financial stability of the beef cattle operation.

Conventional continuous grazing systems are pastures in which cattle are grazed all year round and have been identified as producing better body condition scores or weight gains in cattle, but usually require more supplemental feeding of hay or the planting of introduced forages. However, even with noticeably increased cattle performance, this grazing system increased input costs of the operation and do not allow for improved pasture and soil conditions compared to the rotational grazing system (Harmel et al.).

When operating in a continuous grazing system, some ranchers are required to plant introduced forages, specifically cool season annuals, in order to reduce supplemental feeding and supply cattle with a steady diet. These forages are specifically chosen for their high yield, high nutritive values, the ability to withstand continuous grazing pressure, and growth in cool months when native prairie is otherwise dormant. Despite the advantages of introduced forages, there are increased input costs due to added management that native grasses do not require, including chemical pesticides and herbicides. In addition to these increased input costs, Bidwell and Woods found that the increased use of introduced forages had an adverse effect on the presence of wildlife. Some ranchers depend on hunting and recreational leases to supplement their

income, so when introduced forages are used in an operation, it can reduce this other revenue stream and adversely affect profitability (Bidwell and Woods).

The chemical pesticides and herbicides used to maintain these more traditional operations, whether it be for introduced forage or continuously grazed native pastures, have even more adverse effects on the environment and the operations income. These chemicals are used to produce more forage per acre and increase soil fertility on overused pastures but can lead to issues including but not limited to soil, water, and air pollution, as well as insect and weed resistance, soil degradation, toxicity to animals and humans, and reduced income (BN et al.).

Each of these traditional inputs on the ranch has been found to lead to negative environmental and economic impacts, but it is also important to note the impacts of the traditional supply chain are not directly correlated to the ranch other than through their marketing plan. Traditionally, producers (cow/calf, stocker, or feedlot) sell their products to large packers as their cattle move through the supply chain. However, during COVID-19, more producers began to experiment with direct-to-consumer or business-to-consumer marketing. With this marketing strategy, producers are selling whole carcasses, sides of beef, or specialty meat cuts directly to the consumer, rather than selling to a large packer to process the beef and then sell it to retail stores. In a recent study, it was found that 87% of smaller producers reported that direct-to-consumer marketing was the most profitable while only 3.2% reported that selling to large beef processors was most profitable (O'Quinn et al.). As explained by this study:

> This is likely due to the large differences in beef marketing programs currently available to producers by large processors. Beef producers selling to large packers as part of an alternative marketing arrangement often are eligible to market cattle on quality-based premium grids or formula-based marketing in which animals that produce the most

> desirable, and thus profitable, traits are rewarded with higher premiums. However, in most cases, this requires beef producers to have sufficient animal numbers and consistent supply for negation of such marketing arrangements with packers. (O'Quinn et al., p. 4)

Clearly, traditional marketing and supply chain need to be revised according to this past study.

Holistic Methods

Holistic agriculture has been defined as, ‘‘agricultural technologies and practices that maximize the productivity of the land while seeking to minimize damage both to valued natural assets (soils, water, air, and biodiversity) and to human health (farmers and other rural people, and consumers)’’ (Pretty, p. 171). There are a variety of management practices that are used in a holistic agricultural operation including, soil and water conservation, rotational grazing systems, controlled burning, integrated pest management, support of native polycultures, and direct to consumer marketing (Hiranandani).

Rotational grazing is the practice of utilizing several pastures in a rotation to give native or introduced forages rest throughout the grazing season. A past study done on a North Texas ranch over the span of five years found that:

> Results indicated the potential for increased grassland forage production and soil health improvement on cultivated grazed paddocks under the planned rest-rotation system. The transition successfully reduced costs and maintained profits; however, the conventional continuous grazing system maintained higher body condition scores of cows during the winter because of unlimited feeding of baled hay and higher cool-season forage quality in the cultivated grazed paddocks" (Harmel et al., pp. 544-55).

Rotational grazing and resting pastures creates positive environmental impacts while reducing input costs associated with supplemental feeding.

Controlled burning is another method of pasture management that has been found to improve rangeland conditions. According to White and Hanselka, fire was a natural phenomenon of Texas native prairie before the state was settled, explaining native plants' adaption and positive responses to burns. In combination with other sound management practices, like rotational grazing and reduced use of chemicals, prescribed fire management can increase forage production, control invasive species and unwanted woody plants, improve range composition, improve soil health, increase forage palatability, increase animal production, and remove excess debris (White and Hanselka). Increased forage and animal production directly correlates to the profitability of a cattle operation in terms of the number of cattle that can be grazed, and pounds gained on the cattle themselves. With this holistic management practice, ranchers have the ability to improve their range and business.

The use and support of native forages and polycultures is another main practice when holistically managing a beef cattle operation. As discussed previously, introduced forages have advantages, but can ultimately reduce environmental sustainability by decreasing biodiversity and increasing the need for chemical herbicide and/or pesticide application. These practices can also have adverse effects on the ranch's overall profitability due to higher input costs associated with planting and chemicals or the loss of wildlife and hunting that could have been used for supplemental income. Bidwell, Guinman, and Woods observed that, "…introduced forages do not provide good wildlife habitat. Under these circumstances, the use of introduced forages may reduce the ranch income" (p. 5). Supporting native rangeland and prairies can allow for more environmental sustainability if other management practices are sound due to reduced chemical

use, improved wildlife habitat, and increased biodiversity. This environmental sustainability lends the ranch to increased profits, due to lower input costs and increased wildlife populations that allow for diversification for supplemental income.

By managing native rangelands in a responsible manner with rotational grazing, decreased use of chemicals, and prescribed fire, there is more potential for an increase in sequestered carbon. Carbon sequestration in this case is a natural process by which carbon is stored in the soil through the respiration of vegetation. Schuman et al. identified that, "Potential soil C gains in these lands varies widely and any improvement will be slow and gradual. Therefore, we estimate these gradual gains at 0.1 MgC ha−1 year−1 and 0.6 MgC ha−1 year−1 for previously cultivated lands that have been reseeded to grass (Bruce et al., 1999). Bruce et al. (1999) estimate that lands under the CRP are gaining C at this higher rate, accounting for 8 MMgC year−1. Therefore, the total potential gain in soil C from improved management of poorly managed rangelands (11 MMgC year−1) and that derived from CRP grasslands (8 MMgC year−1) could be as much as 19 MMg C year−1." (p. 394). Schuman et al. also identfied that "Recent studies (Manley et al., 1995, Schuman et al., 1999) have shown that properly grazed rangelands in Wyoming can gain soil C at a rate of 0.3 Mg C ha−1 year−1 compared to ungrazed mixed-grass rangelands" (p. 394). When managing rangelands through holistic methods, there is a potential for increased carbon sequestration and the utilization of grazing of cattle on native prairies can allow for increased amounts of carbon stored each year. Active carbon sequestration on rangeland is beneficial to the environment as a whole. Additional potential income for ranch businesses is through the newly developing carbon markets that compensate ranch operations for carbon dioxide mitigation based on the yearly amounts their native prairies sequester.

Different forms of marketing cattle or beef are often used when holistically managing an operation. A common form of marketing is direct-to-consumer, which allows producers to capture more value on the animal they have raised. According to a recent study, 87.1% of a group of 3,500 producers in Kansas reported that direct-to-consumer marketing was the most profitable channel and all the producers in the study listed it in their top three most profitable channel (O'Quinn et al.). It was discussed that this may be due to the fact that larger beef packers pay for live cattle based on formula or grid pricing mechanisms in which animals with more desirable traits receive higher premiums. These grids and formulas are difficult to negotiate when a producer is smaller than the average feedlot that is selling to these larger packers (O'Quinn et al.). Overall, direct-to-consumer marketing tactics that are commonly used by holistic producers allow for more profitability of the business.

Aims and Methods

The aim of this study is to examine traditional and non-conventional approaches to raising cattle, their benefits, and explain how Taggart's ranching methods create an intersection of profitability and sustainability that may be transferable to other ranches worldwide. This single case study examines a holistic, non-traditional beef cattle ranch owned and operated by Jon Taggart. Jon Taggart's operation is located in Grandview, Texas and raises and sells grass-finished beef directly to the consumer. This ranch was selected based on the utilized set of holistic management practices within the operation's business management plans that are representative of the larger population. Within this single case study, additional outside data sources were collected to better understand the environmental and financial effects of holistic practices. The data collected for this study include interviews with the owner/operator himself, a ranch management subject matter expert, and a local ecologist from the Botanical Research Institute of Texas in conjunction with the ranch's historical management documents, soil reports, botanical reports, government documents, and peer-reviewed scientific journal articles.

Results and Discussion

Traditional Methods

Throughout the United States, industrial agriculture has created a set of traditional methods to raise beef cattle. This industrial system keeps up with the constantly rising demand for food through the same basic pipeline of cow/calf operations to the meat packer. During every stage of this operation pipeline, ranchers also tend to utilize the methods of continuous grazing, traditional rotational grazing, the planting of introduced forages for haying and pasture grazing, finishing cattle on corn based rations, and selling cattle to processing plants to be harvested. These traditional methods can have large adverse effects on the environment as well as profitability when it comes to any beef cattle operation. Here we will examine exactly what traditional methods look like and how they affect the intersection of profitability and sustainability in the beef cattle industry.

There are four basic segments of the beef cattle industry that create a pipeline in the industrial agriculture system. These four segments are cow/calf, stocker, feedlot, and meat processing. Ranchers use similar methods to get their cattle to the next stage of production, but each segment operates differently from the next, despite traditional methods being used throughout. At birth, cattle are typically found at a cow/calf operation. On these types of ranches, cattle are bred, born, calves are weened at seven to eight months old, and then are sold through a sale barn or directly to a stocker operation at an average weight of 550 lbs. Weaning is the practice of separating the calf and its mother to accustom the calf with grass and feed other than their mother's milk. Weaning and time from weaning to sale can vary based on many different factors, but typically seven to eight months is an appropriate time to wean and 45 days after

weaning is the average time of sale. After calves are weaned or have gained a suitable amount of weight, they are sold to a stocker operation.

Stocker operations are where the yearlings (cattle between one and two years of age) will gain an average of 200 lbs. before heading to the feedlot. When being raised on these stocker operations cattle are grazed and given supplemental feeds and minerals to reach this optimum weight. Cattle weighing 750-850 pounds are then sold directly to or through live auctions to commercial feeders. On these feedlot operations, cattle are put on a "finishing program" or are "finished" which means they are fed a certain combination of forage, grains, and supplements in pens, not pastures, until they meet their final weight before heading to a packing plant/processing facility. This method is described as confined cattle feeding. The final average weight before heading to the packing plant ranges between 1,200 and 1,400 lbs. and is typically when the animal is between 18 to 22 months old. Once at the processing facility, the cattle are harvested and packaged into the final product one finds in the grocery store. It is important to note that throughout this entire system, ranchers are required to meet certain USDA and Food and Drug Administration (FDA) requirements.

Although each of the segments of the beef cattle industry varies in goals and form, other traditional methods, besides this pipeline, are used throughout. These include continuous or traditional rotational grazing, the planting of introduced forages, and finishing cattle on grain based rations. Each of these methods has benefits and disadvantages, but ranchers continue to use them throughout the United States without truly weighing their options. In order to understand these benefits and disadvantages, one must know exactly what each of these methods are, in which segments they are used, and how they affect costs, profitability, and the environment.

Continuous grazing is the practice of using one large pasture on which cattle are continuously grazed. Pastures are not divided, and cattle are allowed to reach any area at any time. This practice is found in cow/calf and stocker operations throughout the United States. This system requires less management and manual labor. Additionally, fewer fencing materials are used, and the water system can be quite simple. Although this system is cost effective based on the fact there is less management and materials required, it has many disadvantages regarding nutrition, upkeep, and the environment. Continuous grazing means cattle graze on the best forage first and exhaust it before moving on to other grasses on the pasture. This gives way to uneven grazing patterns, uneven distribution of nutrition, change in pasture composition over time, and the cattle's diet lacking in important nutrients (Smart and South Dakota State University Agriculture and Natural Resouces Extension). These disadvantages force ranchers to put out minerals and additional nutrients for their cattle, fertilize and seed their fields, as well as put out hay or other feed when the grass is low (during a drought or winter season), which adds to their costs. These disadvantages and extra costs will also continue to degrade the land on which the rancher is continuously grazing. The grass is grazed on at a rate where it will not be able to regenerate appropriately, which leads to increased fertilizer application. Resulting in potential ground water pollution, increased rates of eutrophication, and harm other animal and plant populations. Additionally, seeding fields reduce biodiversity, which affects the entire natural population in the vicinity of the pasture. Overall, continuous grazing is typically utilized during the first two stages of raising beef cattle, and clearly has many adverse effects on the rancher, the cattle, and the land.

In order to avoid some of the adverse effects of continuous grazing, some cow/calf and stocker operations utilize the practice of rotational grazing. This means that cattle are rotated

through separate fenced grazing areas to give the natural grasses or planted grasses time to regenerate. Cattle are moved from each fenced area on a set schedule, whether it be seasonal, based on forage heights, or several different techniques, to allow for these recently grazed areas to regenerate. The number of fenced areas can range from two to five different pastures depending on the operation. This grazing system allows ranchers to manage the health of cattle and water quality in each pasture (Whitt and Wallander). Ranchers can also increase their stock density (amount of cattle on pasture), shorten grazing periods, and enhance plant recovery with this specific method of grazing (USDA). This is because cattle are not constantly grazing on the same area of grass, giving the soil and forage time to regenerate. During the recovery stage, forage return to a healthy height and have time to develop a proper root system, resulting in better forage for cattle to graze once returned to said pasture.

There are several different methods of rotational grazing that the rancher must choose from based on their herd, herd size, amount of land, weather conditions, and soil types. It is also important to note that rotational grazing is not an exact science but can also be an “art” for most ranchers. Information and methods of rotational grazing may have been passed down through generations of ranchers, which allows them to figure what method is best for their operation. I have worked for several different cattle operations, stocker and cow/calf, and each operation has had their own method of rotational grazing. For example, one stocker operation I interned with rotated cattle based on when they were being shipped, if they noticed a significant weight difference between certain pastures being grazed on, and if there were open wheat pastures to graze on. It was not an exact science, but an “art form” for my manager to decide what pastures needed time to regenerate. He would not only make this decision based on weight gain numbers but would also simply use his “eye” for cattle and his instinct that had been learned over his

many years of working in the industry. In sum, rotational grazing is an effective way to avoid the many downsides of continuous grazing, but it is not yet an exact science and each operation will have their own ways of approaching this specific method.

Another traditional management practice in the segmented beef cattle industry is the planting introduced forages for maintaining pastures while also creating additional food sources for droughts or colder months. This is typically found on cow/calf or stocker operations where the goal is to get cattle to their optimum weight to sell. Introduced forages, like wheat, are high in nutrients, protein, energy, and minerals, which are all good for the diet and grazing pastures of beef cattle. For example, wheat pastures provide a forage source in the late fall, winter, and early spring when cool season native grass species would typically be lower in volume and nutrients. Wheat pastures can be grazed once the plants have had enough time to develop roots. Then, if cattle are rotated off this pasture in 120-150 days, ranchers can hay the fields or produce grain and have additional food sources for their herd in cold or dry months. Average weight gains from these pastures range from 1.5 to 2.5 pounds per day as well (Duncan et al.). Cattle will tend to gain more weight on these pastures due to higher crude protein content in the wheat, and this is seen as extremely valuable to stocker operations, where the more weight cattle can gain in a shorter amount of time means greater profit and less expense. The quicker a herd reaches their optimum weight; the sooner ranchers can sell or move them to the next segment of the beef cattle industry. The rancher's profits will be higher because they have spent less time and money on pasture costs, water, doctoring, etc. while attempting to get their cattle to an optimum weight. After all, feed is 60-70% of the cost of production, so the faster the herd moves on, the less is spent on feed and pasture (Henke). I have seen this in practice on several of the ranches I have interned with, and it is an extremely common practice throughout Texas. It allows for available

forage in months when weather conditions may not permit natural forage to be plentiful enough for large herds of cattle. Additionally, it can be another source of income or a safety net if these introduced pastures are used for hay by the rancher. In sum, introduced pastures are another method of grazing that can assist in weight gain as well as create a safety net for ranchers in areas where natural forage cannot support their cattle year-round.

Cattle are not only finished or raised on grass or introduced pastures but can arrive at their optimum weight before slaughter by adding or finishing their diet with corn based rations. The traditional methods of feeding cattle grain or corn can be found throughout the segments of the beef cattle industry, anywhere from a cow/calf operation to the feedlot. According to the North American Meat Institute (NAMI), "grain-fed or "corn-fed" beef is the most widely produced type of beef in the United States. Grain-fed cattle tend to gain more fat at a faster rate than grass-fed and produce more marbled pieces of meat as well. Still, grain-fed cattle spend most of their lives on pasture before moving to a feedlot where they will be fed this grain heavy diet. Having the addition of grain to their diet can be seen as more cost effective because cattle are gaining weight at a faster rate, meaning herds can be sold down the chain of the beef cattle industry more quickly, as mentioned before. When cattle are primarily on forage (pasture) one to two pounds of weight gain per day is average, but when cattle are on concentrated corn diets, they will gain about three pounds per day (Henke). These numbers support the use of corn in cattle's diet because it clearly shows how much more weight can be put on in the same amount of time when fed this way. Feeding corn is also applied at feedlots to help cattle reach their optimum weight before processing, along with the fact that feedlots cannot finish cattle on grass with their high stocking rates and a limited amount of space. Adding corn to the diet of cattle clearly is beneficial in weight gain as well as finishing cattle on feed lots, but it must also be

supplemented with mineral blocks and other nutrients because it is lacking in important nutrients and minerals needed for healthy growth. It is also important to note that only 5% of "grass-fed" are on grass their entire lives (NAMI). "Grass-fed" cattle are still subject to a feedlot diet and tend to be finished on corn if processed the traditional way. Grass finished cattle are cattle that were "finished" on grass, meaning that in the last 90-days leading up to their processing, they are on a grass diet (NAMI). Overall, adding corn to the ration or diet of cattle is beneficial to the rancher and necessary at feedlots, but it may be a method that needs rethinking due to its lack of nutrients and minerals, the ethical question of labeling beef as "grass-fed," when most cattle will be grain fed at the feedlot, and the environmental impacts of growing this product before it is ever fed to cattle.

After cattle are finished, either in a feedlot or on grass, they are usually shipped to a processing and packing plant. Industrial agriculture in the United States has made this practice increasingly common throughout the years, and even smaller ranching operations tend to utilize large packing plants in some shape or form. The process of harvesting and processing the animal is highly regulated by the USDA and would be a time and money consuming activity for every rancher to do or outsource themselves. Cattle are sold to these plants based on a grid or formula pricing mechanism, which rewards desirable carcass traits with premiums on the base price of live cattle.

In sum, the beef cattle industry is made up of four main segments, cow/calf, stocker, feedlot, and processing/packing plants, that traditionally utilize the methods of continuous or rotational grazing, planting of introduced pastures, finishing cattle on or supplementing cattle's diets with corn based rations, and marketing cattle through a traditional supply chain. In the next

section, I will discuss how these traditional practices cause harm to both the rancher's profitability and the environment.

Traditional Profitability

Traditional profitability is a difficult topic to discuss based on the fact that every beef cattle operation is different. However, there are traditional inputs or costs that each segment is faced with when raising their herd. Since later I will be discussing a non-traditional stocker operation and its comparison to traditional methods, I will focus on the profitability and inputs at a typical stocker operation. In this specific segment of the beef cattle industry, typical costs that go into the raising of a herd include and are not limited to, grain, round hay bales, mineral, yardage (upkeep of forage costs), vet treatments or vaccinations, water, and processing costs. This can all be found on a lot (herd) closeout sheet, where a manager calculates the total gain or loss on the specific herd. This is information I have gained while working on stocker operations as an intern. These costs add up as herds increase in number at larger stocker operations, but it is typical to see that on traditional ranches, a rancher's profit margin increases with the ranch's size (Hope). The table below (see Table 1) compares smaller and larger U.S. farms and their relative profit margin (Hope). The USDA's definition of a farm covers a wide scope of agricultural activities, which includes the raising of beef cattle, so the table below (Table 1) from the USDA provides numerical data to support the idea that the larger the ranch, the larger the profit.

Table 1

Annual Average Operating Profit Margins Broken Down by Farm Size, 2013

Farm typology group	Farm size, measured by annual GCFI[2]	Operating profit margin[1]: less than 10% (critical zone)	Operating profit margin[1]: 10% to 19.999%	Operating profit margin[1]: 20% or more
All farms	Not applicable	69.3	4.7	20.4
Small family farms (less than $350,000)				
Retirement	Less than $350,000	64.1	4.4	22.7
Off-farm occupation	Less than $350,000	75.4	2.9	13.9
Farming-occupation:				
Low-sales	Less than $150,000	76.2	3.6	16.0
Moderate sales	$150,000 to $349,999	55.8	11.5	32.5
Midsize family farms	$350,000-$999,999	41.6	12.6	45.8
Large-scale family farms ($1,000,000 or more)				
Large	$1,000,000-$4,999,999	28.4	13.1	58.5
Very large	$5,000,000 or more	24.6	11.5	63.9
Nonfamily farms:[3]	Not applicable	59.1	5.1	33.8

Note: The farm typology focuses on family farms, where the majority of the farm business is owned by the operator and relatives of the operator. Family farms are sorted into more homogenous groups based on farm size — measured by gross cash farm income (GCFI) — and occupation of the operator, with retirement counted as an occupation.
[1]Operating profit margin (OPM) = 100% X (net farm income + interest paid - charge for operator and unpaid labor - charge for management) / gross farm income. OPM is based on both cash and noncash items. The ratio was not calculated for the 5.7 percent of farms where the denominator — gross farm income — was 0 or negative.
[2]Gross cash farm income (GCFI) is the sum of the farm's crop and livestock sales, Government payments, and other farm-related income. It includes only cash income.
[3]Farms where the majority of the business is not owned by the operator and relatives of the operator.
Source: USDA, National Agricultural Statistics Service and Economic Research Service, 2013 Agricultural Resource Management Survey.

Small ranches may struggle to keep up with larger, more industrial ranches due to the simple fact that their herd sizes and sales are not large enough to keep up with the numerous costs of running a beef cattle operation. Still, one can gather from the chart above that there are a high percentage of ranches that struggle to have a high profit margin above 20%, regardless of size.

While profitability is hard to reach and maintain in the cattle industry based on the costs discussed above, one still has not considered the specific additional costs of implementing the traditional strategies of continuous or rotational grazing, planting introduced pastures, or supplementing cattle's diets with corn.

When continuously grazing a pasture, a rancher must consider the cost of upkeep of forage in his closeout for the herd as mentioned above. The upkeep of a continuously grazed pasture includes fencing costs, water infrastructure, irrigation, fertilizing, and labor. This is not including the additional costs of mineral blocks for nutrients, utilities, and taxes (Windh et al.). A continuously grazed pasture needs more upkeep than one that is rotationally grazed because natural forage or plants that were specifically seeded by the rancher are not given enough time to regenerate appropriately. This means that more fertilizers and irrigation are required to keep the pasture healthy for grazing. Creating a higher cost in both fertilization, water infrastructure, and irrigation. All of this also requires more labor in the upkeep of the pasture as well (Windh et al.). Overall, this results in a higher yardage cost in association with utilizing the traditional method of continuous grazing.

While rotational grazing is seen as a better alternative to continuous grazing, it still comes with additional costs. Rotational grazing systems require more fencing, transportation of cattle, and more water infrastructure (Windh et al.). More fencing is required to separate pastures utilized for grazing. These pastures all need access to water as well, meaning there will be an additional fixed cost of creating a water infrastructure that can meet the needs of each pasture. Finally, there will be higher transportation costs because cattle are being rotated year-round, based on the schedule chosen, until they are ready for sale. However, after all these initial costs of setting up a rotational grazing system are considered, there still are many benefits to using this

system over a continuous grazing system, including less fertilizer and irrigation costs, reduction in labor costs, healthier and more nutritious forage, and environmental benefits (Windh et al.).

Not only does a rancher need to consider the costs of which grazing system they would want to implement, but whether it is cost effective to begin seeding and utilizing introduced forage pastures in grazing their cattle. The major costs of utilizing this method includes seeding and planting, pesticides, fertilizers, irrigation, mineral blocks, and harvesting. According to the Noble Research Institute, seeding and planting of the introduced forage wheat typically costs $27.50-$30 per acre, and if one plans to graze the pasture, they need to increase seeding rate by 50-100 percent. Additionally, some areas of the pasture will require pesticide which will be another $20 per acre. Along with pesticides, fertilizers are needed in wheat pastures, and their prices are constantly changing. Currently, fertilizer costs approximately $65-$75 per acre (Funderburg). Irrigation is another important cost when planting and utilizing a wheat pasture. Fields need to be irrigated, which will add a significant amount to the water costs of the operation. An additional cost on these pastures is utilizing mineral blocks to fill in areas of nutrients and minerals in which the wheat may be lacking. Finally, harvesting the wheat grown for hay will add labor and machinery costs to the yardage cost as well. I have seen this done at one of the cow/calf operations I worked for, and it is not a simple task to decide if spending money on all these additional costs is worth the extra forage or safety net. Overall, planting and grazing introduced pastures adds significant costs to any beef cattle operation but could be well worth the additional forage.

A method of supplementing the diet of beef cattle that may be cheaper than planting introduced pastures is corn. Corn diets are a simple additional cost of corn feed and what the corn feed will cost per head of cattle. But it is important to note that grain and corn feed prices

have gone up significantly and have affected ranchers' ability to afford the additional input and profit from higher cattle prices (Collins and USDA). As of now, corn is about $88.60 per cwt ($88.60 per 100 pounds of live weight on cattle) (Langemeier). The expected rising prices in this volatile market are an important aspect for ranchers to consider before deciding to supplement their herd's diets with corn based rations.

As mentioned previously, after cattle are finished on corn based rations, they are usually marketed to large packing plants. When cattle are marketed this way, there can be detrimental effects on a producer's profitability. This is due to the grid or formula that cattle prices are based on when selling to the packer. Grid or formula pricing mechanisms price the cattle based on desirable traits included in the pricing equation, therefore the more desirable traits when processed, the higher the premiums paid to the producer. Even though this seems fair, it is usually hard to negotiate a grid or formula contract with large packing plants unless you have a large number and consistent flow of cattle, so not every producer can take advantage of these pricing premiums without the leverage commonly found at large feed yards (O'Quinn et al.).

In conclusion, there are several important and large costs that go into the raising of beef cattle that affect a rancher's profitability. Each traditional method discussed comes with its benefits but also comes with higher cost inputs. It is difficult to reach and maintain profitability when all these traditional costs are accounted for and is hard to find a balance of costs and profitability when considering pastures and weight gain of cattle per day on traditionally managed beef cattle, no matter the size of the ranch.

Traditional Environmental Effects

Not only do these traditional methods influence the rancher's profitability and costs, but they also harm the environment in several different ways. These environmental effects can be directly due to the rancher's traditional practices or the secondary effects of outsourcing. Harm can come to the environment in every segment of the beef cattle industry and many of these effects are due to the traditional practices already discussed. It is important for a rancher to consider these effects, as they could be detrimental to their land and their profitability if not addressed.

Continuous grazing can be extremely harmful to the land on which the rancher operates their business. Continuous grazing can lead to the overgrazing of certain forage and the under grazing of others. This leads to the loss of forage that is desirable to pasture grazing, the invasion of undesirable forage, poor distribution of manure, and soil erosion (Boyles). With cattle picking and choosing forage, there is a loss of desirable plants, which leads to less biodiversity on the pasture and in the environment. Additionally, this leads to the appearance of undesirable forage, like weeds and invasive species that cattle are less likely to graze further affecting the biodiversity and natural biosphere. Furthermore, this specific grazing pattern will lead to a disproportionate distribution of manure, which will have an adverse effect on the forage attempting to grow in these areas due to over saturation of waste materials needing to be absorbed into the soil. Another problem with cattle overgrazing in specific areas is the causation of soil erosion from not only tearing up of the ground with hooves, but from less plant roots to prevent runoff. Weather like rain or high winds will be better able to move soil and cause erosion because of the lack of forage in these overgrazed areas, which then can lead to water pollution from increased sediment (turbidity) and additional runoff. Finally, the under grazed areas will

not have enough turnover and without correct grazing, new leaves and grasses will not have the correct sunlight penetration to encourage plant growth (Boyles).

While rotational grazing solves most of these grazing issues, it still can cause problems depending on the schedule set. If rotations on pastures are not in time with certain pollination schedules, which have drastically changed over the past decades, there is a high possibility of loss of biodiversity. If plants are not given the opportunity to pollinate or seed out for the months they are in season, plant life is at risk of being overgrazed and not naturally returning to the pasture. It is important that natural forage can continue to regenerate to maintain pasture biodiverse and healthy (O'Connell and Botanical Research Institutue of Texas). Ranchers have the tendency to go with the rotational grazing schedule they have had for years, but to keep natural forage healthy, they may need to adjust these schedules by monitoring their pasture's phenological patterns.

Not only do the traditional methods of grazing affect biodiversity and the surrounding biosphere, but the planting and seeding of pastures made up entirely of "introduced forage" can have a great environmental impact. A monoculture is potentially harmful to biodiversity and soil health. There is an obvious loss of biodiversity when only one kind of forage is found in a large pasture. Tilling the entirety of a pasture destroys all the natural forage and continuously using this pasture for one specific crop continues to degridate the soil if not properly cared for. The soil quality is compromised because the constant replanting of the same crop or forage depletes the soil of natural nutrients that it does not have the time or resources to regenerate. The soil is consistently used and there is not much organic matter or animal waste to support the microorganisms responsible for naturally processing nutrients like nitrogen. The soil can be further compromised using chemical fertilizers and pesticides that damage natural soil

components as well (GeoPard Agriculture). This leads to soil erosion and eventually makes the pasture unusable due to poor soil quality. Not only is soil compromised, but pollution of water sources and overuse of water are large issues in these monoculture pastures. Soil moisture is unstable, and this leads to massive amounts of irrigation being needed. Additionally, the runoff of this irrigation or rainwater pulls chemical fertilizers from the pasture to water sources pollutes the groundwater affecting the biodiversity in streams, rivers, and lakes (Gallant International INC.). Overall, there is a large environmental impact when one decides to plant and seed an introduced pasture.

Farmers may decide to substitute this higher protein crop with a corn-fed diet. But corn has a number of environmental impacts as well. These impacts are not directly correlated to the ranch itself but to the growers and suppliers of corn. Growing corn as a monoculture on any farm has the same environmental effects as growing an introduced forage monoculture. Corn also is one of the reasons that groundwater is being rapidly drained in the middle-United States, because this kind of monoculture requires a large amount of water irrigation. Additionally, the pesticides used on this crop has been identified as negatively impacting butterfly, bee, insect, and bird populations, along with its effect on water systems when pulled into water sources by runoff (New Roots Institute). In sum, it is just as harmful to utilize this substitution of high protein introduced pastures because of its similar environmental effects that are not directly linked to the ranch feeding said corn diet.

Not only are there large environmental impacts found on cow/calf, stocker, and feedlot operations, but there is a large amount of waste and pollution in the segment of processing and packing. After cattle are harvested, they are processed into specific cuts of meat that one finds at their local grocery stores. But sixty percent of the animal never makes it to the shelves. Bones,

tendons, skin, blood, and internal organs must be recycled or disposed of by these processing plants. The waste waters from disposing and processing contain extremely high amounts of nitrogen, phosphorous, and grease concentrations, which can seep into soil and other bodies of water and cause acidification. This water can be treated, but it is extremely costly and uses high amounts of fossil fuel energy. Burial pits can be used for the disposed carcasses, but the same problem of seepage is present, and it can take up to 25 years for these carcasses to completely decompose (Conzachi). Not only are the solid, air, and water bioproducts harmful to the environment, but there is a high use of plastic packaging at these sites. The creation of these plastics is toxic and harmful to the environment, through greenhouse gas emissions and uses a significant amount of water. Additionally, it is confusing on how these plastics should be disposed of considering they were used to hold a food product. Finally, one of the largest amounts of waste can be found in the amount of meat that goes bad in transit to and at the grocery store. The processing and delivery of the meat is not chosen by the consumer, so many parts of the processed animal can go to waste. Overall, there are many points of pollution and waste in the processing and packaging of beef that need to be understood by the consumer as well as the rancher.

In sum, there are several detrimental environmental impacts throughout the segmented industry of raising beef cattle. But not all hope needs to be lost on this important segment of our agricultural industry. If ranchers could find a way to cut costs and preserve the land, they are using it could be beneficial in a number of ways, and this is exactly what Jon Taggart, and the Ranch Management program at Texas Christian University's Living Laboratory are working towards.

Jon Taggart's Business Model

Jon Taggart has been running his angus based, beef cattle finishing operation for 24 years, and has been implementing sustainable and non-traditional practices long before TCU's Living Laboratory began to collect data on his pastures. He operates his business on two ranches. One which is 850 acres and another which is 2,000 acres. As mentioned before, a finishing operation is the cattle's last stop before slaughter in the beef cattle industry. Typically, these operations finish cattle on a corn-based diet until they leave for processing. However, Taggart has been finishing his cattle on a grass only diet. His management practices perfectly follow the triple bottom line of people, plant, and profit, making his ranch a perfect place for the Living Laboratory to gather data on sustainable practices. These practices include rotational grazing, brush control with prescribed burning, no use of fertilizers, planting native grass species, varying carrying capacities based on land health, finishing cattle at a slower rate, and direct-to-consumer marketing.

Taggart's utilizes a rotational grazing system to maintain his pastures. His system is more of an art form than a science. When discussing his management practices, he mentions that he does not use conventional rotational grazing practices of similar sized pastures and set schedules. Instead, he has several different sized pastures rather than a structured paddock system, which he monitors himself and decides when to move his cattle based on weather patterns, grass health, and carrying capacities. He monitors his pastures, and with his years of ranching experience, he knows when it's time to move his cattle to a new pasture. Additionally, during the winter or droughts, he runs cattle for a shorter amount of time on a specific pasture to reduce the cattle's effect on the land.

On each of these pastures, Jon Taggart plants clover, winter annuals, like rye grass, alfalfa, and legume species, supplements protein with alfalfa hay, uses zero fertilizers, and utilizes brush control to further maintain pasture health. Rather than planting an entire pasture with an introduced forage, which would require a lot of maintenance and harm the land in the long run, Taggart seeds pastures with the plants listed above among the native grass species. This maintains and improves pasture health by not disrupting native species, maintaining biodiversity, and increases nitrogen levels in the soil. Not only does this support land health but seeding these plant species is beneficial to the cattle and their grazing. It gives more variety of nutrients and proteins and can improve weight gain in cattle as well.

Not only does the planting of these species improve land and soil health, but zero use of fertilizers and controlled burning further improves land health. Without doubt, land not treated with fertilizer results in a much healthier ecosystem. Harmful chemicals are not seeping into the soil or surrounding ground water supply, and the issues mentioned earlier regarding planting introduced forages and utilizing these chemicals are completely avoided. Additionally, this reduces Taggart's input costs due to the fact he is not purchasing these fertilizers and pesticides. Furthermore, controlled burning improves soil health and native plant growth. Prescribed burning rids the fields of an excess of organic matter that has been overgrown from previous years. Organic matter is beneficial in increasing forage growth and additional organic matter, which leads to more native fertility, however, excess amounts can reduce forage growth. Excess organic matter can smother plants and new seedlings, which reduces the amount of new and healthy growth in pastures. Prescribed burns also reduce weeds, woody plants, and other unwanted invaders from taking over an otherwise healthy pasture. Burns require proper timing to improve plant and soil health, but when used correctly they can greatly improve pasture health

(Anderson). It is important to note that Jon Taggart has done less burning than he has in the past due to urban encroachment, which effects his ability to safely burn his pastures. Overall, this non-traditional upkeep of his pastures allows him to spend less money on upkeep, improve his profit margins, and ensure that his land is healthy enough to support proper cattle weight gain.

Jon Taggart also varies his carrying capacities (the number of cattle) on his pastures, based on the time of year and pasture health. Again, this is not an exact science, but something Mr. Taggart is able to time with his knowledge of his pastures and his experience with cattle. During the winter, Taggart does not destock his ranches completely, but rather runs fewer cattle on his pasture to ensure that cattle have enough roughage and nutrients to gain appropriate weight, as well as to maintain pasture health. During the "green season," he can restock his pastures to former carrying capacities, meaning he runs a higher number of cattle on his pastures at that time. Carrying capacities also change depending on the Texas weather. When severe drought occurs on either of his ranches, Taggart lowers his carrying capacities to still run cattle on his land with lower amounts of forage available. Varying his stocking rates and carrying capacities on pastures allows Jon Taggart to keep his business profitable because it allows him to successfully run cattle on the land without having to sell his herd early. Additionally, this non-traditional method of ranching allows him to keep his pastures and land healthy throughout droughts and colder weather.

One of the most non-traditional methods that Jon Taggart employs on his ranches is the finishing of beef cattle on grass. Rather than sending his herd to a feedlot where they meet their final weight requirements, Taggart retains his herd until they are ready to be harvested. This process of finishing cattle on grass is much slower compared to finishing cattle on corn or on a feedlot. Weight gain from grass takes more time than the typical weight gain on corn, so Taggart

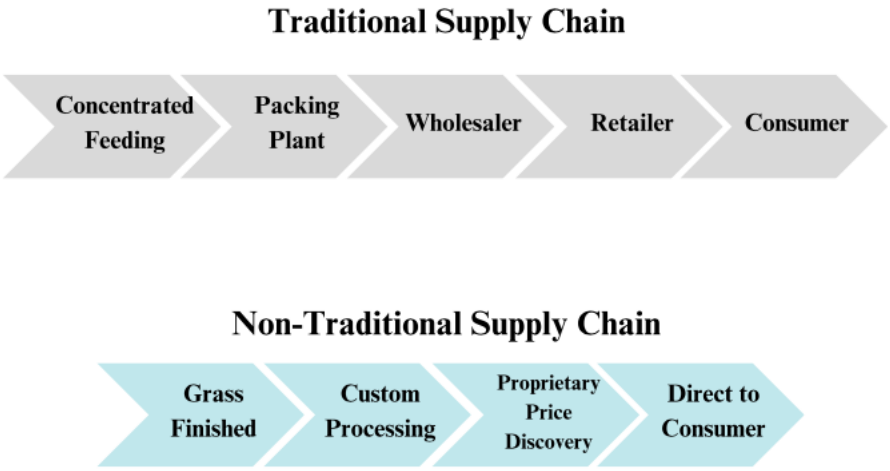
retains his herd longer than a traditional stocker/backgrounding operation and his herd takes longer to “finish” or meet their end weight goal than if they were on a feedlot. As stated previously, backgrounding operations typically send cattle to a finishing operation when they meet the optimum weight of 750lbs and will stay on the feedlot until they reach a weight of 1,200 to 1,400 lbs. Taggart continues to graze his herd until they meet this final optimum weight, which is out of the ordinary for a typical backgrounding/stocker operation. This allows him to certify that his beef is entirely grass fed, which allows him to separate himself through niche marketing from other beef producers and profit from selling his beef through his own butcher shops.

The other main difference between Jon Taggart and a traditional backgrounding operation is his direct-to-consumer marketing program. Taggart runs Burgundy Pasture Beef, three stores located in Dallas, Fort Worth, and Grandview. At these locations, Taggart sells his 100% grass-fed beef to the public and shoppers can be certain that the beef they are buying is grass-fed, without hormones or antibiotics, and are raised on sustainable land. He contracts processing to an outside facility, which is USDA inspected. Then quartered carcasses are transported to their USDA inspected facility in Grandview, where meat is dry aged for two weeks. Then meat is cut, packaged, and transported to their retail stores. These stores sell bones, organ meats, hard liver, and tongue as well as the typical cuts of meat ensuring that every part of the carcass is used. Typically, backgrounding operators do not butcher and sell their own meat, but Taggart is dedicated to ensuring his beef is safe for public consumption as well as raised responsibly and sustainably. By doing this, Taggart eliminates several steps in the supply chain, becomes vertically integrated, and avoids selling to large packing plants on a grid or formula basis as seen below in Figure 1. He is also able to control how the animal is processed into

wholesale and retail cuts of beef to match consumer demand. Because he represents the processer and retailer, his pricing mechanism of his cattle and beef is based on a proprietary pricing structure of the carcass cut-out. He is not required to follow the pricing of the USDA or the large beef packing plants. The pricing is instead based on his operational costs and his customers, making it more possible to capture all the value possible on his grass-finished beef. Because Taggart controls so many steps of the supply chain, he can add more value to his product and capture more of this value than traditional producers as well as reduce food wastes found at traditional packing plants.

Figure 1

Traditional Versus Non-Traditional Beef Supply Chain



In conclusion, Jon Taggart's backgrounding operation is vastly different from the traditional operation. He uses non-traditional tactics including seeding native grass species, zero use of fertilizer, prescribed burns, varying stocking and carrying capacity rates, finishes his cattle on grass, and butchers his own beef. These methods allow Taggart to keep his land sustainable

and healthy as well as increase his own profits and ensure the public has access to responsibly raised beef (Taggart).

The Living Laboratory

In 2015, Jon Taggart's ranch was established as the first Living Laboratory for Texas Christian University's Institute of Ranch Management (IRM). The Living Laboratory is a collaborative multidisciplinary effort that examines agricultural science, botanical science, environmental science, and the economic impact of sustainable land stewardship practices. Led by Jeffrey Geider, the Director of the Institute of Ranch Management and a professor in the Ranch Management program at Texas Christian University, a group of undergraduate and graduate students from many different backgrounds (including business, geology, science education, and, of course, ranch management) have had the opportunity to work with the Living Laboratory. The Living Laboratory network has expanded to include three holistically managed North Texas ranches. Additionally, partners of the Living Laboratory include the Botanical Research Institute of Texas (BRIT), the Audubon Society, and Natural Resources Conservation Service. IRM collects information regarding the ranches' agricultural practices as well as sharing data between all the partners involved. BRIT has primarily examined the botanical biodiversity and phenological patterns at the ranches'. Phenological patterns have been identified through the use of time lapse cameras to score the flowering patterns of native plants. One of the goals of the Living Laboratory is to create a guide for the seasonal behavior of native grasses and flowers to aid ranchers in decisions on their grazing schedules. The NCRS has developed and facilitated controlled burns at the ranches' and has collected and analyzed soil samples at the ranches. At the Living Laboratory, the IRM maintains weather stations, periodically takes drone footage,

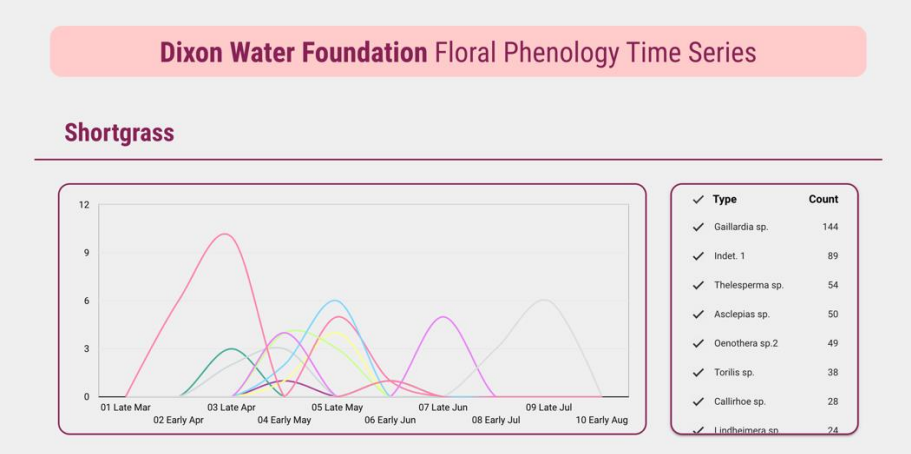
forage clippings, and carrying capacity calculations to evaluate the agricultural sciences aspect of the ranch. This is an interdisciplinary approach, and Living Laboratory is not just viewed from an agricultural standpoint, but also from a business, environmental sustainability, and botanical science point of view. The primary goal of this project is, "to create a ranch management model that demonstrates the economic value found in good stewardship practices" (Geider). In order to meet this goal, IRM's Living Laboratory collects a variety of data to verify the sustainability and profitability of non-traditional practices at Taggart's ranch.

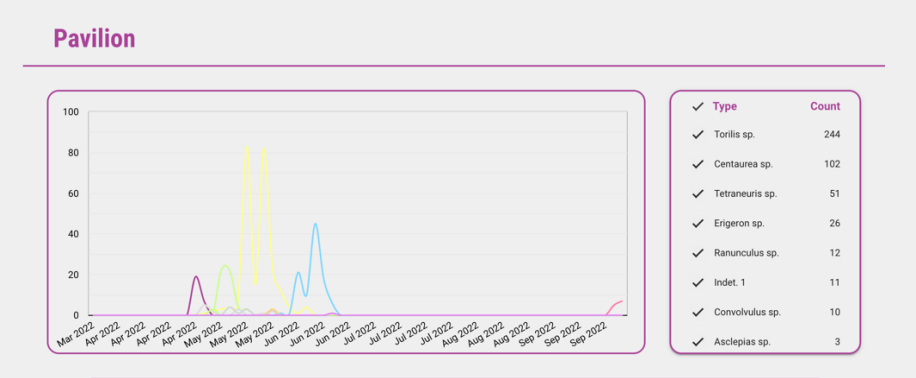
First, it is important to understand the technology being used and how it aids the Living Laboratory in the process of collecting data and managing land health. Drones, weather stations and phenological cameras are used throughout Jon Taggart's ranch. When Living Laboratory students visit the ranch, drones are used to take aerial imagery of the land and track any visual changes in the vegetation. These aerial views give insight to pasture and plant health, which helps to decide if new management practices are working as well as collecting data on improving vegetation health. Additionally, there is a weather station located on Taggart's ranch to track weather patterns, dry and wet periods, and helps the Living Laboratory to understand how weather changes and patterns affect the vegetation in the pastures, as well as how to better manage forage throughout the pasture based on weather trends. Weather stations are also used by BRIT in tandem with phenological cameras to understand the effects of the changing weather on pollinators and vegetation growth to develop better grazing schedules for the ranches. The weather station used by The Living Laboratory is a Capricorn FLX, manufactured by Columbia Weather Systems. This specific station measures wind speeds, temperature, humidity, rainfall, solar radiation, and barometric pressure. It is connected to a network, and those working with the Living Laboratory can see weather patterns in real time. Finally, solar powered phenological

cameras are placed in each pasture on Taggart's ranch in association with BRIT to track what flowers and plants are native to the pasture and when they are blooming (for example see Figure 2). Cameras are programmed to take photos at specific times of the day, and there are about 2,000+ photos total taken each day from all four ranches involved in their phenological study. It is important to note that all these technologies are easily accessible and usable by anyone. Ranchers around the United States could easily implement any one of these technologies into their practice to have a better understanding of their land and its health. These drones, cameras, and weather stations are all pertinent to gathering data at each ranch to examine the effectiveness of new management practices as well as continuing to create better, non-traditional, and sustainable management practices for each ranch.

Figure 2

Examples of a Phenological Study Conducted at One of the Living Laboratory Ranches





(Source: The Botanical Institute of Texas, 2023)

Not only “high-tech” cameras and drones are being used to measure pasture health, collect data, and create new management practices, but more traditional data gathering is being utilized on Jon Taggart’s ranch. Ranchers across the United States already use grass clippings and soil samples to record the types of native forage growing and soil health in a specific pasture. The Living Laboratory uses these methods of data collection to measure the effect Jon Taggart’s management practices has on his pastures. Grass clippings allow the students of the Living Laboratory and BRIT to measure the cycle of pollinators on Taggart’s ranch. These clippings give insight into where exactly in the pollination cycle certain species of plants are and allow them to chart the growth of these species. It is important to track when certain grasses are pollinating to adjust grazing schedules to ensure plants continue to grow on these native grass pastures. While grass clippings give insight into plant growth and pollination, soil samples give

the Living Laboratory an understanding of the soil health on the ranch. Soil sampling provides information on the chemical and physical condition of the soil. These samples are tested and return salt, pH, contaminant, and nutrient levels in the soil as well as soil texture. It is important to test these samples to understand how management practices are affecting the soil, including controlled burns and pasture rotations. This can allow for adjustments to be made in the management plan if soil is lacking in any nutrient or other levels. Additionally, these soil samples can be compared to those of a traditional operation to help the Living Laboratory and other ranchers understand the positive impacts that Jon Taggart's practices have on his land. These traditional methods of data gathering help one to understand the conservation efforts that are being seen on this more sustainable operation as well as helps any rancher make changes in their management practices to ensure soil and plant health.

The Living Laboratory works to understand plant and soil health with the assistance of BRIT. BRIT has been working with multiple ranches, including Jon Taggart's, to measure changes in pollination and pollinator levels, formally called phenological studies. These studies are important to ranches around the globe to create more accurate rotational grazing schedules that are in tune with the growth cycles of the grasses and flower species of native pastures. These phenological studies require the Living Laboratory students to do ground truthing (plant and pollinator transects and plant community quadrant surveys) as well as maintain weather stations and phenological cameras on Taggart's ranch. Ground truthing is ensuring that the pictures the cameras are taking each day match what is being seen in person. Students visit the ranch to ensure that the cameras are capturing accurate data in terms of plant growth and flowering. It also requires students to take grass clippings to double check that the species being shown in pictures are the species growing in that area of the pasture. Transect lines are a process similar to

ground truthing which ensures data being gathered by phenological cameras is accurate. This process requires students to track and record when species are flowering and pollinating. Students also maintain weather stations to track the effect weather patterns have on the pollination cycles of the native species. Most importantly, phenological cameras, which take multiple pictures of the pasture each day, help to measure the plant growth and flowering in each pasture and it is important they are maintained properly to ensure the correct information is being recorded.

This maintenance, data gathering, and ensuring data is accurate allows BRIT and the Living Laboratory to help ranchers to increase biodiversity and conservation on their pastures. BRIT is currently working with ranchers to make them aware of what is growing on their pastures and when to leave plants undisturbed during pollination. For example, on one of the many ranches BRIT is working with, they discovered milkweed was pollinating in a pasture. This weed is extremely important to monarch butterflies but can also make cattle sick, so BRIT informed the rancher to move cattle off that pasture and have them graze in one of the pastures where this plant was not flowering. This movement was beneficial to the cattle, the biodiversity of the land, and to the protection of the monarch butterflies. This is just one example of how working with ranchers to strengthen awareness of what is growing and pollinating on their land increases biodiversity. The BRIT has the end goal of educating ranchers how to manage these cameras and pollinators on their own to maintain biodiversity, pasture health, and increase conservation (O'Connell and Botanical Research Institute of Texas).

Not only are these studies important to conservation efforts, but pollinators are extremely important to the cattle industry. When a pasture is returned to a polyculture and natural prairie is restored, cattle can have a more nutrient rich and diverse diet. Additionally, native grasses are

available year-round because they are more resilient to the climate and weather. Pastures become more regenerative, sustainable, and resilient, which allows cattle related businesses to survive. Less cattle would be sold off during droughts or colder weather because polycultures of native species are better suited to survive and keep up with carrying capacities. These grasses also require little to no fertilizers or pesticides which decrease costs for ranchers. Finally, the quality of meat of cattle fed on these pastures is better due to a non-restrictive diet. Overall, BRIT is helping ranchers to improve conservation of the prairie while making their businesses more sustainable, which is the main goal of the Living Laboratory.

All this data collection, including weather stations, drones, phenological studies, grass clippings and soil samples allows the Living Laboratory to implement and support that proper management practices to create ranches that are sustainable economically, environmentally, and socially. Data collection and analysis can be used to improve land health, cattle health, and support that these new practices can work on any beef cattle operation. It can quantify the differences between a traditional operation's practices and these new non-traditional methods, which will help support ranchers in implementing these more responsible practices. Additionally, it helps to exhibit that this technology can be used by any rancher to create more sustainable management practices since it is currently in use on an actual operation. Overall, the collection of data by the Living Laboratory is assisting the research group in comparing methods, presenting numerical data of land health, and proving that there is economic value in good stewardship practices in hopes that these practices can be used worldwide.

Profitability of Non-traditional Methods

Profitability is important to any business, including the segments of the beef cattle industry. Ranchers must maintain profitable ranches to continue operating. With these new, non-traditional methods, profitability can be increased, but may also need to be determined differently than when traditional practices are utilized.

Traditionally, profitability on ranches is determined by the cost of the inputs on each herd and the amount for which each herd is sold. These inputs and revenue are recorded on lot closeouts sheets, something I have had experience in handling during my time on more traditional operations. These lot closeouts include the prices of maintaining pastures (irrigation, fertilizers, pesticides, etc.), feed, mineral supplements, round bale hay, water, processing, and vet treatments. They also include total dead, average weight gains, and cost of cattle in and out of the operation. This helps managers determine their profit on the herd each time they sell. This method would still have to be utilized on a ranch implementing non-traditional methods, but it is important to note that their inputs would be vastly different and potentially cost much less.

Using Jon Taggart's ranch as an example, his lot closeouts would not include the costs of fertilizers or irrigation because he is using native grass that does not require these kinds of upkeep. Additionally, his lot close outs would not have mineral supplement or feed costs because he does not have to implement either of these practices on his ranch. Finally, his weight gain per day would look very different from that of a traditional backgrounding operation considering he finishes his cattle on grass. The native grasses he finishes his cattle on can be more nutrient rich and dense than a planted wheat or introduced pasture. These grasses have potential to contain more protein and other nutrients that support weight gain in cattle. Additionally, they are more resilient to the constantly changing weather in Texas since they are native to the areas in which

he is ranching. With better nutrients, efficient and healthy weight gain, and less upkeep, Taggart can make a more sustainable and consistent profit on his cattle with his non-traditional methods. Although there are many differences, Taggart would still include cost of alfalfa bales and seeding on his lot closeouts. Altogether, it is clear Jon Taggart has less input costs compared to a traditional beef cattle operation because of the reduced management his native pastures require and less supplemental feed due to nutrient rich native grasses. This would increase his profitability because his costs are fewer while his cattle are still gaining healthy weight, allowing for consistent profit after sale.

Ranchers can also potentially increase their profitability by vertically integrating their business. By eliminating steps in the supply chain, similarly to Taggart, they could potentially avoid having to sell on grid or formula based pricing mechanisms to large packing plants. According to a recent study, in a group of 3,500 producers, 87.1% of these operations found direct-to-consumer marketing more profitable for their operation (O'Quinn et al.). Communicating directly with the consumer allows for more value to be captured on the cattle they are producing because they can be custom raised, processed to fit demand, and allow for producers to potentially ask for higher but appropriate prices to match their production costs. Additionally, it allows smaller producers to avoid selling cattle to large packers without a negotiated contract entirely, thus avoiding price discounts they may have encountered in the traditional supply chain.

Implementing strong, non-traditional management practices not only increase a rancher's monetary gain, but they improve land health and resiliency. As mentioned many times before, non-traditional practices like planting native grass species, using zero fertilizers, and rotational grazing improve the health of the land. This allows ranchers to put less into their land in terms of

irrigation, fertilizers, and pesticides, which would obviously cut input costs. Ranchers would also not have to supplement diets with certain feeds and minerals because cattle are grazing on a polyculture that would naturally offer these nutrients. Most importantly, improved land health allows pastures to be more resilient in times of drought and extreme weather. This would prevent ranchers from having to sell their herds or reduce their carrying capacities during these extreme weather events, which in turn allows them to keep cattle until they meet optimum weight, thus retaining their profits. Overall, these strong management practices that improve land resiliency help ranchers to cut costs as well as retain their carrying capacities, therefore retaining, or improving their profit margins.

With improved land resiliency, not only is it important to measure profitability traditionally by subtracting costs from revenue, but one must consider the environmental and social profits when operating with non-traditional methods. It is difficult to put an exact dollar amount with land conservation. It is a largely debated subject on how to even begin to put a cost on things like carbon sequestration or water conservation, but it is still important to note that not only do ranchers profit from these non-traditional methods monetarily, but the community and the planet benefit from responsibly raised beef. Until it is decided how these environmental and social benefits will be measured, one must simply keep in mind that ranching with new, sustainable management practices is measured monetarily, but does have great environmental and social benefits.

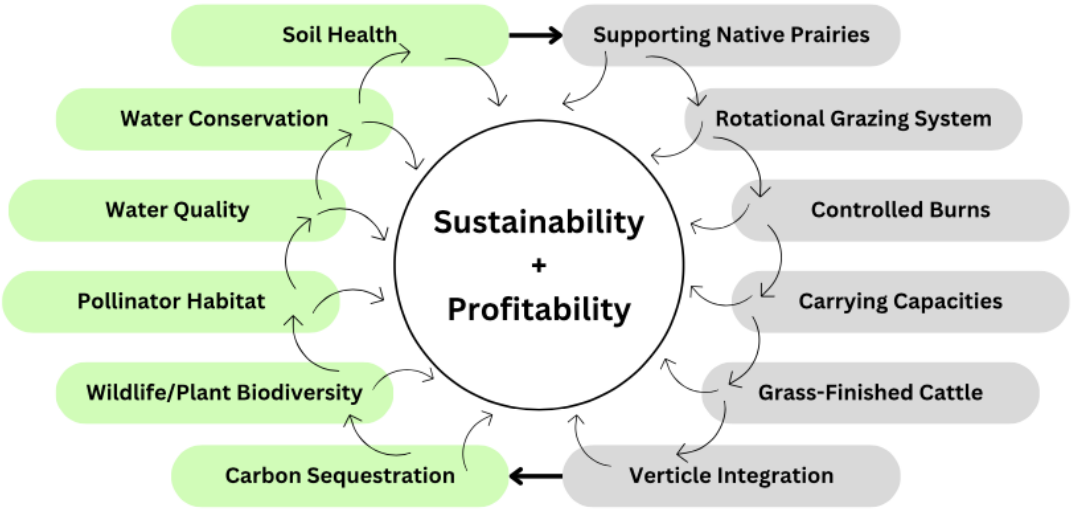
Environmental Benefits of Non-traditional Methods

As discussed previously, traditional ranching methods have many adverse effects on the environment, and in general, are not sustainable. However, if ranchers begin to use some of the

non-traditional methods above, they will see improvement in land health as well as improvement in the surrounding environment. The connection between these management practices and environmental benefits are exemplified in Figure 3. These improvements include better soil health, carbon sequestration, better water quality and conservation, and improved biodiversity.

Figure 3

Circular Ranch Management Techniques



Soil health is improved through non-traditional methods by the reduced use of fertilizers, pesticides, the planting of polyculture pastures, prescribed burns, and rotational grazing. Topsoil regenerates slowly at a rate of 500 years (Pretty et al.). It is important that soil is carefully managed to ensure that the regeneration is not needed. When polyculture pastures are in use, it reduces the overuse of soil that occurs in the planting of a monoculture like wheat. Pastures are not constantly supporting one type of grass, which allows different nutrients to be taken up by the soil. For example, native legume species aid in the fixation of nitrogen into the soil. Additionally, native grass species of a polyculture take up water and varying nutrients at

different times, allowing the soil to not be entirely depleted. Not only do polycultures maintain water and nutrient levels in the soil, but they reduce the use of chemical fertilizers and pesticides. These grasses are biologically suited for their environment, which allows them to be resistant to specific bug species and they are already adept to the natural make up of nutrients in the soil. Furthermore, polyculture pastures reduce erosion and run-off because they are not being tilled and topsoil is not fully exposed to the elements because these grasses do not need to be seeded like an introduced pasture. With the addition of a rotational grazing schedule, these grasses are prevented from being overgrazed which also reduces erosion from plant loss. Reduced erosion is beneficial to water quality, due to reduction of runoff and retention of water in soils (Misra and Ghosh). Topsoil health is also improved by controlled burns, which increase nutrient cycling, moisture filtration, and controls invasive species that harm the soil itself (White and Hanselka). In sum, soil health is vastly improved by the implementation of polyculture pastures made up of native grasses and prescribed burns due to maintaining of nutrients and water levels, less chemical usage, and reduced erosion.

Native grass polyculture pastures not only improve soil health, but also increase carbon sequestration. Carbon sequestration is process of carbon dioxide being removed from the atmosphere and help in a solid or liquid form. In this case, carbon sequestration is done naturally and is held in soil or sequestered through the process of photosynthesis. First, atmospheric carbon dioxide is absorbed through the process of photosynthesis. Then, it travels through plant shoots and roots into the soil. Carbon is then used by soil microbes in microbial respiration. In sum, carbon is taken from the atmosphere and then stored and used in plants and soil (Ontl and Schulte). When a polyculture is in use, there is an abundance of plant species that can take up different levels of dioxide. Additionally, the improved soil health from multiple non-traditional

methods allows for better storage and use of the carbon taken from the atmosphere by the plants. With healthier soils and native grass species, more carbon dioxide can be sequestered, therefore reducing carbon levels in the atmosphere.

In addition to improved soil health and carbon sequestration, water quality and conservation efforts are improved by these non-traditional methods. As mentioned before, the use of native grass species and polycultures reduces the use of fertilizers and chemical pesticides. With little to none of these chemicals in use on pastures, there will be significantly less runoff of chemicals into rivers and streams, an increase in the quantity of groundwater infiltration, as well as less seeping of these chemicals into groundwater storage areas like aquifers. Furthermore, since there is no tilling when these native polycultures are in use and no over grazing with rotational grazing schedules, erosion is reduced, which reduces the runoff of sediment into streams, rivers, ponds, and lakes (USDA, "Water Quality Practices and Resources"). Water conservation is also improved with a significant reduction in irrigation. Some traditional introduced pastures require large amounts of water usage through irrigation because this crop is not suited for the climate and weather patterns in Texas. Already stated, native grass species require little to no irrigation, which means a significant reduction in water usage. This would allow ranchers to reduce their water usage, thus conserving large amounts of surface water and groundwater.

With the improvement in soil health and water quality, biodiversity is also enhanced. Healthy soil, polycultures, and rotational grazing practices encourage the return of native insect species and plants. For example, Jon Taggart and BRIT work to improve pollinator health in these pastures, which encourages the return of monarch butterflies, bees, and other insects that depend on the health of these plants. Additionally, the phenological studies conducted on

pastures measures the biodiversity of native plant species in every field being used in the rotational grazing schedule. When cattle are rotated in tune with pollination cycles, it can be guaranteed that these plant species will return in the following year, which ensures plant and insect biodiversity. These rotational grazing schedules also prevent the overgrazing of native grass species, thus further improving plant biodiversity. Improved soil health also ensures that native plant species can thrive on these pastures. With water quality along with plant and insect biodiversity improving, there is an expected improvement in wildlife biodiversity. Native animal species like deer, rabbits, and bird species can safely use water sources as well as the native grass species for sustenance. With improved land health and reduced environmental impact, it is clear that wildlife and native species are able to return or continue to use their native habitat.

Conclusions

In sum, the non-traditional methods of rotational grazing, native grass pastures, and controlled burning have many environmental benefits. These benefits include but are not limited to improved soil health, biodiversity, improved water quality, water conservation, and carbon sequestration. The use of non-traditional methods on ranches can conserve and environmentally protect the planet while continuing to supply food to the exponentially growing population.

Applicability Around the World

As previously stated, the goal of The Living Laboratory is "to create a ranch management model that demonstrates the economic value found in good stewardship practices." The research group wants to find methods of ranching that maintain profitability while also being environmentally sustainable. The most important thing to note is that The Living Laboratory is not prescribing these methods to ranchers, but they are showing that these methods of ranching are applicable on any ranch of any size. The hopes are that these practices can be applied to achieve regenerative agriculture and can eventually be used around the world if data can be recorded and understood.

These non-traditional methods can be implemented in any segment of the beef cattle industry as well as on any size ranch. What is necessary and how these methods can be implemented remains the same for any rancher or steward of the land. The technology and data collection can be used and carried out by any ranch manager. Furthermore, this data is used in the same manner on any ranch of any type/size to implement these non-traditional methods. For example, the operation does not have to be a backgrounding/stocker operation, but a cow-calf operation could use the same pasture management methods as well. The Living Laboratory

currently has a cow-calf operation that is interested in assisting with the research on the impact these management practices would have in this specific segment of the beef cattle industry. Moreover, there are currently operations larger than Jon Taggart's that are implementing conservation efforts. For instance, Ranchlands is a large ranching operation running through the states of Colorado and Wyoming. They run a large-scale cattle and bison operation which "partners with conservation-minded owners to implement ambitious conservation programs that coexist alongside their own cattle operations." (Ranchlands) They work to build biodiversity on their properties while remaining economically viable. This is just one example of how non-traditional methods can be implemented on any size ranch. In sum, there are ranches of different sizes that operate within different segments of the cattle industry that want to work alongside The Living Laboratory in implementing non-traditional methods, along with larger ranches in the United States already implementing conservation efforts. This exhibits the idea that these non-traditional management methods are applicable at any ranch, which is the ultimate goal of The Living Laboratory.

It is also important to note that these management practices are not limited to ranches in the United States. There is a universal applicability of these non-prescribed methods. What must be done in order to apply these methods in other areas around the globe is data collection. Different weather patterns, native species, water sources, and more must be considered in order to apply new methods of rotational grazing and pasture management. Once the data is collected and interpreted, any rancher can understand what must be done to improve their soil health, water quality, biodiversity, and overall land health.

These applicable management practices meet the triple bottom line of sustainability. They improve the profitability of the rancher by reducing their costs and improving their land

resiliency, they are sustainable for the planet and environment, and they help the surrounding community by ensuring beef is responsibly raised as well as ensuring water sources and the environment are in good shape. Overall, people, planet, and profit all benefit from these non-traditional methods that can be applied to any ranch, in any segment of the beef cattle industry, of any size, in any area of the world, not just Grandview, Texas.

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