
RENEW
IDEAS
“You regenerate the soil, but you also regenerate the farmer.”

Cover

Buckwheat plants aproaching maturity might look smaller one would expect. However, plants across different ecological systems that receive different wind, rain, and soil conditions will look different from one another. Here these short plants are actually a successful crop product for this arid region of Colorado.

Photography, Illustrations, Text and Design by **Erik Makić**

Quote on cover by Roy Pfaltzgraff

REGENERATIVE AGRICULTURE

What is it.

How does it work.

Why is it the future.

Above
Golden Hoof Farms, in Boulder, Colorado, is an urban regenerative farm.

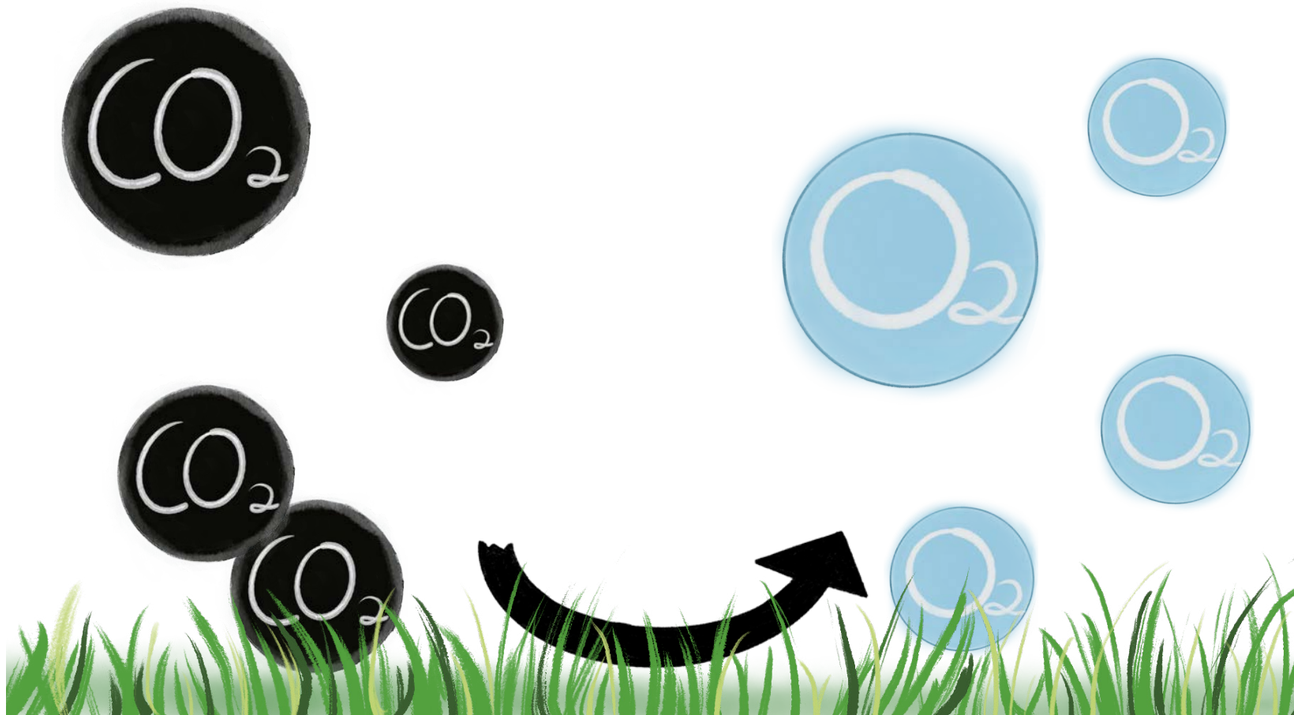
Previous
Roy Pfaltzgraff preparing his combine for a field harvest in Haxton, Colorado.

Beginning in the early 1900's, industrial agriculture slowly grew to be the most prominent form of agriculture in the United States. Prior forms of agriculture were more localized in scale due to both a smaller global population and a more holistic food approach to the general human diet. During World War II the dramatic increase in food needs, to support troops overseas, forced a rapid shift in urgency and priorities of those in the agricultural industries. The government began subsidizing farms and ranches and promoted the idea of quick and large scale production of only one agricultural good. This method of farming was known as monoculture. This shift largely benefited farmers as they were able to scale up operations and were guaranteed a profit from the government subsidies. This shift in methodology benefited the US government, farmers, and the troops fighting the largest war the world had ever seen. However , it came with an unforeseen costs that wouldn't be fully understood for years. These costs came in the form of soil depletion and massive release of carbon dioxide (CO2) into the atmosphere.

This new mass production methodology was able to produce large quantities of crops across the US. Unfortunately, soil health was depleted by the lack of crop diversity, heavy pesticide and herbicide use, as well as large scale tilling and removal of natural grassland prairies. Soil health is comprised of many things but can most simply be defined as a soils ability to function as a living organism. To break it down, think of it like this; Soil is the first few feet of Earth's surface and is biologically active thus for all intents and purposes , alive. Conversely, dirt is also part of the Earth's surface and looks like soil but is not biologically active and therefore not alive. Soil when destroyed becomes dirt, and this process can happen rather quickly. While turning dirt into soil takes much longer. The destruction of soil not only hurts the lands ability to support plant life in the future, but this depletion of soil additionally supplies the surrounding air with carbon in the form of atmospheric CO2 which is a prominent greenhouse gas. As soil decayed, like many decay processes, it released gases, two of which being Methane (CH3) and Carbon Dioxide (CO2).

Fundamentally the role of soil is to provide structure and nutrients supporting plant growth. This is where the plant absorbs water, stores energy, and pulls nutrients like nitrogen, manganese, calcium, etc. So, it makes sense that as a plant grows the soil it is growing in will deplete over time. This is in fact exactly what has happened to the soil across the planet over the past few hundred years, mainly since the 1900's associated with the boom in monoculture farming. But if plants do take nutrients from the soil, why haven't all soils been destroyed already? In fact, there is a balance between the give and take of plants and their soil homes. All plants pull nutrients from the soil, but plants are also able to provide a wide variety of services back to the soil. Some plants are known as nitrogen fixers, meaning they help add nitrogen back into the soil while other plants remove it. The same is true for many other plants and organic chemicals like manganese and phosphorus. Plants also provide structure to the soil through its complex root structure. This prevents the destruction of the soil due to wind and water erosion. Think of the dust bowl era of the 1930's, a time when crops failed on a large scale that resulted in a dry and barren landscape due to massive soil erosion. The lack of soil health and plant structure precipitated the devastating dust storms.

Plants and soil have what is known as a symbiotic relationship, or a partnership where both sides benefit from the presence of the other, increasing the success of life for both parties involved. This at its very core is regenerative biology. When considered in the form of plants and soil that provide food for humans the partnership is known as regenerative agriculture.



Jonathan Lundgren from the Ecdysis Foundation holds a shoveled-up section of grassland soil in a demonstration to local farmers in Boulder, Colorado. Lundgren explains to farmers the intricacies of soil and how things like root structure, insect populations, and ground cover play a major role in regenerative agriculture.

Regenerative agriculture is an ecosystem centric approach to food production. The balance between producing enough food for the eight billion people on Earth while simultaneously rebuilding soil health. To rebuild soil health means to not only to replace what is used in a given time frame, but to rebuild soil beyond where it was when you started. In a way it turns back the clock and builds soil deeper into the surface of Earth, similar to where it used to be before our anthropic destruction of it . This understanding of the whole system requires changes to traditional agricultural methods but provides a multitude of benefits when done correctly.

Often described as the ultra-rare win-win-win scenario, regenerative agriculture has complex layering of benefits. In a world where most benefits come at a cost, or a win-lose situation, regenerative agriculture provides mainly positives. The basis of this methodology is to work inharmony with billions of years of ecological development and systems. Most farmers that adopt regenerative agriculture have reported increased soil health, increased soil carbon (from atmospheric CO2), strengthened plant resilience and increased crop production. This is the first win; healthier soil. The second win, is increased crop or livestock value. In regenerative systems plants and animals are provided significantly more and a larger diversity of nutrients that support plant growth and animal grazing. This produces healthier and more nutrient dense foods such as healthier cattle or more delicious and healthy fruits and vegetables. The third win is increased profits directly from agricultural products. These increased profits are not from subsidies or insurance bail-outs but rather due to significant and measurable increases in crop quantity, quality and diversity which allows for more income streams at different times of year. Better soil health, improved product quality, and generation of more profits. The win-win-win.

Regenerative agriculture is, at its core, a methodology. It is a set of guidelines that farmers, ranchers, and even the average gardener can follow to work with local soil systems . Where industrial monoculture and regenerative agriculture differ are in the varied applications. Industrial agriculture supports growing the same primary crops, like corn or soy, regardless of the farmland's geographical location, topography or local climate. Planting crops in non-supportive climates requires significant herbicide and pesticide use as well as the addition of nutrients. These plants don't naturally strive in all locals and especially struggle when biodiversity is removed. Industrial monoculture is a one size fits all approach.

Regenerative agriculture takes a different approach. It is a methodology that focuses on and aligns with specific ecosystem needs and functions, which when addressed in turn benefit the agricultural production. This means that the basic ideas of regenerative agriculture remain the same across all applications; Promote soil health, reduce or eliminate soil disruption (i.e. no till farming), promote biodiversity and provide cover crops to minimize bare soil exposure. The methods used change depending on the farmland location. Take the land owned by regenerative farmer Roy Pfaltzgraff. Located in Haxton Colorado, Roy's land receives less than an inch of natural rainfall on average per year. While a regenerative farm in Indiana or other mid western states receive hundreds of inches of rain per year. The methods that Roy implements on his farm will be dramatically different from those in Indiana, while their fundamental goals can remain the same. Certain staple crops like corn, wheat, soy, peas or sugar beets are grown all across the country. Although these plants need similar

PLANTS

Current Issues.
Tools & Improvement.

Buckwheat is a versatile crop and is more drought-resistant than other more common crops like wheat. This characteristic is especially useful to regenerative farmer Roy Pfaltzgraff as he is unable to irrigate his cropland due to low aquifer volume in the area.

This specialized combine header is fitted with teeth that allow for the harvest seeds, or fruiting bodies of a plant, leaving a significant portion of the plant's structure intact. The remaining plant structures provide shade for the soil. Decreasing water evaporation and soil warming.

care their local environments will change which regenerative tools are used best. Roy for example needs to focus primarily on water conservation and will put efforts into cover cropping and new technology for harvesting plants with minimal soil disturbance. While a farm growing the same crops with plenty of rain may struggle due to overgrown fields and would consider integrating forms of livestock on their land to manage the growth.

There are also differences between the methods and approaches between crop agriculture and livestock raising. While each produces food for the human population they often occur on very different types of land space and ecosystems. They also require different inputs, tools, and have different benchmarks of success.

Agriculture focused on producing crops focuses mainly on growing specific crops in large quantities with the goal of having them harvested by a specific time of year. This type of agriculture is strongly influenced by seasons and the final product quantity and quality is affected by weather throughout the growing season. The simplest idea behind growing crops would be to sow seeds at the right time, manage nutrients and water, as well as maintain preventative measures for pests and weeds. The final step being to harvest at the right time for the best product quality and quantity. Too late in the season and food may be over ripe or damaged. Too soon and you may limit your harvest that you only get one try at obtaining.

Where regenerative agriculture influences this form of production is the increased likelihood of plant and soil resilience. Resilience is an art and something that nature has perfected. Inclement weather such as hail, floods, wildfires and drought have increased in number and severity over the past 50 years due to climate change. The necessity for resilience has never been greater. When regenerative methods are applied the crop systems of a given farm are reinforced with the benefits of deeper and healthier soils and more plant and biome biodiversity.

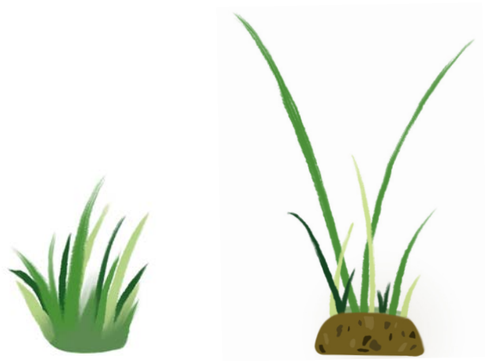
The shadow cast by plants play a major role in soil water retention. A collective shading of direct solar exposure can lower soil temperatures and prevent evaporation of moisture in the soil.

Monocrop farms, like a thousand-acre corn farm for example, are susceptible to complete devastation if a single large hailstorm moves through the area. Whereas a regenerative agriculture farm with multiple crops, i.e. biodiversity, split between crops like corn, alfalfa, wheat, soy and peas, all of which have staggered growing seasons, would only have one crop damaged by the hail. The farm with biodiversity would have 4 of the 5 crops planted remain viable for that year. This is the difference between 0% product at harvest and 80% product at years end.

Increased soil resilience in regenerative systems function in a similar way. When a crop is destroyed or has a poor growing season in a non-regenerative system, the soil gains no benefit from those crops that year and degraded further. Which in turn negatively effects the crop production the following year. In a regenerative system where soil health is consistently rebuilt the ecosystem services provided by this soil remains viable year to year regardless of the events of a single year.

Regenerative agriculture and its methodologies are sometimes difficult to adopt for some food producers as they go against many generations of tradition and understanding. Let's take tilling for example. Tilling is as ancient as farming itself and is a practiced tool in almost every agricultural system in history. The purpose of tilling is to loosen soil for sowing seeds and to loosen soil for root growth and water absorption. And although tilling has its benefits, its destruction to soil is far more significant. During tilling, CO2 is released into the atmosphere as the soil is disturbed. Soil is a living organism built by billions of microorganisms and is home to millions of different other organisms such as insects and mammals. The process of tilling dramatically disrupts the biome living in this soil and kills many of the organisms it supports. Although no-till farming is not possible in every landscape the adjustment from large tilling operations to minimal tilling can also make a big difference in reducing CO2 emissions and biodiversity loss.

Another foundation of regenerative agriculture that opposes many previously accepted growing traditions is that of cover cropping . Many industrial farmers operate under what is known as crop rotation cycles. This method of crop rotation addresses the known problems associated with growing the same crops year after year on the same pieces of land. In these systems farmers often grown 2-5 different crops and rotate them from one field to the next in a circular system, often leaving a single field to be barren and rotating which field is left barren from year to year. The idea being to give that plot of soil a break from growing plants and the ability to rest and regenerate. However, soil does not regenerate in the same way as humans. As humans, we require sleep and a break from external variables. Soil requires rest in the way of it not being overused, but more importantly soil requires consistent environmental support such as the addition of new moisture and shade. While, it is true soil can be over used, leaving soil completely barren has multiple negative affects to the health of the soil and the biome underneath. Soil that is left bare is



A dried wheat head sits on the dashboard of Roy Pfaltzgraff's truck. Roys land is thousands of acres and is comprised of multiple large rectangular fields of specific crops.. The roads function as both boarders between neighboring farms as well as a communal system for surveying your crop lands.

exposed to direct sunlight which literally burns the surface of the soil destroying any living organisms that don't feed off photosynthesis and additionally this exposure warms the soil by multiple degrees. Warmer soil creates poor living conditions for the biome underneath and over time kills many organisms, which destroys the soil.

The regenerative principle of cover cropping is the solution to this problem. Cover crops are inexpensive crops of any kind that are grown but not necessarily intended to be harvest. These can be sunflowers, wheat, fava beans, or just regular prairie grass. The presence of these cover crop plants allows the soil to be shaded from direct sunlight. The shade can increase water retention that would have been lost otherwise to evaporation. In many cases the amount of water prevented from evaporating can be so large that it equates to more total water than what falls naturally over a given year. This is the case on the farm of Roy Pfaltzgraff mentioned before , whose land receives less than an inch of rain per year and is not suitable for irrigation. The presence of cover crops in the form of sunflowers allows enough shade on the soil that the water retained is more than the equivalent of an inch of rainfall. This retained water provides a more suitable environment for the microbiome and aids soil health, further allowing Roy's farm to be successful despite lack of natural rainfall.

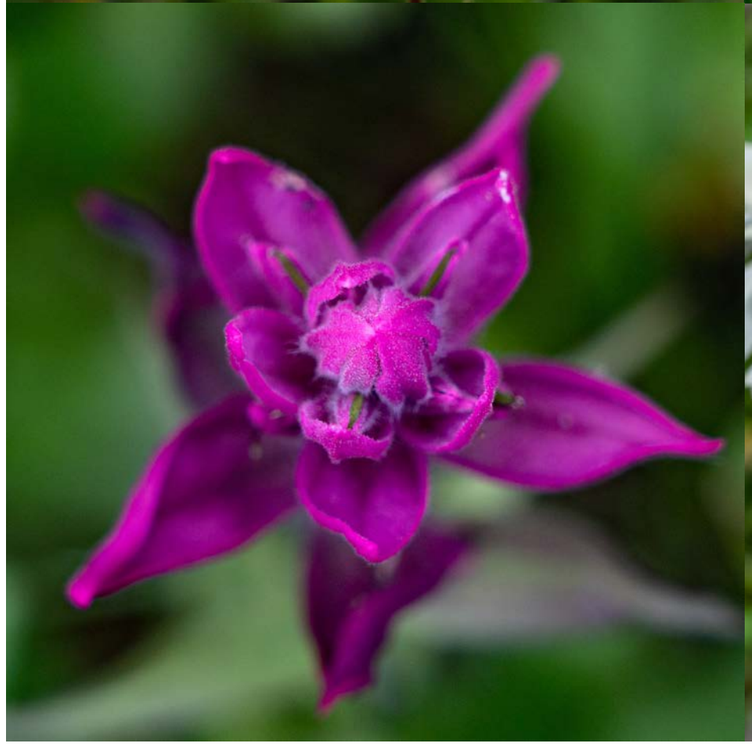
The presence of plants promotes water absorption and retention. It is logical to think that dry soil, such as that of soil found in deserts, would be more able to absorb water due to its arid nature. However this is untrue. Dry soil is solidified and unwelcoming to new water. Think about flash floods that occur after a singular large rain fall in areas that suffer from drought. The water simply runs across the top of the ground and does not permeate downwards. Soil that contains complex root structures and holds previous moisture is significantly more capable to absorb water as the root structures allow pathways for the water to travel deeper into the soil and the presence of water previously means the soil structure is such that additional water is able to diffuse and be absorbed by the soil.

A specific tool that bridges the need for crop shading and crop harvesting is a special combine header. A combine header is the tool attached to the front of a large tractor that spins much like a vacuum cleaner and strips the desired crop from the plant stem and stores it in the back of the combine.

Specialized combine headers are made that can strip minimal amounts of plant stem from a crop such as peas or buckwheat. The combine header still collects the desired seeds but leaves behind standing plant stems that are taller than an average combine would. The stem left behind will cast a shadow for the remainder of the year and will help retain soil moisture. A traditional combine harvest would not allow this process, resulting in more exposed soil. Furthermore, retaining some of the plant allows for stem decomposition back into the soil which returns nutrients taken by the plant during its growing season.

Wildflowers are an essential part of natural prairies and grassland ecosystems. Diversity of plant type, plant size and plant functionality all play roles in the function of the prairie ecosystem. Some flowers are great food for cattle while others can be deadly. Cattle generally know what plants to avoid.

A very different form of agriculture compared to crop agriculture is that of raising livestock. Livestock



Wildflower diversity is as unique as the landscapes they live in. Here multiple western and alpine plant species grow in the same rangeland permit. Ranchers are skilled flora identifiers and can point out and describe the characteristics of almost any plant growing on their land.

raising is the process of providing nutrients, shelter, reproduction and in most cases the eventual processing of a livestock animal. These animals range from chickens to pigs to cattle. Although there are many ways to raise livestock, regenerative agriculture methodology promotes the raising of livestock in ways, that again, benefit the soil these animals walk on. And contrary to a popular belief, the raising of livestock can actually be in the best interest of the planet and the climate under certain circumstances.

To understand the roles of animals in modern ecosystems we first need to understand the roles of animals in natural ecosystems. There is an ecosystem web and in all ecosystem structures, where plants are at the edges, providing food for grazing animals. Further inward in this web is an increasing structure of predatory animals like wolves or mountain lions. These apex predators eat mainly other animals and provide population regulation of large animal herds like deer or elk. The grazing animals that consume plants and grasses are in most cases ruminant animals. Ruminant means that these animals are able to consume and digest cellulose, the primary structure of plants. We as humans are unable to do this, but animals such as bison and modern cattle are able to digest cellulose. This means grassland prairies provide a complete food source for ruminant grazing animal herds.

Historically in the U.S. the most prominent ruminant animal was bison. Bison roamed the U.S. in such large quantities hundreds of years ago they were a staple in almost every state. Unfortunately, early colonizers and settlers hunted the Bison almost to extinction. These animals roamed the landscape consuming grasses and providing gentle ground disturbance, seeds dispersion, and fertilization through their feces. They lived and functioned in a perfect circular system of nutrients and carbon for thousands of years. Much of

Above

Strip-cropping is a method of crop production that divides a field into parallel sections, or strips, and alternates crop and fallow (empty soil) year to year. Although this idea is meant to allow soil to recover, its lack of cover-cropping exposes the soil to the elements, eventually destroying the underlying microbiome over time.

Below

A combine navigates the seemingly flat landscape of this yellow pea field. Although the field is flat to the viewer, gradual and uneven changes to the fields topography can cause issues when a combine header of this size navigates it only inches off of the ground.

Irrigation sprinkler systems are common practice on many farms. Top-down watering means the water may evaporate before reaching the soil or plant roots. To minimize this risk farmers will often water early in the morning or right before sunset to avoid direct sunlight and evaporation.

ANIMALS

What are ruminant animals?

Emission vs. Absorption.

A Scottish Highlands cow at Ayrshire Farm takes shelter from the sun to the edge of the day's roaming field.

Much of the National Forest land is challenging terrain. Unlike National Parks these Forests permit use of small motorized vehicles for transportation.

regenerative agricultural systems are based on mirroring the natural systems known by observing the historical relationships of wild ruminants and their ecosystems.

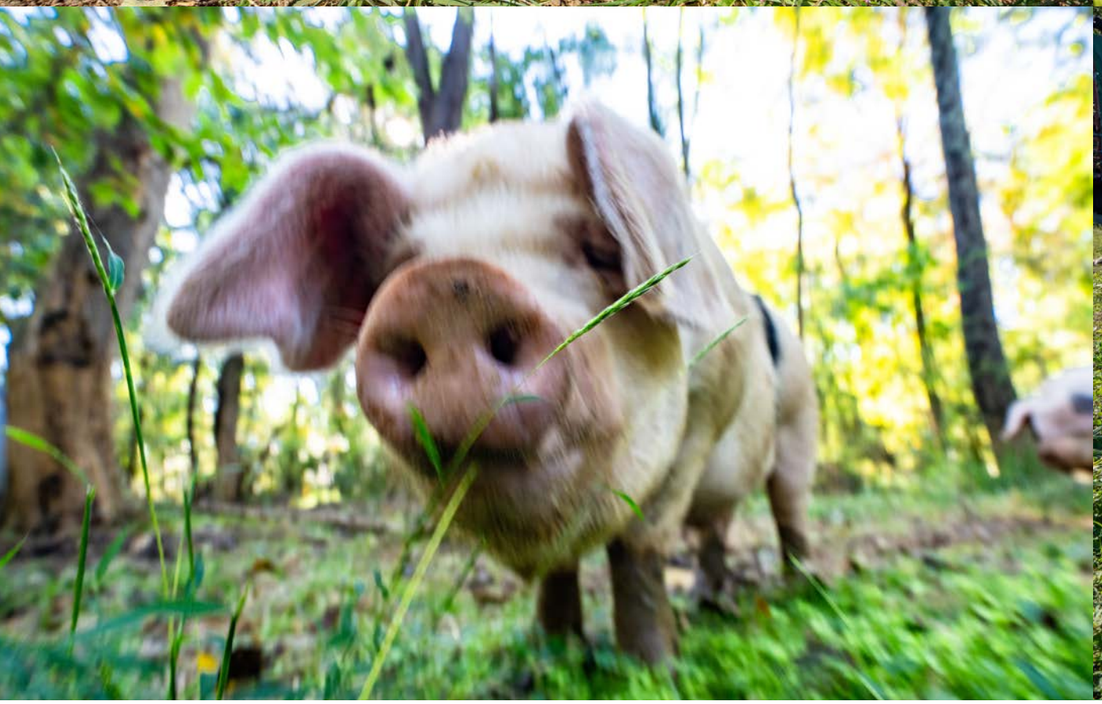
The most regularly vilified ruminant animal is cattle. Widely thought of as a massive greenhouse gas producer, cattle are judged mainly due to their digestive biology and the production of methane through burping and somewhat in flatulence. This is, on its face, a true statement. Cattle do in fact release methane during burping and emit greenhouse gas in much larger quantities than other animals such as chickens. This does not however mean they are a primary contributing adversary responsible for the global greenhouse gas problem which is at the heart of climate change.

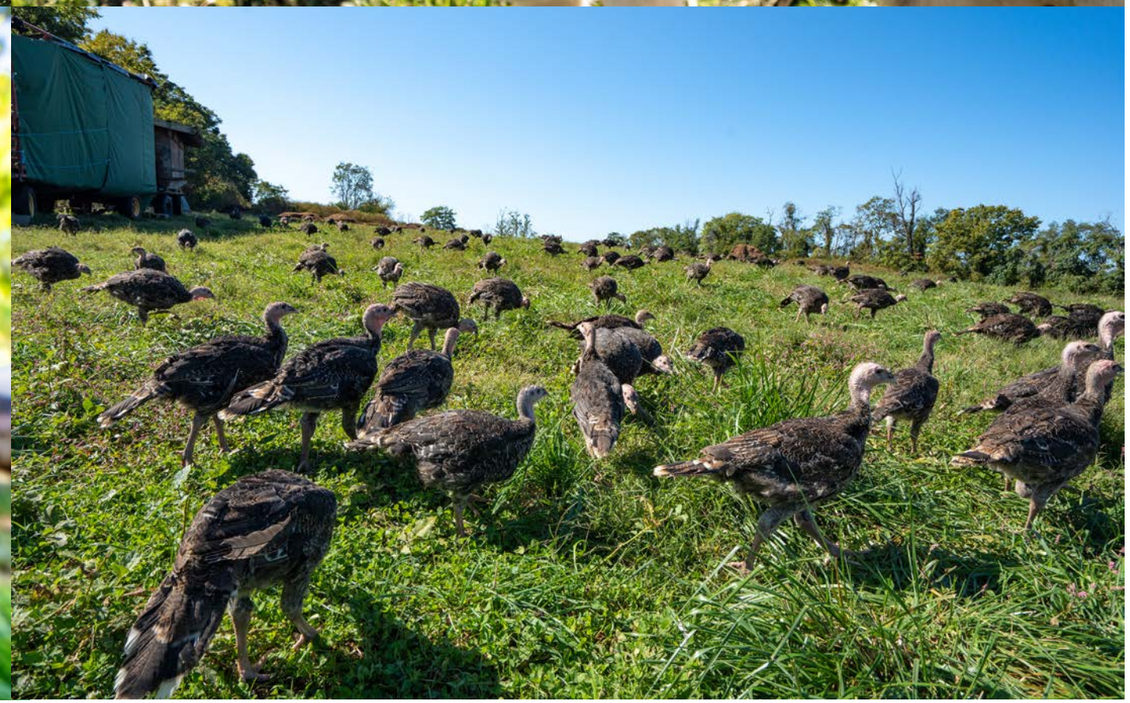
Learning from history, bison roamed the prairies and steppes of the continent for millennia and there was no significant increase in global greenhouse gases. As bison were removed, ranchers replaced them with the more domesticated cattle breeds. Cattle today produce methane in the same way as all ruminant animals that roam in the wild including animals like elk and goats. To see cattle as a significant contributor to climate change is a very myopic view of the system. Cattle do emit methane, but they live and consume food in an ecosystem that is built to absorb atmospheric carbon. To put it simply; cows eat grass and digest it in a way that a byproduct of that digestion is methane. This methane enters the atmosphere and over time breaks down via natural processes into carbon dioxide. The grass consumed by the cattle was trimmed down due to the consumption of it, which promotes the grass to grow again in the matter of days or weeks back to its previous size. This growth is fueled via photosynthesis which is the use of sunlight + water + CO2 as food to produce structural sugars and a byproduct of atmospheric oxygen (O2). In essence the removal of atmospheric carbon.

GRAZING
activates soil and spreads seeds

MANURE
fertilizes soil and is food & shelter for insects

Cattle actively graze a grassy pasture at Ayrshire Farm in Virginia. Diversity of cattle species promotes different diets and plant preferences. Cows (female cattle) often graze with their young, while bulls (male cattle) are relocated or kept separate.





Upper Left
A juvenile turkey – a Jake (male) or a Jenny (female) – roams in open space. Turkeys gather in the shade and make small divots in the ground to lay in.

Upper Right
A mature female Ancient White Park Cow protects her weening calf. The yellow plastic tag in the calf's nose isn't painful. It is intended to make suckling difficult, weening the calf faster.

Lower Left
A young pig that shares a sizable pen with two other pigs carefully navigates the electrified hot-wire that keeps them away from the maintenance road.

Lower Right
The large group of juvenile turkeys roam a few acres of grassland with mobile shelters and feeding stations. The flock often moves together in a similar direction.

A drone composite panorama shows the Uncompahgre National Forest where Jim Howell holds a cattle grazing permit.

The rugged typography of the Uncompahgre National Forest, including mountains and high elevation forest, provides many sources of water and shelter for cattle.

RESEARCH

Soil rebuilt
The future of soil.

Researchers Megan Machmuller and Paige Stanley of Colorado State University's soil research team, along with Jim Howell trek to a geo-marked position to perform a soil core sampling.

Howell provides detailed information about his cattle operation to the researchers as they drive to the sampling site.

Stanley takes multiple soil core samples. The sample locations are often far from the main road. Hiking in is the easiest way to access all the waypoints.

The carbon emitted by cattle is reabsorbed by the grassland prairies the cattle live on. And although this may seem simple, the carbon cycle is a well documented phenomena of all ecosystems on Earth, similar to the well known water cycle. The real difference here, is that when cattle are not allowed to roam natural grasslands and prairies and are instead fed via corn, alfalfa and other human controlled crops, the carbon cycle is broken and the carbon emitted by the cattle is in excess of the carbon absorbed in the crop growing processes.

The solution is regenerative agriculture, both in the form of crop production and livestock raising. As stated before, regenerative agriculture is an ecosystem centric approach to agriculture. The ecosystem has long been almost perfectly cyclical in terms of nutrients and carbon. Importantly, if livestock are raised following regenerative models the carbon can be more than offset but can actually be net carbon negative.

Cattle when allowed to roam are able to consume grasslands and prairies without overgraze the landscape. This is beneficial because when cattle are not allowed to roam, landscapes become overgrazed and barren, losing biodiversity and the ability to absorb and store carbon. Under-grazing the land can have an equally detrimental impact. As prairies are allowed to overgrow they become crowded and dead plants, also known as detritus, covers the soil in a way that blocks water absorption. Microbiome respiration and plant detritus that decays under a lack of oxygen is anaerobic in nature and produces methane while it decomposes. Therefore, a lack of grazing animals can result in methane production similar to the presence of ruminant animals. The benefit of allowing cattle to roam and graze is to limit plant overcrowding, anaerobic decay, and plant detritus.

There is clearly a balance between these two extremes: Prairies with no ruminant animals and overcrowded feed lots. This balance is the grazing patterns of bison and other ruminants. They graze areas in large herds which dramatically trims grasslands in a short period of time, however the herd is also constantly on the move which allows for continuous plant growth. These patterns are repeated year after year due to migratory patterns, creating a cyclical system. This can be applied to cattle and other livestock like pigs and goats as well. Strategic movement of animals so they impact the land and move on is the basic idea behind regenerative livestock raising.

There are additional circumstances to be considered in support of regenerative ag livestock farming. One common argument is the idea that it takes massive amounts of land to grow the food we use to feed livestock animals. Which will eventually be processed and used to feed humans. The argument being to cut out the middle piece and use land to grow food directly for humans. This argument has some basis when considering livestock raising done on feed lots where animals live in small, crowded areas and eat only highly processed foods. Where this argument can be deconstructed is yet again through truly regenerative agriculture. For example, the land operated by Jim Howell of Grasslands LLC employs principles of regenerative agriculture

CSU soil scientist, Megan Machmuller, locates a soil coring control point in the irrigated cattle pasture of the herd that travels into the National Forest land. The cattle remain in the irrigated pasture during the winter where it is warmer, and move upslope as temperatures rise.

with his livestock. Jim runs thousands of heads of cattle across the U.S. Many of which are being grazed on national forest land through permits given to him by the US Forest Service, a section of the US department of Agriculture. Jim runs his cattle on steep terrain full of natural grassland prairie, and moves the cattle passively using hot-wire systems and the natural topography of the permit landscape. This land is completely unusable for crop agriculture and therefore can be considered useless land for producing food for the human population. This land however is quality grazing land for cattle with dense biodiversity, natural water sources, and large roaming area. When Jim runs his cattle on these permits it effectively takes useless agricultural land and turns it into land useful to feed humans through the successful ranching of ruminant livestock. The land can feed cattle and in turn provide very necessary animal protein to the growing human population, overall increasing the usable agricultural land in the U.S. Simultaneously increasing livestock production and thousands of pounds of food. Allowing additional cropland that is used to grow feed to be grown for other crops instead.

Research is being conducted across the world by many institutions, universities, and private entities, on the benefits and function of regenerative agriculture. One current research study conducted in part by researchers at Colorado State University (CSU) and the STAR (Saving Tomorrows Agricultural Resources) program is a pragmatic study to understand real world regenerative systems. This research is being conducted by soil scientists to quantify and further understand the benefits of regenerative methodologies. One portion of this study was done on the lands of Jim Howell. As mentioned earlier, Jim raises thousands of head of cattle on national forest land and has done so for almost a decade. This provides a perfect variable location adjacent to a control location in which livestock do not roam. In this research the scientists are analyzing the effects of multiple or single changes as compared to the same situation that is not altered. Jim's permit land is in the middle of national forest land where the land has been preserved and overall unaltered for many years. And Jim's permit having been in use for almost 10 years means that there has been enough time for there to be measurable changes in the soil of the land Jim's cattle are raised on. The research being conducted by CSU scientists is focused on measuring and analyzing the soil of locations both on and off of Jim' national forest permits. Using satellite data to assess green plant cover and soil core sampling to directly measure carbon levels of the soil, the research project is aimed to compare the soil carbon absorption over time of grazed land versus non-grazed land. Although results are not finalized, over the last 10 years it is already obvious through the measured data that has been analyzed that the land on which Jim's cattle roam has actually increased in absorbed atmospheric carbon. Meaning that the presence of Jim's cattle and his regenerative grazing practices has allowed the soil to absorb and permanently store more carbon than nearly identical land where cattle are restricted and do not roam. This increase in carbon is consistent across much of the permit land where cattle roam and when thought of collectively the amount of carbon absorbed by one herd of cattle is in the range of metric tons.

There is a similar story on crop lands such as that of previously mentioned Roy Pfaltzgraff who has been practicing regenerative methods for many years. The measured carbon levels in his soil were around 1 percent on average when he first started regenerative methods. Over time the same land was reevaluated and shown to have increased to an average carbon level of 3 percent, meaning a 300% increase in atmospheric carbon multiplied across thousands of acres of land. With absorption rates like these the conclusion can be argued that the amount at which carbon is absorbed is greater than the amount of carbon emitted cumulatively between the processes (automobiles, electricity, livestock, etc.) incurred when growing these foods. Making these systems literal carbon sinks and climate solution tools.

Regenerative agriculture has many benefits. As is stated in the name of the concept, the main function of this method of agriculture is to regenerate what is used as it is used. This idea is mostly achieved through soil and soil health as the foundation for all other processes and benefits. However, this regeneration can also be expanded to people and communities. Regenerative farmer Roy Pfaltzgraff said “When you regenerate the soil you regenerate the farmer.” Meaning that through regenerative methods the soil health will in fact improve and this basic fact reinvigorates the desires that all farmers have, which is to grow and produce good food for people and to sustain a successful income stream.

Left

Machmuller annotates detailed information about the soil core site including topography, aspect, foliage, canopy cover and ground type.

Below

Many species of grass and wildflowers grow abundantly in the un-manicured pastures of the National Forest land. Machmuller returns from a soil core retrieval through natural prairie grassland.

This soil core tube was hammered into extremely fine clay, making it difficult for Howell to remove. A vacuum created below the tube resisted Howell's efforts as he twisted, turned and pulled on the stuck tube. The core took nearly 4 hours over 2 days to retrieve.

The soil core sampling tools used by Paige Stanley and Tayin (Tony) Wang are made of solid steel, put into the ground with a sledgehammer. Additional tools needed for measurements add to the difficulty of long and unmarked hikes from waypoint locations in the Uncompahgre National Forest.

Achieving wider understanding and adoption of regenerative agriculture can and will provide many benefits to any food producer adopting these methodologies. And knowledge of the progress in this field should regenerate any lost hope to the average food consumer, for a more climate stable future. As the soil is healed across the globe the human population can sleep a little more soundly knowing that there is indeed hope for the future, not only to slow the climate crisis but to even reverse it. To this end I say make sure to thank a farmer and shake the hand of a rancher and, understand that as a consumer and human being your food choices and support can make a big difference.

Above

The soil core sample is removed and measured on a make-shift mobile table. The preferred length is 50cm, which will be cut into smaller, 15cm sections and put into baggies.

Right

Savanna Howell and her father Jim Howell enjoy the festivities at the local children's rodeo in Cedaredge, CO.

Back Cover

Grassland prairie near Cedaredge, CO. This land is used as a basecamp for Howells herd management team as well as a research station. The land here has been grazed for years, yet maintains a wild spirit.