



CARBON FOOTPRINT EVALUATION OF REGENERATIVE GRAZING AT WHITE OAK PASTURES

RESULTS PRESENTATION

Prepared for:



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Executive Summary



- + Livestock products, especially beef, are often shamed for having high carbon emissions.
- + However there are potential benefits to raising livestock, including climate benefits in cases where soil carbon is being accumulated.
- + Traditional LCAs don't account for soil carbon sequestration and therefore don't take into account the full carbon story for regenerative agriculture systems

- + Soil samples were taken and evaluated to quantify soil carbon sequestration and allow a highly credible inclusion of this information into the LCA.
- + Our team visited WOP to ensure a thorough understanding of the farm operations and the ability to represent the production system accurately.
- + We conducted an LCA (carbon footprint only) of the entire WOP farm operation and developed a product-specific LCA for WOP beef.
- + Pre-existing references are used for comparison with conventional US beef and other benchmarks.

PROJECT AT A GLANCE

- + Regenerative grazing is a management practice that accounts for the optimal resting time of the land to prevent overgrazing and allow regeneration of degraded land.
- + White Oak Pastures (WOP) practices regenerative grazing to regenerate degraded cropland and convert it to permanent pasture
 - + Here, we've assessed the carbon footprint of beef from WOP and made comparisons to evidence about the carbon footprint of conventional US beef.
- + This scope of work is focused on carbon, and does not include other indicators such as water consumption
 - + An emphasis is placed on quantifying the net carbon footprint of WOP beef, identifying the potential areas of uncertainty and variation and in defining the conclusions that can be drawn from this information.
 - + As there is little information published on this topic and the outcomes challenge much conventional thinking on beef's carbon footprint, careful consideration should be given to the conclusions and messaging.

WHAT WE FOUND

- + The net result is that WOP beef has a carbon footprint **111% lower** than a conventional US beef system.
- + The WOP system effectively **captures soil carbon**, offsetting a majority of the emissions related to beef production.
- + The largest emission sources—from cattle digestion and manure—are **highly uncertain**. We believe the results shown here are on the conservative side.

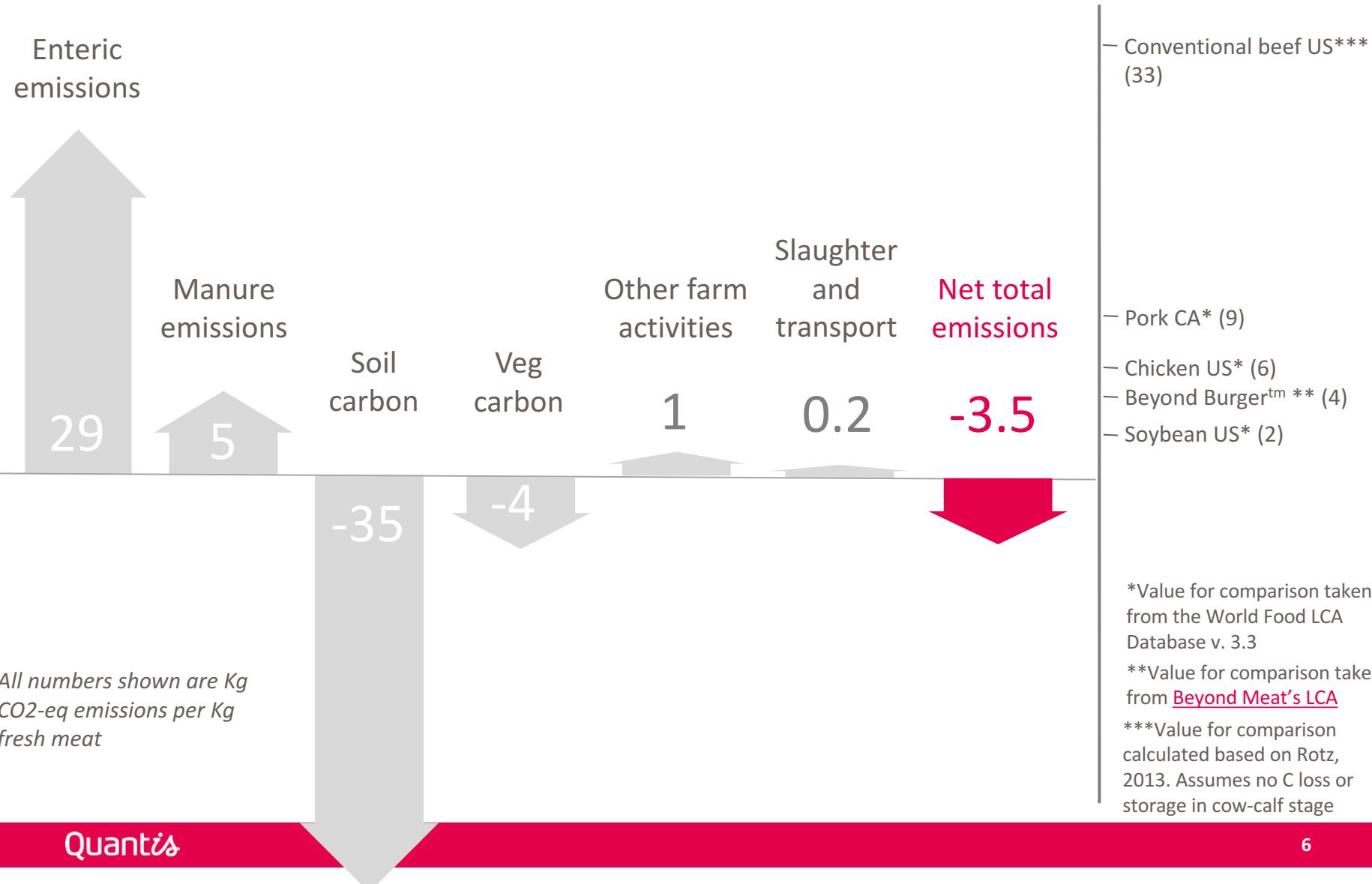
SO WHAT

- + Regeneratively grazed beef, can likely **escape the stigma** of extremely high carbon emissions attached to conventional beef.
- + Accounting for soil carbon capture is not yet standard practice and the results **may meet with challenges**, such as on ensuring long-term storage.
- + In the best case, the WOP beef production may have a **net positive effect** on climate. The results show great potential.

NOW WHAT

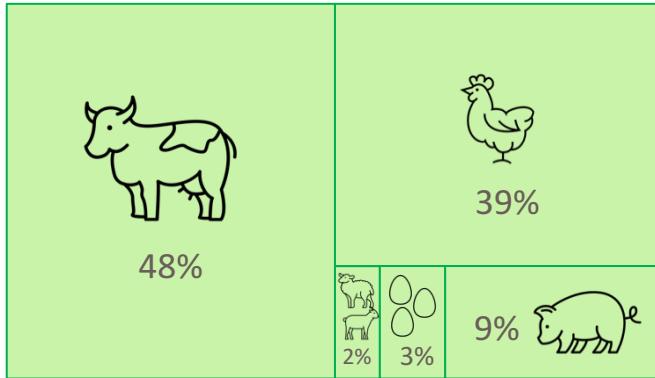
- + There is a great positive story to tell at WOP and on the potential for regenerative grazing as a carbon solution. General Mills, Epic and WOP should consider **how to tell this story** to ensure brand enhancement, minimizing brand risk and having a positive influence
- + Following this preliminary assessment, there are several potential paths for future exploration. There are **uncertainties to be addressed** regarding enteric emissions and long-term carbon storage. There are also **other areas of benefit** to consider such as land use, water use and water pollution.

Carbon footprint breakdown per kg of White Oak Pastures' beef



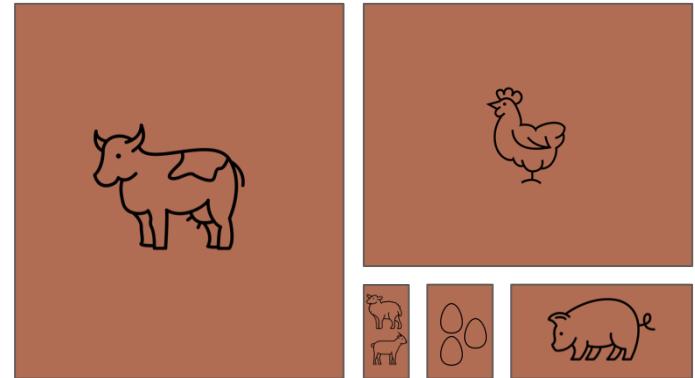
WOP's integrated system is **6 times more carbon efficient** than North American average production systems for the equivalent amount of carcass weight

WOP regenerative grazing



*Percentages based on carcass weight from WOP production

Conventional production model



*Carbon emissions per kg carcass weight based on Gerber et al 2013

706,000 kg

TOTAL CARCASS WEIGHT OUTPUT
Per year for all animals

706,000 kg

1.9 mil kg CO₂-eq

TOTAL EMISSIONS
To produce equivalent output

11.5 mil kg CO₂-eq

3 kg CO₂-eq/kg CW

AVERAGE EMISSIONS
Per carcass weight

16 kg CO₂-eq/kg CW

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Introduction



Project rationale

Livestock production is often implicated as the **largest contributor to environmental issues** related to the food system (especially climate change, water use, nutrient cycling, antibiotic resistance, land use, etc.).

The concept of regenerative grazing, which has been shown to significantly increase soil carbon content by drawing carbon from the atmosphere, is leading some people to question whether the carbon footprint of grass-grazed meat is as high as is often published or if alternative production systems could have a significantly more positive story. Some evidence has emerged that there is a potentially a net-positive impact to raising meat with regenerative practices.



What is Regenerative Grazing?

The concept of regenerative grazing (also known as holistic planned grazing or holistic management) is rooted in the “law of the second bite”. Conventional grazing systems typically lead to overgrazing, by allowing grazing animals to take a “second bite” of a plant before that plant has had time to recover from the first bite. This, combined with other factors, leads to degenerated land.

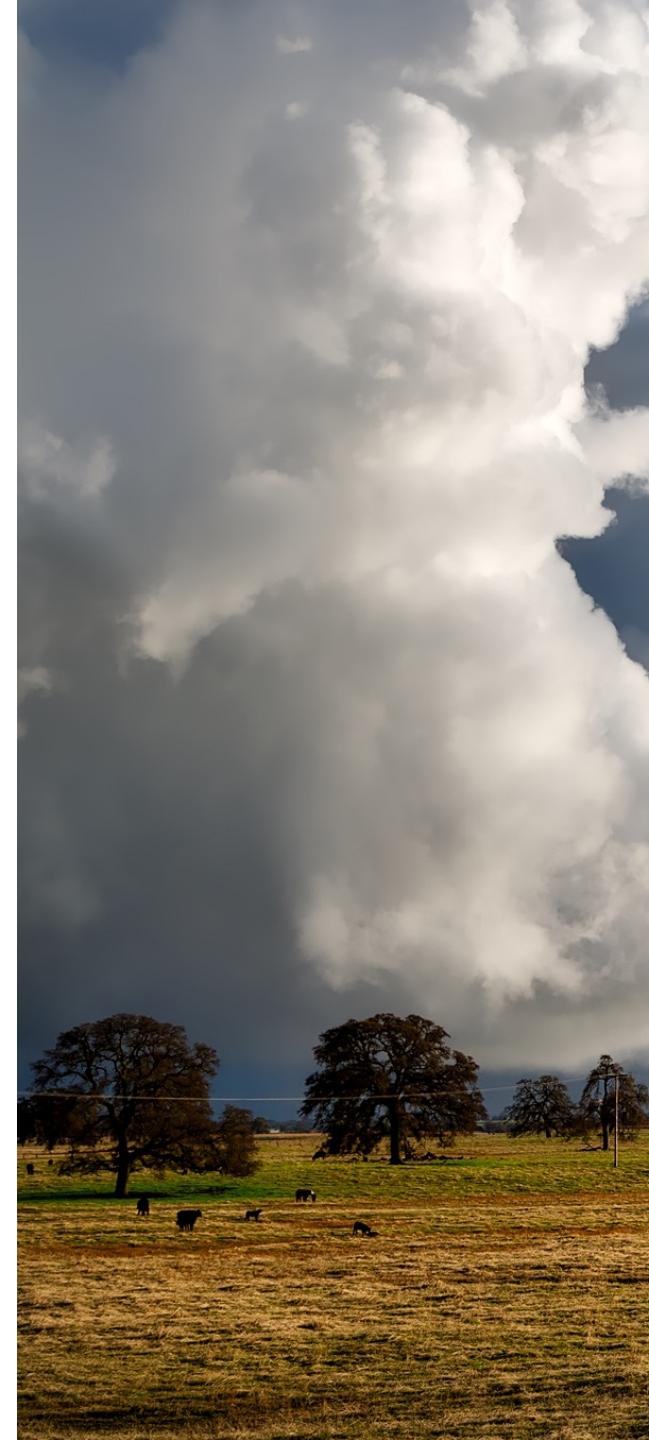
In carefully and well managed grazing, the land is allowed to rest for an optimal amount of time before the grazing animals are allowed to return to that spot. This allows the grasses to build up their root structure. The complex relationships and interactions between soil microbes, plant roots, and grazing animals allow for a net sequestration of carbon in the soil.



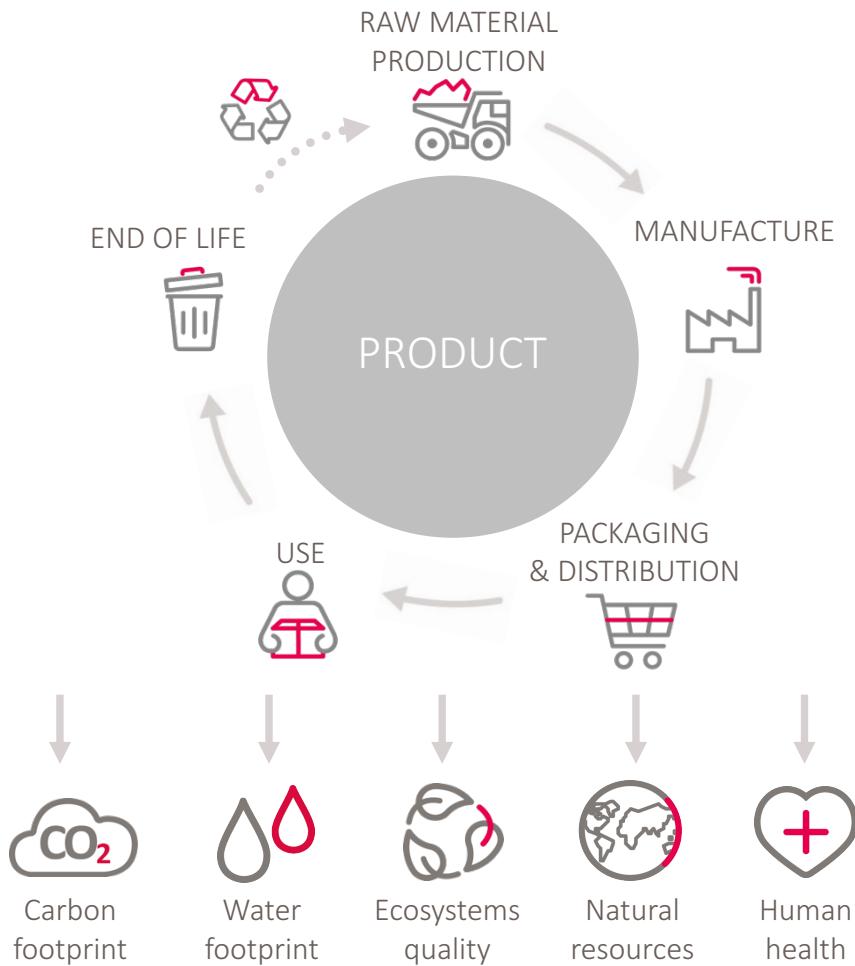
Intro to White Oak Pastures (WOP)

WOP is a 3000 acre family farm in Bluffton, Georgia. Originally a conventional beef farm, 20 years ago they began the shift to regenerative grazing practices after Will Harris, the owner, became disenchanted by the industrial tools of the existing system.

By converting annual cropland to perennial pasture, and a monoculture of cattle to a diverse range of animals, they are regenerating the health of the soil that has been heavily degraded from years of tillage, pesticide use, and mono-cropping. They now raise sheep, goats, hogs, poultry and rabbits in addition to cattle in an integrated farming system.



What is Life Cycle Assessment (LCA)?



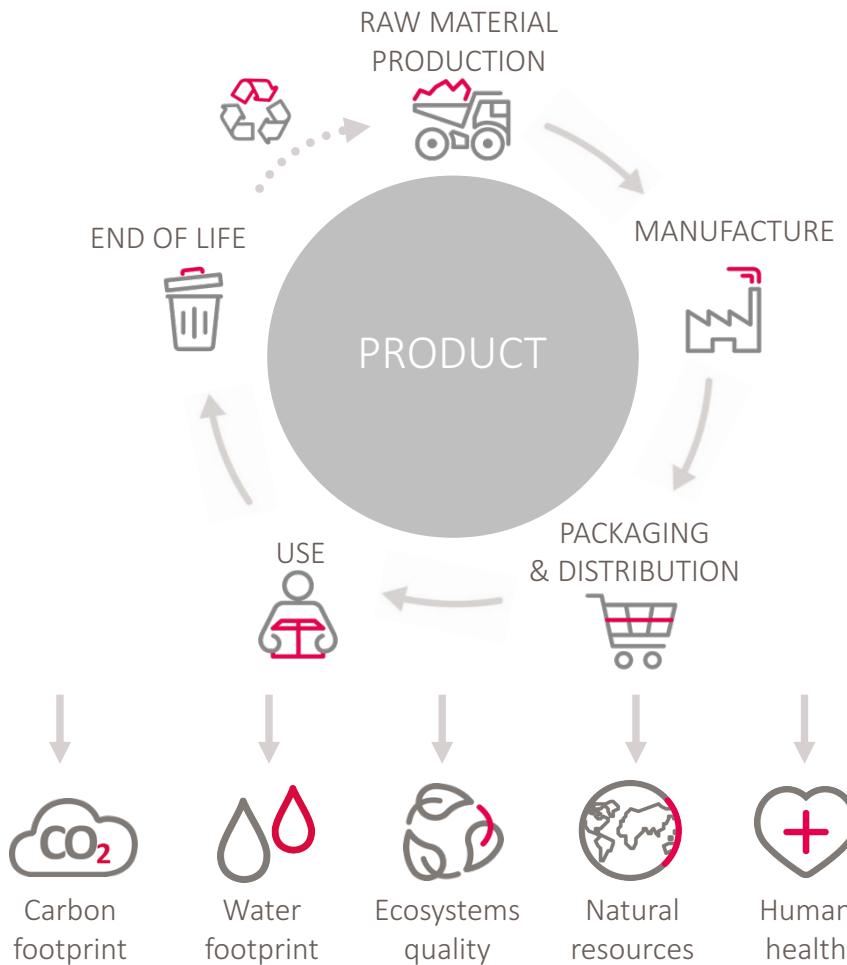
An LCA evaluates the total environmental impact of a product over its entire production (and/or consumption) chain, allowing for a comprehensive comparison of alternative ways of meeting human needs and economic functions.

LCA aims to avoid missing the important part of the environmental story by looking at all aspects of the system and by considering a wide range of environmental impact.

It's an ideal tool for directional comparisons and to support big-picture strategies and decision-making. It is not intended for site-specific environmental management or risk assessment.

LCA gives us a framework to think clearly about the sustainability of a given product or system. However, it alone cannot define benchmarks for what is sustainable or not. It usually omits societal impacts from consideration and may omit important environmental issues.

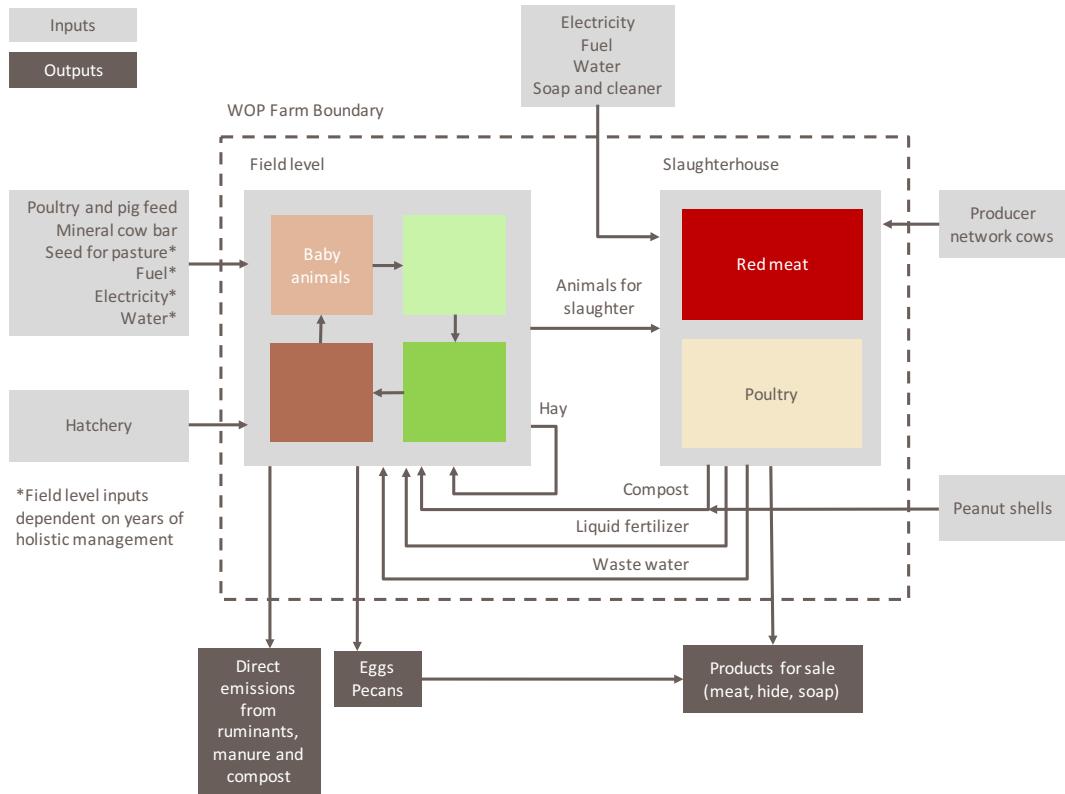
Here, we consider only carbon footprint of the production



In line with conventional beef LCAs, the scope of study is only up to the point of slaughter of the animal to produce beef. Downstream aspects of packaging, shipment, retail, storage, and cooking are not considered. However, it is expected that comparisons to conventional beef are valid within this scope.

There are several other potentially important stories to tell about regenerative agriculture systems such as at WOP. These include at a minimum, land availability, water use, nutrient run-off, pesticides, and long-term productivity. It is likely that all of these have further positive stories to tell.

Farm System Boundary



This study considered the full farm operations from field to slaughter for the year 2017

The following were ignored from the LCA boundary

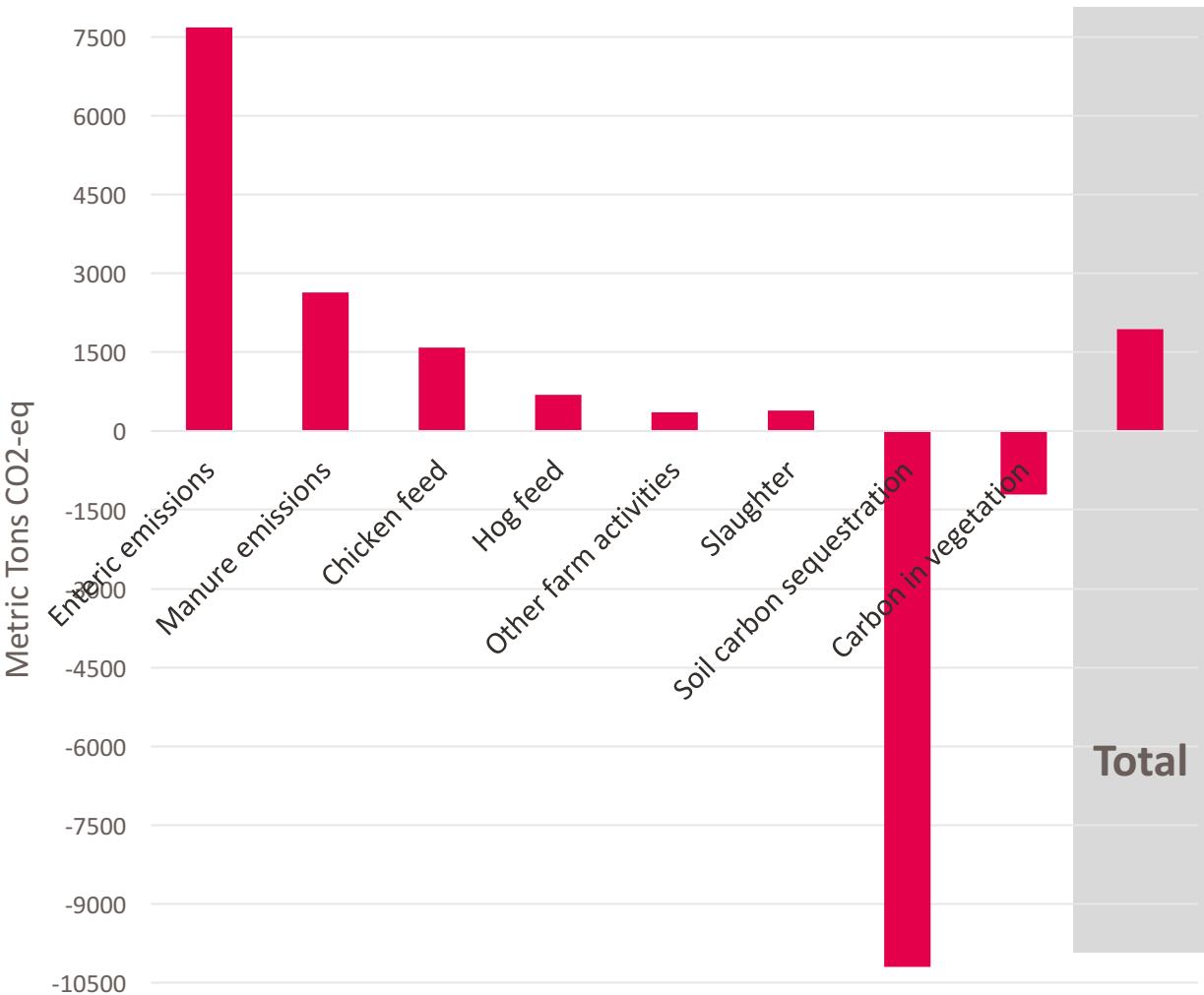
- Row crops/vegetable garden
- Restaurant
- Farm offices/cabins
- Packaging waste for farm level inputs

The background image shows a wide, flat landscape, likely a grassland or farmland, stretching towards a distant horizon. The sky above is filled with various types of clouds, from wispy cirrus to large, puffy cumulus. The lighting suggests either early morning or late afternoon, with strong highlights and shadows. In the far distance, a row of trees and some utility poles are visible.

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| Results

Full farm carbon footprint of WOP



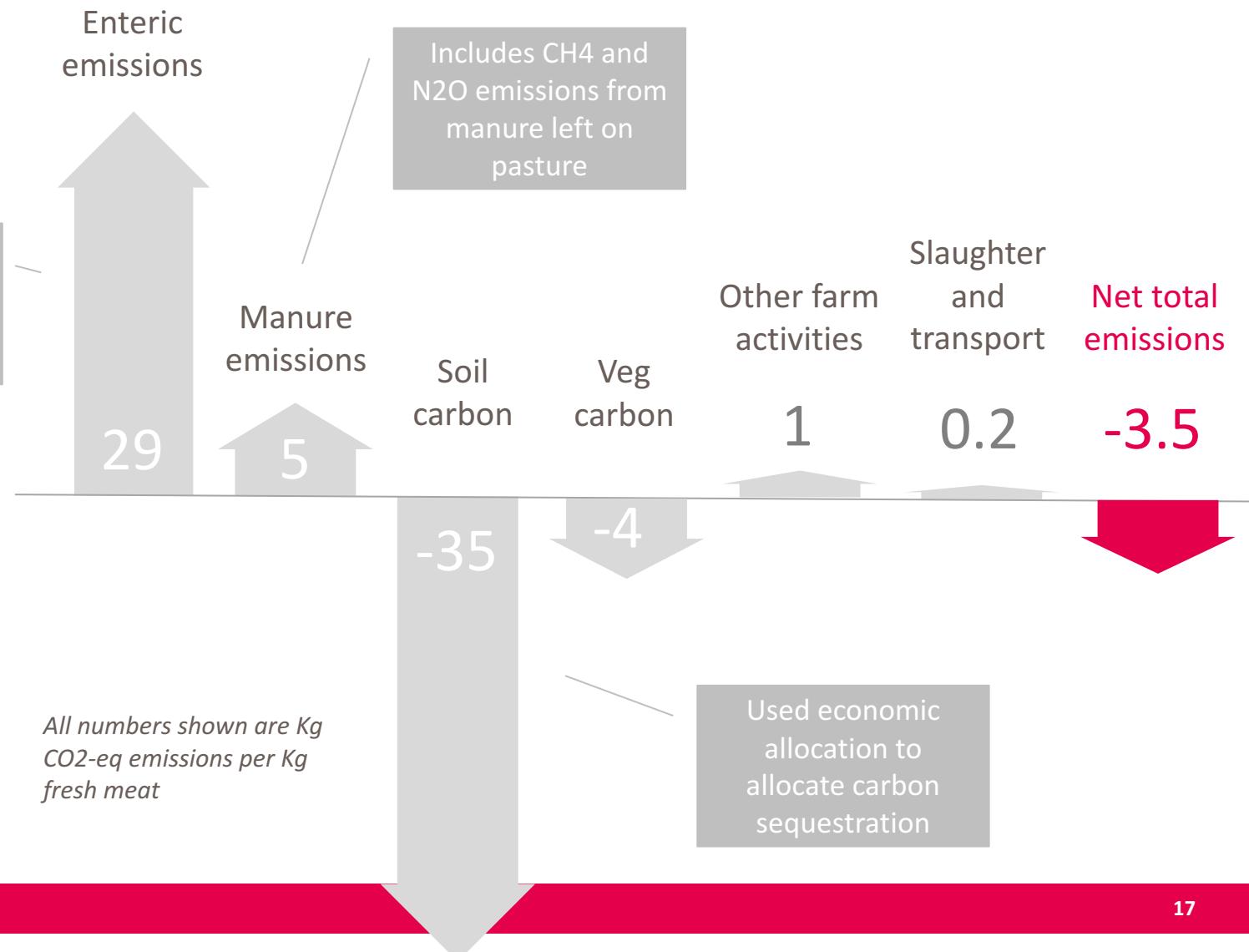
+Numbers shown here include emissions from all animals and all farm activities

+The WOP system effectively sequesters carbon, offsetting a majority (~85%) of the farm's total emissions

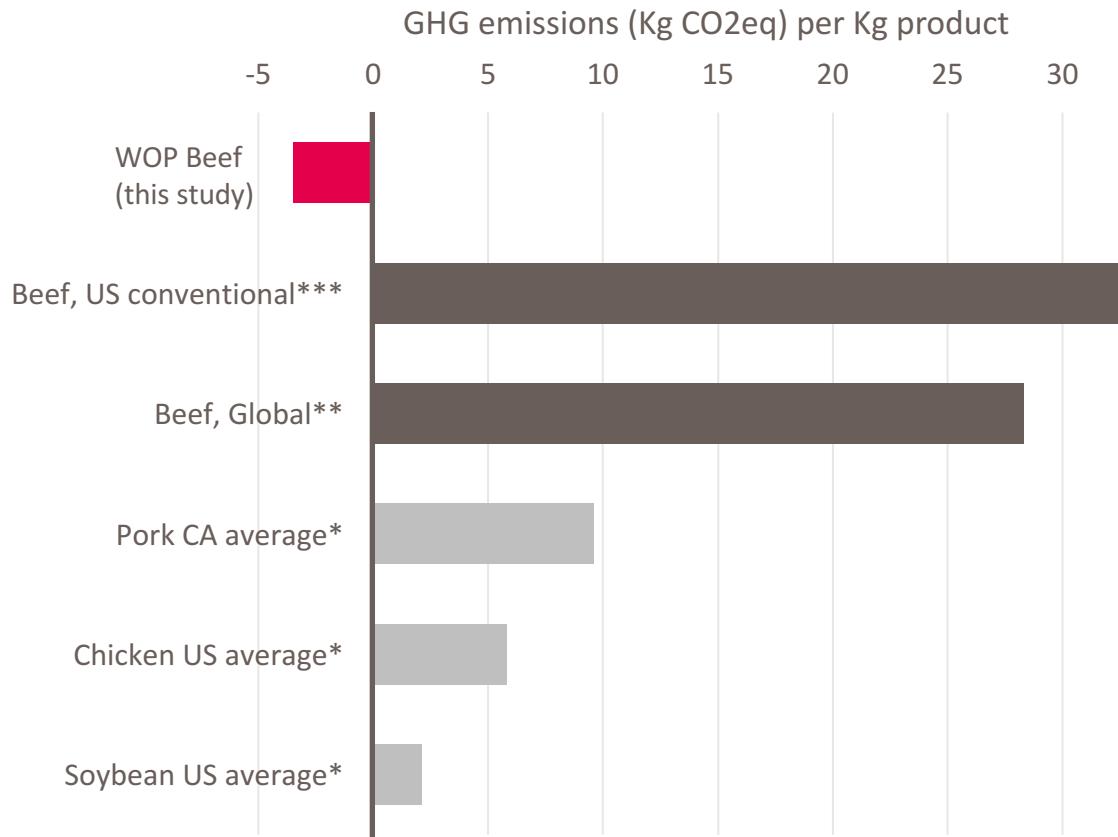
+For scale, the net total emissions of WOP in 2017 represents 0.01% of General Mill's F17 corporate footprint

Carbon footprint breakdown for WOP beef

Numbers shown here include only farm level activities and emissions that are directly related to beef production



How does our result compare?



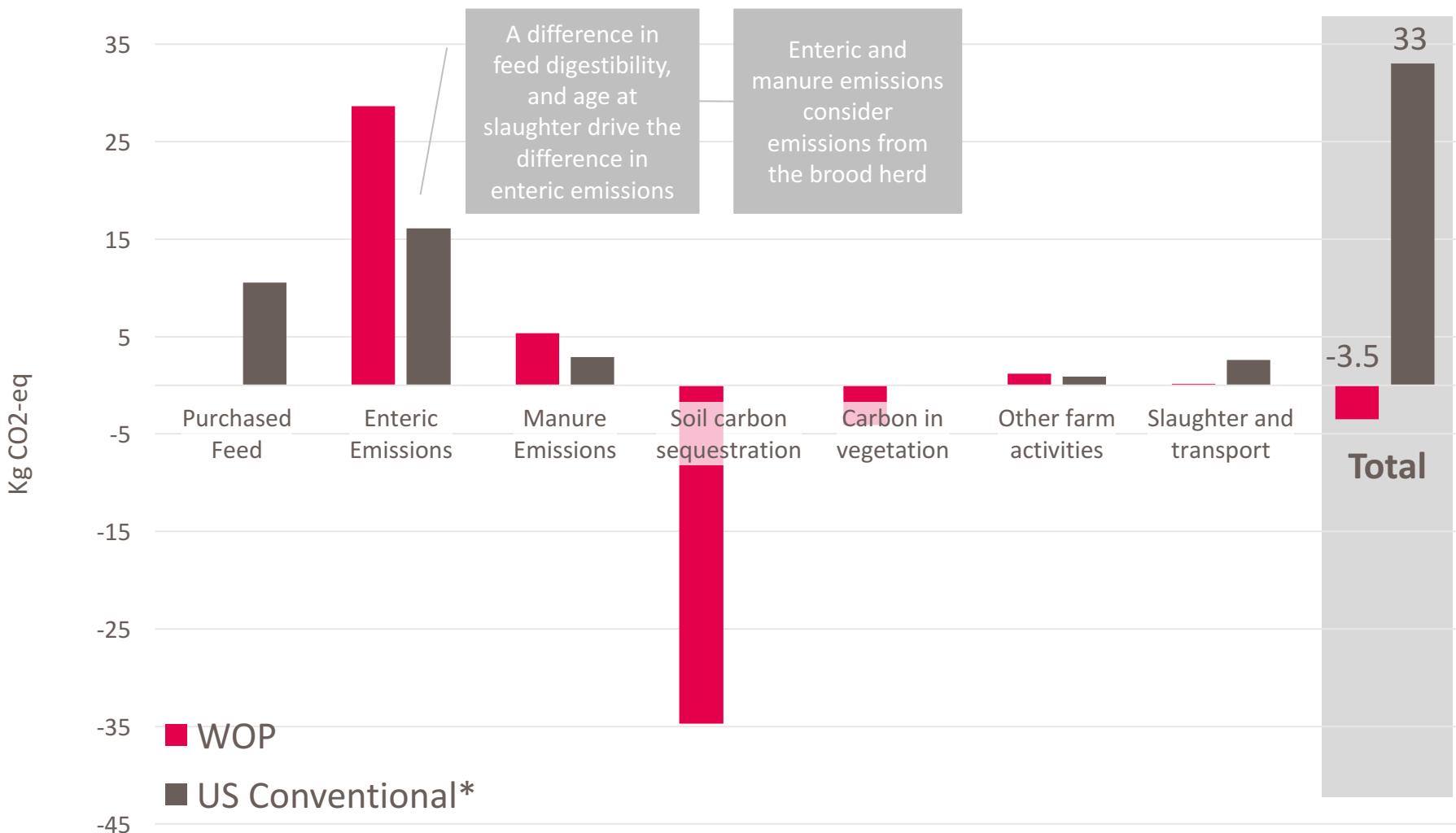
*Value taken from the World Food LCA Database v. 3.3

** Average of 20 published values summarized by Desjardins et al. 2012. "Carbon Footprint of Beef Cattle" in *Sustainability*, v4, p3279

***Value for comparison calculated based on Rotz, 2013

- + WOP's beef shows a much lower carbon footprint than conventional beef. It doesn't share the stigma of extremely high carbon emissions attached to conventional beef.
- + The most likely result is that WOP beef falls within, or even below the range of other protein sources.
- + At the best case scenario, rotationally grazed beef may be a very unusual case of having a net negative carbon impact from its production.

Comparison of WOP emissions to US conventional beef emissions per kg fresh meat

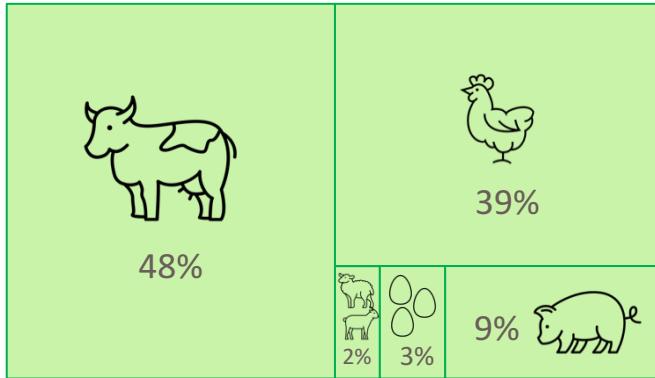


WOP and Rotz 2013 comparison

	WOP	Rotz 2013
Method	Grazing	Rotational grazing for cow-calf stage, Feedlot for finishing
Cattle age at slaughter	24 months	17 months
Average annual herd size	Breeding age females 1,200 Breeding bulls 60 Heifer/calves 200 Young steers 1,095 Slaughter age steers 500 Total 3,055	Breeding age females 5,498 Breeding Bulls 285 Replacements 1,180 Calves 5,050 Total 12,000
Average annual slaughtered heads	990	5050
Average weight at slaughter	520 kg	580 kg

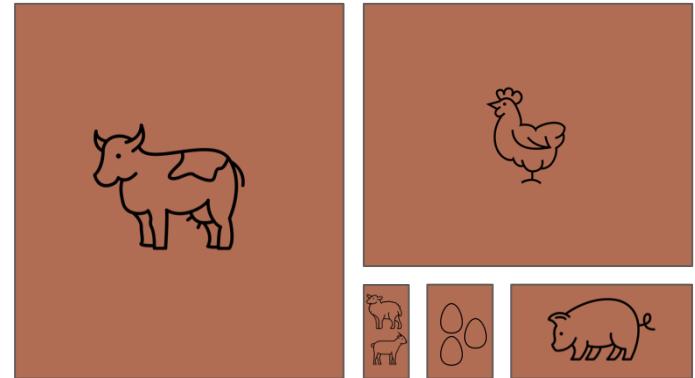
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- + Regeneratively grazed beef, can likely **escape the stigma** of extremely high carbon emissions attached to conventional beef.
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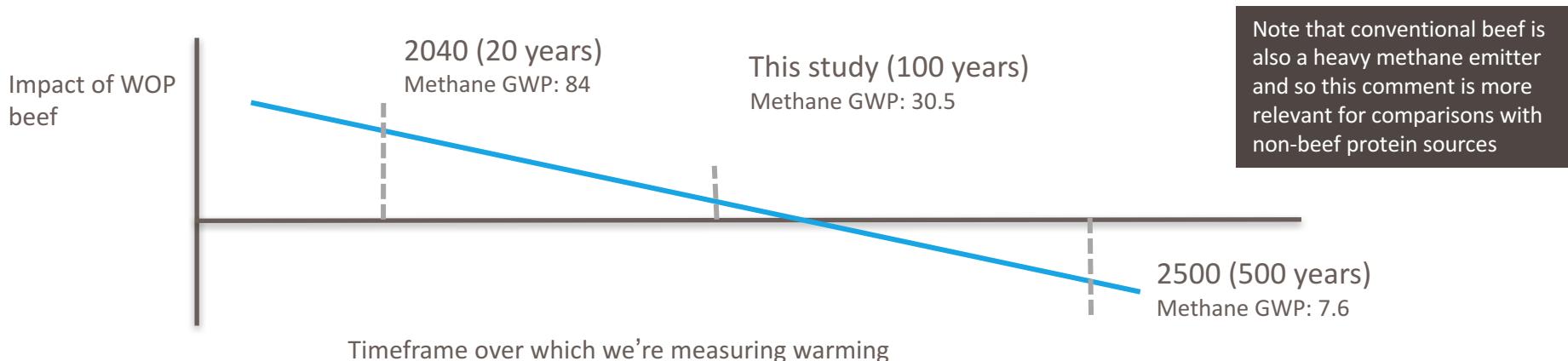
Why might the benefits be LESS than shown here?

The impact of methane may be underestimated if considering the critical 2050 period for achieving global targets.

We've used the IPCC's global warming potentials based on total warming within a 100-year timeframe (these are by far the most widely used GWPs).

Methane has a sharply higher warming potential for the first 10-20 years after it is emitted, after which it is removed from the atmosphere (12.4 year lifespan).

It is believed that the necessary period to reduce GHG emissions to avoid irreversible damage to many earth systems is in the coming 30-50 years.



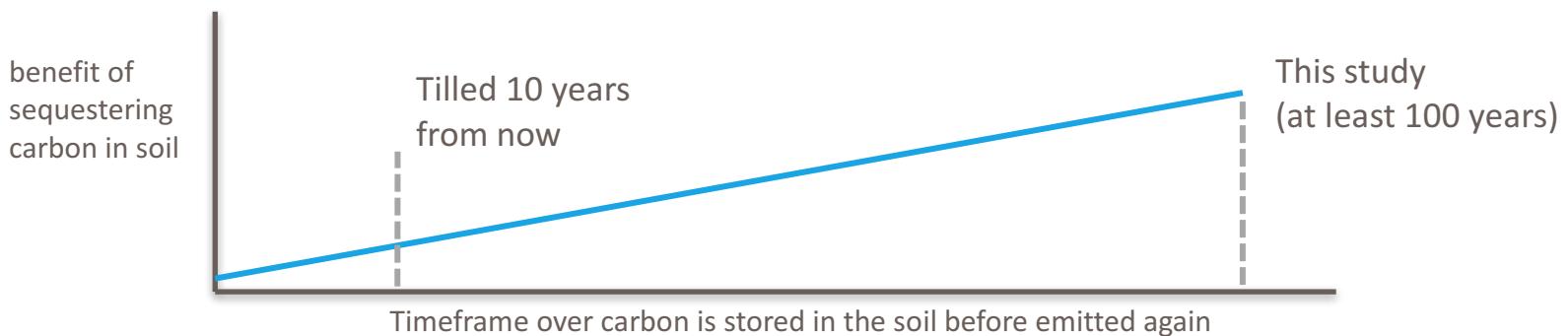
Why might the benefits be LESS than shown here?

The carbon sequestered could be re-emitted next year (or next decade)

When we emit carbon dioxide, we are sure that most of it will remain in the atmosphere for 100 years or longer.

However, when we take carbon from the atmosphere and store it in soil, we are less sure of how long it will be stored. Future management of the land will determine whether the carbon remains there and tilling the land for agriculture could re-release much of this carbon at any time.

It is therefore uncertain whether it is accurate to consider soil sequestration as the opposite of an emission.



Why might the benefits be LESS than shown here?

The rate of carbon sequestration may slow as the soil becomes “carbon saturated”

We are starting from a point of very low organic carbon content in the soil, so there is very large room for improvement.

However, over time, some of the carbon in the upper layer of soil will be buried more deeply in the soil, while the surface layer will become saturated with carbon and accumulate carbon at a slower rate.

While the change in soil carbon measured here are credible, this amount of change may slow considerably in the coming decade or two.

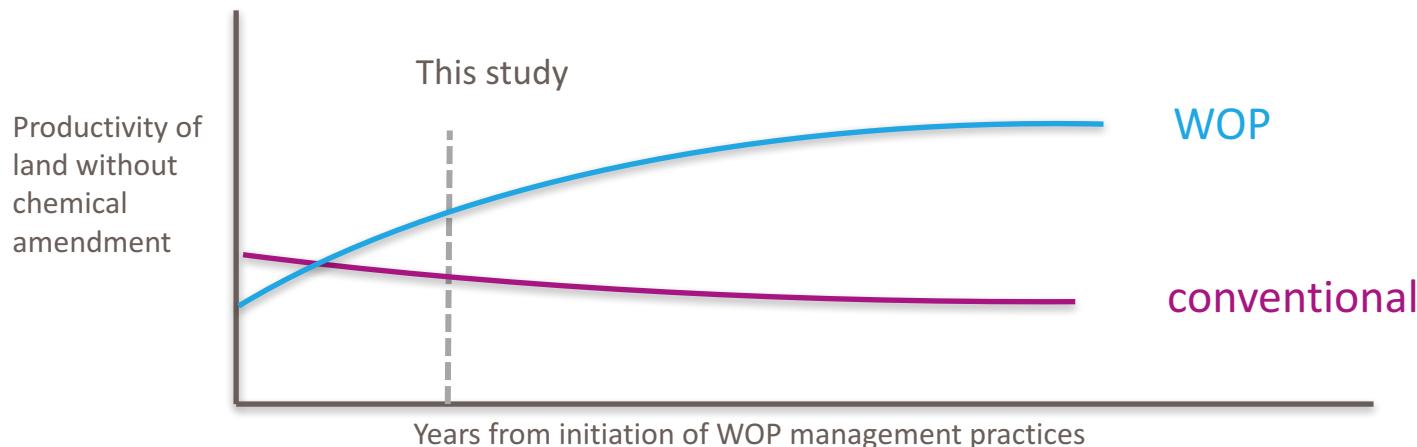


Why might the benefits be MORE than shown here?

We're not accounting for increased productivity of the land as soil carbon increases

The conventional beef model and the WOP model are both a snapshot of 1 year's production.

However, each year the WOP land becomes more fertile as soil carbon is restored and the land on which grain is grown for the conventional beef very likely has its fertility further depleted. Taking a longer term view (a few decades) would likely show that the efficiency of the WOP system continues to increase while the conventional system either decreases or requires increasing amounts of chemical treatment to sustain production.



Why might the benefits be MORE than shown here?

We could be over-estimating enteric methane emissions

There are relatively few direct measures of methane emissions rates from cattle while grazing in such systems. Some experts (e.g., J. Rowntree) believe that the IPCC references used here are likely to be an overestimate of the true enteric emissions.

We have erred on the conservative side for these results. If indeed overestimated, the results could show a more highly positive carbon emission benefit for WOP beef.

Why might the benefits be MORE than shown here?

We're only looking at the carbon emissions story

There are potentially many environmental benefits of the operation at WOP relative to conventional beef raising. These include:

- Reduced water use if avoiding the need to irrigate crop land
- Reduced nutrient runoff from fertilizer use on conventional crop land, or concentration of manure from confined feeding operations
- Reduced pesticide use on conventional crop land
- Increased natural habitat, depending on landscape of farm

There is a potential that the WOP production system could in net use a greater land area than the conventional feedlot production model, but initial estimates indicate that the total land area used per amount of beef may be similar between the two.

What can we say with confidence?

- The WOP beef is much, much better for net carbon emissions than conventional beef
- The WOP beef is potentially on-par or better than other non-beef protein sources with regard to its carbon footprint. It does not share the large negative carbon stigma of conventional beef
- Within our margin of error, there is a potential that the WOP beef production is *climate positive*. This would be very rare and it is unusual that there is more benefit to producing something than to simply not produce.
- There remain caveats about the certainty of these results, as explained in previous slides.

The story depends on the extent of the impact or benefit

If the carbon footprint of
the beef is (Kg CO₂-eq)... ...then...

2-10

WOP beef is substantially better than conventional beef and there could be a large carbon benefit should these production practices replace the conventional beef production system.

0-2

WOP beef is a favorable protein source compared to other meats and potentially to dairy and vegetable proteins.

<0

WOP beef is a rare climate-positive product and there could be a large net-positive carbon benefit should this production model replace degraded crop land.

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| Future steps



Next Steps

- This study was prepared by Quantis with input and assistance from Dr. Steven Rosenzweig, General Mills Soil Scientist, Dr. Jason Rountree, Associate Professor, Animal Science, Michigan State University and employees of White Oak Pastures in Bluffton, GA. Quantis to site LCA methodology here
- Major findings from this study were shared with Dr. Sasha Gennet and Dr. Clare Kazanski of The Nature Conservancy and Dr. Keith Paustian and Dr. Rich Conant of Colorado State University, who provided feedback on conclusions and statements.

Potential future steps to consider

- ISO compliant full LCA?
- Peer-review publication?

Any Questions?

Thank you